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STANDARD TOOLS FOR MEASURING POST IMPLEMENTATION TECH MOD  
COST SAVINGS

Information Spectrum, Inc.  
1745 S. Jefferson Davis Highway  
Arlington, Virginia 22202

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<p>The objective of this study was to develop methods/tools to measure and validate the post implementation cost savings from Technology Modernization (TECH MOD) projects. Although many contractors are involved with the TECH MOD program, only six have completed the analysis, design and implementation phases. Of these, four have measured actual savings, and the measurement methodology employed varied in each case. The advantages and disadvantages of each method are examined. A matrix was developed as an aid to the program office based on the four methods of cost savings measurement (study, formula, automated tracking, and cost management system restructure) and the factors that impact TECH MOD.</p>			
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## EXECUTIVE SUMMARY

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The Department of Defense is attempting to improve contractor productivity and reduce weapon system cost with three inter-related initiatives. These three initiatives are competition, improved quality, and modernization. Competition is being stimulated by such actions as the establishment of competitive advocates to oversee the contracting process, component break-out, dual sourcing and leader/follower. Quality is being addressed through warranties, guarantees and incentives. Modernization of the factory is being encouraged through programs such as Manufacturing Technology (Man Tech) and Technology Modernization (Tech Mod) known DoD wide as the Industrial Modernization Incentive Program (IMIP).

The objective of this study was to develop methods/tools to measure/validate the post implementation cost savings from Tech Mod projects. The effort was accomplished through interviews with contractors, program offices and plant representative offices that have implemented Tech Mods.

Although many contractors are involved with the Tech Mod program, only six have completed the analysis, design and implementation phases. Of these, four have measured actual savings. The measurement methodology employed varies in each case. Two contractors used a study approach which established specific guidelines for the measurement of cost savings. Another contractor developed a formula based on the Cost Performance Report (CPR) which provides unit cost savings. The final contractor measured direct labor hour savings through the use of an automated cost tracking system. The advantages and disadvantages of each method are provided. In addition, during the research, efforts to develop a restructured cost management system were noted. This system changes the traditional labor-based cost accounting system to a process method where contribution to product of all manufacturing elements provides an expanded direct cost base.

No single method was identified which should be used by participants to measure the post implementation cost savings from Tech Mod projects. The uniqueness of each company, the variability of accounting systems, the variations in the degree of automation, the number of manufacturing methods, the differences in management practices, and the complexities of weapon system development prevent the adoption of a standard method of measuring cost savings.

As an aid to the program office, a matrix was developed based on the four methods of measurement of cost savings (study, formula, automated tracking, cost management system restructure) and the factors that impact the Tech Mod.

The most important measurement of cost savings is the estimate of savings developed at the end of Phase II. This estimate is the key to project approval and the eventual implementation of the project. Return On Investment (ROI), cost savings sharing arrangements, budget adjustments, and manufacturing methods are based on this estimate. Therefore, this is the point where the cost savings should be validated through an independent assessment.

The study provided the following recommendations:

- o Provide the matrix to all program offices as an aid to Tech Mod contracting
- o Develop guidance for the program offices in the following areas:
  - Cost baseline "as is" and new method "to be" cost estimate methodology
  - Budget impact analysis - under and over estimation of savings
  - Incentive experience and opportunities
  - ROI criteria
- o Develop a Tech Mod/IMIP experience data base and provide program offices in all services; crossfeed through trend analysis and status reports.

## TABLE OF CONTENTS

<u>Section</u>		<u>Page</u>
	EXECUTIVE SUMMARY.....	i
I.	INTRODUCTION.....	1
	A. BACKGROUND.....	1
	B. DEPARTMENT OF DEFENSE INITIATIVES.....	2
	C. TECH MOD HISTORY.....	3
	D. THE TECH MOD PROCESS.....	4
	E. REQUIREMENT.....	5
II.	DATA COLLECTION AND ANALYSIS.....	6
	A. GENERAL APPROACH.....	6
	B. DATA LIMITATIONS.....	6
	C. METHODOLOGIES IDENTIFIED.....	7
	D. SUMMARY OF METHODOLOGIES.....	12
	E. OBSERVATIONS.....	12
III.	CONTRACTOR COST DATA.....	14
	A. MANAGEMENT CONTROL CRITERIA.....	14
	B. COST MANAGEMENT SYSTEM RESTRUCTURE.....	15
IV.	TECH MOD COST SAVINGS MEASUREMENT CRITERIA.....	19
	A. EVALUATION FACTORS.....	19
	B. USE OF THE MATRIX.....	21
V.	VALIDATION MEASUREMENT.....	26
	A. PROCESS BASED COST MANAGEMENT.....	26
	B. DECISION TO IMPLEMENT.....	26
	C. VALIDATION.....	27
	D. SAVINGS VALIDATION PLAN.....	27

VI.	IMPLEMENTATION.....	29
VII.	SUMMARY, CONCLUSIONS AND RECOMMENDATIONS.....	30
	A. SUMMARY.....	30
	B. CONCLUSIONS.....	31
	C. RECOMMENDATIONS.....	31
APPENDIX A - LETTER TRANSMITTING MEASUREMENT MATRIX.....		A-1
APPENDIX B - BACKGROUND DOCUMENTS.....		B-1

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1.	TECH MOD Measurement Matrix..... 22

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## I. INTRODUCTION

### A. BACKGROUND

Numerous articles have documented the decline in productivity of the defense industrial base. When comparing the annual rate of productivity improvement for the U.S. to other industrial nations, we are at an all time low. The average annual rate of capital investment as a percent of output, as published by the U.S. Department of Labor, shows Japan at 28% and the U.S. at 14.7%. Five countries lead the U.S. in this important area.<sup>(1)</sup>

Economists generally agree that technology and capital are major influences of productivity, and that productivity is directly proportional to the application of these two influences. However, infusion of technology and capital in the U.S. defense industrial base is inhibited by several facts of life. One important fact is that the current and future business base of every contractor dedicated solely to defense contracting is totally dependent upon the needs of DoD, the desires of Congress, and the ability to win competitive business. Business base planning is, therefore, not contractor controlled. This lack of control makes any major capital investment, intended to reduce labor and/or material costs, a high risk venture, which contractors are understandably reluctant to undertake, and for which banking institutions exact premium rates.

### B. DEPARTMENT OF DEFENSE INITIATIVES

The DoD is attempting to improve contractor productivity and reduce weapon system cost with three interrelated initiatives. These three initiatives are competition, improved quality, and incentives for modernization. Competition is being stimulated

lMittino, John A.; Reeves A. Douglas; Productivity Improvement in the Department of Defense Acquisition Environment, Program Manager, Nov-Dec 1984.

by such actions as the establishment of competition advocates to oversee the contracting process, component break-out, dual sourcing, and leader/follower. Quality is being addressed through warranties, guarantees and incentives. Modernization of the factory is being encouraged through programs such as Manufacturing Technology, and the Technology Modernization/Industrial Modernization Incentive Program. Each of these initiatives, when coupled with multi-year procurement and accelerated depreciation, provide industry with inducements to modernize.

Further elaboration of those programs designed to reduce cost and enhance the industrial base by integrating advanced technology into the production process is provided below:

1. The Manufacturing Technology (ManTech) Program which consists of all actions taken by the Air Force to develop and carry out new or significantly improved production systems, processes, techniques, or equipment for use in contractor facilities or ALCs in support of Air Force systems, subsystems or equipment (AFR 800-33, 22 APR 82). The purpose is to demonstrate the advantages of advanced manufacturing processes in a line defense contractor environment. Funds are made available through the ManTech program for new or improved manufacturing technology efforts which are beyond the normal risk of industry and directed toward production of current or anticipated defense requirements. The program is designed to bridge the gap between R&D innovations and full scale production applications by increasing the chances that new more efficient technologies will be utilized in the production of DoD systems.

2. The Technology Modernization (Tech Mod) Program, a joint venture between the government and industry to reduce weapon system, subsystem or equipment acquisition costs, is an effort to accelerate the implementation of modern equipment and management techniques in the industrial base (AFSCR 800-17, 1 Nov 83). Tech Mod is a contractual method developed to increase industrial productivity, efficiency and quality assurance and

reduce Air Force acquisition and support costs through the use of contractor capital investment incentives. Tech Mod is a separate agreement with a contractor which contractually couples potential government seed investment in technologies in combination with the contractors investment in productivity enhancing capital equipment (ASDR 800-4 12 Jul 83). Tech Mod differs from ManTech in that Tech Mod is oriented toward factory-wide improvement and involves established, state-of-the-art technology, while the ManTech program is designed to make initial manufacturing process and equipment improvements in the production environment. The government shares the cost risks associated with ManTech initiatives as well as the cost savings generated as a result of contractor investments in Tech Mod initiatives. Industrial Modernization Incentives Program (IMIP), evolved out of the successes the Air Force achieved in its Tech Mod program and strong tri-Service support for continued development of the concepts. The IMIP encompasses, expands, and provides a common framework for service programs (Draft DoD Guide 4 Oct 1984).

### C. TECH MOD HISTORY

The first Tech Mod planning started in late 1970 with the F-16 program and the need to improve the government-owned General Dynamics (GD) operated plant at Ft Worth, Texas. Little modernization had been accomplished since the late 1960s when the last F-111 was produced at the plant. Both the Air Force and GD agreed that some mechanism had to be found to share the risk of developing and implementing technologies that would improve production and reduce costs. In 1978 an F-16 Tech Mod program was initiated by the signing of an agreement which committed GD to over 100 million in investment funding and the Air Force to 25 million, for technology development. The signatories projected a savings of over 300 million.

On 2 Nov 1982, Frank C. Carlucci, Deputy Secretary of Defense, established the Industrial Modernization Incentives

Program and approved a test program to measure the effects of the proposed policy. The policy targets industry through contractual incentives to substantially increase capital investments, primarily with its own financing, in manufacturing technology for enhanced production efficiency and productivity.

From the first Tech Mod in 1978, through the adoption of the program by OSD (IMIP) in 1982, until today, the program has continued to grow. Today more than eighty contractors are involved in IMIP.

#### D. THE TECH MOD PROCESS

The Tech Mod program is structured in three phases. Phase I consists of a top down factory analysis which evaluates facility needs and identifies candidate technologies; in addition, high cost drivers are evaluated. Phase II includes design and prototype of various technologies in an effort to improve the manufacturing process. It is during this period that projects are continually evaluated based on go/no go criteria. Only those projects which continue to show potential for success are brought into Phase III. Phase III is the actual implementation of the Tech Mod and includes purchase and installation of capital equipment by the contractor. Government seed money may or may not be provided in Phase I or II; however, Phase III is always funded by the contractor.

This over-simplified view of the Tech Mod process merely illustrates the normal steps. Numerous other activities occur such as the business deal, memorandum of understanding, funding, incentives, proposal development and contracting methods. More important to this report, however, is the determination of savings. Throughout Phases I and II the development of estimated savings for each project is refined. The accuracy of the estimates improve, starting with rough order of magnitude estimates in Phase I, progressing to those that are as accurate as possible at the end of Phase II. This estimate of savings will

have a major impact on the decision to implement the project. The establishment of the baseline cost (the "as is" system) is critical to the measurement of savings. Without an accurate baseline the measurement of actual costs for the implemented project cannot provide true savings. It is important to remember that the estimated or actual savings calculations must utilize the same type of data for determining the "as is" cost and the "to be" cost - apples to apples.

#### E. REQUIREMENT

The cost savings to the DoD, which are attributable to the implementation of Tech Mod initiatives, must be identified in order to justify the commitment of the considerable public monies required. A requirement therefore exists to identify methods for quantifying these cost savings. The objective of this study, therefore, is to develop methods/tools to measure/validate the post implementation cost savings. This is the point at which the decision has been made, funds have been expended, and the new process is in operation. The measurement of actual savings will provide data which may be utilized to improve the process, validate the contractual shared savings agreement, and to inform management as to the degree of success of the project. Specific tasks documented herein include:

1. An analysis of the methods of post implementation cost savings measurement currently used by contractors. Included within this task was a search of current literature, as well as review and analysis of existing systems.

2. The development and validation of standard procedures for measuring post implementation Tech Mod savings.

3. The development of the necessary procedures appropriate for implementing the standard procedures developed in Task 2 above.

## II. DATA COLLECTION AND ANALYSES

### A. GENERAL APPROACH

ISI first undertook the augmentation of corporate bibliographical data on Tech Mod/IMIP by researching such organizations as the Defense Technical Information Center (DTIC), Defense Logistic Studies Information Exchange (DLSIE), and the library of the National Security Industrial Association (NSIA). During review of documents already held and those obtained, ISI was able to refine previously developed planning criteria for evaluating Tech Mod/IMIP measurement tools. The review also assisted in determining the appropriate categories of information to collect during the follow-on interviews with government offices and industry organizations active in the IMIP test. Results of the survey, combined with the documentary search, identified evaluation criteria currently in use.

### B. DATA LIMITATIONS

Although numerous defense contractors are participating in the Tech Mod program, the majority of those participating have yet to reach Phase III, during which capital investments are made. However, the research did identify six contractors who are in Phase III; subsequent research efforts are therefore concentrated on the Tech Mod management of these six contractors.

Of the six contractors identified as being in Phase III, four had measured the post implementation cost savings, three as a result of contractual requirements and one as a result of verbal agreements. Detailed discussions were held with the four contractors, the related program offices and plant representative offices. Confidentiality was requested; therefore individual contractors are unidentified in this report.

C. METHODOLOGIES IDENTIFIED

Each of the four methodologies are discussed individually in the following subsections. Following each discussion is an assessment of the advantages and disadvantages of the methodology.

1. Contractor A

"A" used data readily available from the monthly Cost Performance Report (CPR), and estimated Tech Mod cost savings per deliverable unit based upon the following relationship:

$$CS = \frac{(BAU \times PPC) - ABC}{(TCDQ) \times (PPC)}$$

Where:

CS = Cost Savings Per Deliverable unit

BAU = Business as Usual = Total Contract Budget at Completion (BAC) of the previous method

PPC = Physical Percent Complete =  $\frac{BCWP \text{ to date}}{\text{Budget at Completion}}$  - New Method

BCWP= Budgeted Cost of Work Performed

ABC = Actual Booked Cost = ACWP to date - New Method

ACWP= Actual Cost of Work Performed

TCDQ= Total Contract Deliverable Quantity

If the new process does not encompass the entire manufacturing process and overhead is applied at the cost account level, the cost account which covers the change can be substituted for BAC. This would focus on just the area being affected rather than the entire manufacturing process. In addition, the contractor has applied internal controls to measure performance of

major functional areas of responsibility at the work package level. As accomplishments are reported against the work package, cost and schedule variance is monitored to identify problems and develop solutions.

a. Advantages of the formula:

- o Does not require the development of a new system to track cost savings. Data is available from the CPR
- o Reinforces an existing system
- o Allows tracking of savings attainment on a monthly basis
- o Alerts management to possible problems
- o Provides cost savings by unit, which should relate to contract cost reductions.

b. Disadvantages of the formula:

- o The lowest level at which this formula can be used is the cost account. The change incurred by the new method may be occurring at or below the work package level. Changes other than the new process cannot be identified, therefore the actual savings may be under or overstated. For example, a poor material handling system can negate the savings of a new machining cell
- o Indirect costs continue to be allocated based on old methods which may no longer be valid
- o The contractor must be utilizing C/SCSC or a similar earned value accounting system.

c. Assessment of Contractor A's Method

Based on the advantages and disadvantages of the formula for measuring cost savings from Tech Mod projects, some rules appear appropriate. If the process being changed is established and has accurate cost data, then the prior BAC should be valid and the baseline correct. This then provides the foundation for the measurement. Likewise, if the product being produced is stable with minimum changes occurring, then the changes in the CPR data



may truly reflect the Tech Mod cost savings. Since Tech Mods are being developed by subcontractors which may or may not be required to have a validated C/SCSC management system, the universal application of the formula will be limited.

The contract on which the formula is being used is unique in that it provides a varying savings share based upon when the estimated savings are achieved, e.g., the 500th unit or the 200th unit. If the savings are attained by the X unit then a 15% ROI is provided; however, if the savings are achieved earlier a return on investment up to 30% can be achieved. Utilizing the formula allows monthly measurement of unit cost savings.

## 2. Contractor B

"B" conducted a detailed cost savings study for each Tech Mod effort. The contractor established a study completion date one year after implementation of the project on the shop floor. In addition, a principle investigator was assigned to the project to monitor and assist with the implementation and operation of this equipment. The principle investigator was responsible for completion of the study which was reviewed by the industrial engineering department to ensure the adequacy of the methodology and accuracy of results prior to submission to the Air Force.

## 3. Contractor C

"C" also utilized the individualized study approach to measure his actual cost savings. In this case cost data from previous bought parts and time and motion study data for built parts were merged to form the baseline (old method). With the Tech Mod equipment, all parts were made in-house, and time and motion studies developed cost for the new method. This industrial engineering study was individualized for this particular Tech Mod.

a. Advantages of the study approach:

- o Can be individualized for specific projects
- o Allows adequate time for break-in of the new process
- o Study can incorporate both direct and indirect cost savings
- o Does not require a change in methods for capturing cost
- o Provides adequate time for fine tuning of new standards.

b. Disadvantages of the study approach:

- o One-time review of savings does not provide management with trend data
- o May not provide adequate guidance on baseline development
- o Lacks consistency, as each principal investigator or study manager will complete study based on his own methodology.

c. Assessment of Contractor B&C's Methods

The use of a different specific study method for each Tech Mod without adequate guidelines can produce inconsistent results. This approach has merit where a Tech Mod is designed to reduce cost on a single program within a required number of units when future business is unknown.

This specific methodology was used on contracts with a single end-item, a known production quantity, which were not subject to change. Upon implementation of the Tech Mod, a sharing agreement was concluded based on a specified return on investment. The validated savings based upon the study determined the actual savings which were shared.

#### 4. Contractor D

"D" developed an automated cost tracking system designed to calculate the project savings at the part level. In the computation of manhour savings an old method average and a new method average are compared. The old method average (baseline) is the summation of all records with the same part number, quantity and hours that fit the old method range and dividing the quantity into the hours to get an old method average time per part. The new method average is the summation of all records with the same part number that fit into the new method range, quantity and hours, and dividing quantity into hours to get an average time per part. Savings per part is the difference between old method average and new method average. Savings per shipset is obtained by multiplying the savings per part by the shipset quantity. To find the total savings the number of aircraft per lot is required. This then, based on the schedule, provides the labor hour savings by lot and fiscal year. Application of labor rates to the hours provides a calculated savings.

- a. Advantages of development of a cost tracking and analysis method:
  - o Provides management with continuous cost savings status information allowing further improvement
  - o Produces cost relationships at the impacted level
  - o Can handle multiple Tech Mods and their impacts
  - o Provides appropriate time for validation.
- b. Disadvantages of development of a cost tracking and analysis system:
  - o Very expensive method for validating post implementation Tech Mod cost savings
  - o Does not capture indirect costs which may be greatly impacted by the change
  - o Requires part cost from previous method for development of the baseline.

### c. Assessment of Contractor D's Method

This method provides accurate direct labor hour data which, when compared to the baseline, will provide validation. For contractors who have multiple Tech Mods and numerous parts impacted, this may be the only method in which the results will be meaningful; however, it does fail to provide visibility into the indirect cost impact.

The contract upon which this method is being used is a long term weapon system contract which involves complex manufacturing and assembly processes. Numerous Tech Mods have been negotiated, making the problem of tracking individual project impacts extremely difficult. A percentage of the cost savings is provided through an incentive if the estimated savings are accomplished based on the negotiated ROI.

### D. SUMMARY OF METHODOLOGIES

Each of the above noted cost savings validation methods provides a means of measuring the impact of the Tech Mod on direct costs. Only the study can incorporate the impact upon indirect cost, since this can be included in the study ground rules. Criteria for the use of the study technique need to be developed to ensure consistency in cost determination.

### E. OBSERVATIONS

Two problems were noted when evaluating measurement methods at the part level. Frequently a new machine will replace several older machines within a task center, however a second Tech Mod project may include additional new machines in the same task center. The new machines may have the capability to run all parts interchangeably. Allocating savings to each project requires the development of a factor or multiple record keeping. Added to this problem is the problem of efficiency of the

new machine. The cost savings estimate was established based on the parts that were run across the replaced machines and planned to be run on the new machine. The efficiency of new machines will cause parts, which were not planned to be run on the new machine, to gravitate to it, and parts planned to be run on the new machine may be moved to other machines. This tends to destroy the baseline and the measurement of savings, however it is normally the most efficient method of manufacturing.

### III. CONTRACTOR COST DATA

#### A. MANAGEMENT CONTROL CRITERIA

The dissimilarities in defense contractor organizations, products, and management requirements preclude the use of common, highly structured management control systems. The DoD therefore requires defense contractors to comply with guidance, promulgated by DoDI 7000.2, which defines the criteria (C/SCSC) that management control systems must meet. The responsibility for developing and applying the specific procedures for complying with the criteria is vested in the individual contractors, subject to review and acceptance by DoD. This current diversity of management control systems, particularly cost management methods, prohibits the identification of a uniform approach capable of measuring the cost savings generated by specific Tech Mod initiatives.

Traditional cost accounting techniques in the defense industry are based upon the accounting theory that direct labor and material costs constitute the preponderance of procurement costs. This traditional approach was developed in a manufacturing environment when direct labor and material were the dominant portion of manufacturing cost and the direct laborer controlled the pace of the manufacturing process. Manufacturing cost data are therefore collected by work order for direct labor and material and all other costs are collected in the aggregate and allocated to production on a quantifiable basis - frequently direct labor.

Advanced manufacturing processes currently in use have made the traditional cost accounting techniques unresponsive to management requirements. These processes generate far different development and operating costs than the traditional production process. The amount of engineering, development, maintenance

and computer resources have increased. Many costs which historically have been considered fixed or indirect can now properly be evaluated and managed as direct. In addition to the three cost measurement techniques previously discussed, several aerospace contractors are pursuing a complete restructuring of their cost management systems. These efforts, although caused by the limitation of traditional cost accounting techniques, will substantially enhance the ability to estimate the cost savings of Tech Mod initiatives. The following discussion highlights some of the important details associated with restructuring cost management systems.

#### B. COST MANAGEMENT SYSTEM RESTRUCTURE

The determination to restructure the cost management system should be made relative to the intended use of the information within the management decision making process and the cost of modifying the system. A series of Tech Mod projects may create islands of technology with little integration of the flow of cost management information. Since the measurement of actual to planned cost is a means of management control, a complete revision of the cost management system may be appropriate. Ideally in an effective cost system, managers should be able to compare planned to actual costs in detail by department, employee, work station/cell and product. The goal of a cost tracking system is to measure the actual impact of an improvement project on the total manufacturing cost and operational performance. Specific reasons for restructuring cost management systems include:

- o Reduction in direct labor as the primary factor in production cost
- o Product cost data not readily available
- o Major overhead cost growths
- o Cost system focus at the organizational level rather than at the evolving process
- o Inability to relate engineering costs to product development and production

- o Inability to measure operational performance adequately
- o Failure by the existing system to identify points at which costs can be reduced
- o Lack of timely information
- o Development of multiple systems to monitor government contracts (Tech Mod and C/SCSC).

A combination of the above factors may indicate the need to evaluate the adoption of a new cost management system. This could be advantageous not just in monitoring the savings generated from Tech Mod projects but also in improving the control of cost throughout the manufacturing process.

The design of a restructured cost tracking system should satisfy the following requirements:

- o Measure performance of each manufacturing process, cell or function based on cost and schedule
- o Measure performance in relation to quality, cost, schedule and equipment utilization
- o Capture all cost elements
- o Provide better control over material and overhead
- o Support and identify cost reduction opportunities
- o Provide cost estimation/pricing information
- o Provide changes in production program scope and volume and identify their cost impact
- o Provide, as a by-product of the production process, cost management data at the work cell/center level by product
- o Provide cost and performance measures consistent with government and internal reporting requirements
- o Provide appropriate data for audit.



The restructure of the cost system is a major undertaking and must have top corporate support if it is to become a success. Implementation of this type of restructure can be expected to take up to two years, and possibly longer, from initial development to full implementation. Therefore, a series of events will be required to provide adequate justification. Although a single Tech Mod project seldom will provide adequate justification for a cost management system revision, the completion of Phase I, top down factory analysis, can provide the foundation for a cost management system restructure.

The Vought Aero Products Division of the LTV Aerospace and Defense Company, and Price Waterhouse have developed manufacturing cost models to evaluate all critical factors of production. These models are based upon the following general cost breakout:

Manufacturing cost = Direct Labor  
+ Direct Material  
+ Machinery and Equipment  
+ Operational Support  
+ Engineering  
+ Plant and Facilities  
+ Information Systems  
+ Inventory  
+ G & A Support  
+ Finance

The objective of the manufacturing cost model is to provide management with actual cost data by unit, thereby assisting in both the analysis of improvements and the management of the manufacturing function. More accurate cost information provides better cost/pricing data which improves overall contractor cost management.

The availability of data on the manufacturing process has increased, and collection hardware has now reached the point where data collection can be accomplished as a secondary task to a primary manufacturing task. No longer must data collection be

performed in place of production. Cost/benefit tracking should capture, to the extent possible, actual cost data for all functional areas. The overall goal is to attribute all costs directly to individual products, and where this is not possible, to allocate in a more sensible manner. For example, operational support may contain such functions as material planning, purchasing, receiving, production planning, and configuration management. The time spent by operational support personnel on specific projects should be logged against those projects. Revision of work orders can capture costs at machine/cell or work center levels and can be designed to capture operational support costs as well. Engineering costs can be attributed to projects by charging to a work order.

#### IV. TECH MOD COST SAVINGS MEASUREMENT CRITERIA

##### A. EVALUATION FACTORS

The variations between contractor data bases, automation, documentation, accounting systems and manufacturing methods, compounded by program variations such as complexity, type of contract, reason for Tech Mod, program length, and weapon system characteristics support the premise that no single post implementation cost saving validation system can be developed for all DoD contractors. However, several factors must be evaluated prior to determination of the post implementation cost savings measurement requirement and the method to be utilized. These factors are:

- o Tech Mod can be implemented for several reasons. Although the primary reason is usually reduction in DoD program costs, it may not be for a specific Tech Mod initiative. For example, if a process requires excessive lead time due to the limited number of subcontractors, a Tech Mod may be structured to increase an industry's capacity. Likewise, the need for quality improvement can be the driving force for a new manufacturing process. A formal system to measure cost savings may not be appropriate to the reduction in lead time or improvement in quality.
- o The nature of cost savings may differ depending upon the extent of the Tech Mod. If a single process is impacted, an elaborate cost tracking system may not be justified; however, if the entire manufacturing process is reorganized, capture of the total manufacturing cost impacts may be needed to fine tune the process and provide management with more finite cost control data.

- o Length of program remaining has a major impact upon the suitability of Tech Mod projects. If a limited number of weapon systems are to be produced and the time required for production is only a few years, the most important factor is early implementation of Tech Mod; or savings may not be generated for the sponsoring program. This situation would eliminate any cost measurement system which requires a long implementation period.
  
- o Tech Mods with contractors who manufacture multi-use components or subsystems provide cost savings to multiple programs. The requirement to validate the cost savings may be driven by the need to ensure that benefitting programs, although they may not be sponsors, contribute their share of the savings to the contractor.
  
- o Where large dollar savings (50 million and above) and major investments are involved, a requirement to measure the post implementation savings should be a normal management practice both from the control of the Tech Mod aspect and from the need for data for future negotiations. Likewise, if the project is of small dollar value and the price is reduced, a tracking system may not be needed.
  
- o The difficulty of measuring cost savings is magnified as the number of projects are increased. For example, if several projects impact the same process and are implemented at different times, establishment of the baseline or "as is" process becomes very difficult and the tracking of cost savings becomes equally difficult. The difference between the baseline (old process) and the new process is the cost reduction due to the new manufacturing environment; however, the baseline becomes a floating baseline if a new project impacts the same process.

- o The requirement for measurement of the cost savings becomes stronger when government funding has been provided to assist in the development of the Tech Mod. The expenditure of taxpayers money used to increase contractor productivity and reduce program cost, should be auditable.
  
- o The last variable is sharing of savings. If the contractor has reduced price and desires no shared savings, then the measurement of savings does not appear appropriate.

Figure 1 provides a matrix which lists the methods for measurement and the relevant factors. Generally, a combination of factors will be involved with each Tech Mod; therefore, the appropriate measurement methodology becomes a prioritization of factors.

#### B. USE OF THE MATRIX

The examples listed below of use of the matrix as an aid to determining the cost savings validation method/requirement, may oversimplify the Tech Mod process; however, its function is to illustrate the matrix.

- o Assumptions:
  - Business agreement complete
  - Phase I Top Down Factory Analysis complete
  - Phase II Design and Prototype complete
  - Limited automation
  - Contractor Capital Investment Plan reviewed
  - Follow on work unknown
  - Fixed price contract, no CPR reporting required
  - No Phase I or II government funding

TECH MOD MEASUREMENT MATRIX

MEASUREMENT METHODS	FACTORS									
	PURPOSE	IMPACT	SIZE	SAVINGS	TIME	BENEFIT	PHASE 1 & 2 FUNDING	DATA	TYPE OF CONTRACT	
	COST REDUCTION LEAD TIME REDUCTION QUALITY	SINGLE PROCESS MULTIPLE PROCESS ENTIRE MANUFACTURING SYSTEM	SINGLE TECH MOD MULTIPLE TECH MODS	10M- 10-50M 50M+	LESS THAN 1YR MORE THAN 1YR	SINGLE PROGRAM MULTIPLE PROGRAMS	GOVERNMENT CONTRACTOR SHARED	MANUAL LIMITED AUTOMATION AUTOMATED	FIXED PRICE SHARED SAVINGS COST	
NO VALIDATION				•	•		•		•	
CPR FORMULA	•		•						•	•
STUDY		•	•	•	•			•	•	
IMPROVED TRACKING	•	•	•	•	•	•		•	•	
NEW COST ACCOUNTING SYSTEM	•	•	•	•	•	•			•	•

A DOT WITHIN A BOX INDICATES THAT FACTOR IS SIGNIFICANT  
NO DOT WITHIN A BOX INDICATES ALL FACTORS OF EQUAL WEIGHT

- o Tech Mod Project: Flexible Machinery Center
  - Will allow contractor to centralize machining
  - Provide capability to manufacture parts previously bought
  - Reduce lead time
  - Reduce cost
  - Improve quality
  
- o Program Status:
  - Final lot of 50 weapon systems negotiated
  - Production to start on final lot in 6 months
  - Program to be complete in 28 months
  
- o Contractor Tech Mod Phase III Proposal:
  - Projected savings 30K per weapon system
  - Contractor ROI 25%
  - Final lot price reduced 1.5M
  - Project implementation within 6 months

The matrix should be utilized to analyze this proposal and to determine if a measurement of cost savings should be required.

<u>Factor</u>	<u>Validation</u>
Purpose	
Cost Reduction	Any Method
Quality	No Validation
Lead Time Reduction	No Validation
Impact	
Single Process - Machining	Study
Size	
Single Tech Mod	Study
Savings	
1.5M	Study

Time	Less Than 3 Yrs	Study
Benefits	Single Program	No Validation
Phase I & II Funding	Contractor	No Validation
Data	Limited Automation	Study
Type of Contract	Fixed price (Reduced Price)	No Validation
	Shared Savings	Any Method

o Analysis of the example identifies the following as the key factors:

- Fixed price contract with a reduction in price for Tech Mod
- Contractor funded all phases
- Final lot-less than 3 years remaining

o Based on the above factors no validation should be required.

Second example

o Assumptions:

- Major Program
- Phase I Top Down Factory Analysis complete
- Phase II Design and Prototype complete
- Contractor Capital Investment Plan reviewed

o Tech Mod Project: Mill Profile Tracer Controlled

- Reduced cost
- Increase productivity
- One of 40 projects with a projected savings of 400 million over life of program (all projects)

o Program Status:

- Initial low rate production
- 6 Years of production planned could extend to 12 years
- Cost plus fixed fee contract

o Contractor Tech Mod Phase III Proposal:

- Direct labor savings first year \$200,000
- Total savings planned program \$18M
- Target cost to be reduced by savings
- Contractor to earn 40% of savings which will provide a 23% return on investment
- Implementation period 1 year



<u>Factor</u>	<u>Validation</u>
Purpose Cost Reduction	Any Method
Impact Single process-machining	Study
Size Multiple Tech Mods	Automated Tracking
Savings \$18M Project (\$400M Total all Projects)	Automated Tracking New Cost Accounting
Time 6+ years	Automated Tracking New Cost Accounting System
Benefits Single Program	Any Method
Data Automated	Automated Tracking
Type of Contract Cost Plus Shared Savings	Any Method

o The key factors on this program are:

- Long Production Run
- Shared Savings
- Multiple Tech MODs
- Projected Saving of \$18M (Total all Projects \$400M)

Based on the key factors, an automated cost tracking system should be implemented, however a new cost accounting system which would be process-oriented would benefit the contractor and the government.

## V. VALIDATION MEASUREMENT

### A. PROCESS BASED COST MANAGEMENT

No single method has been identified to measure the post implementation cost savings from Tech Mod projects. This is resultant of many qualities, among them: the uniqueness of each company; the variability of data structure usage, and the multiplicity of accounting systems; the variations in the degree of automation; the number of manufacturing methods; the difference in management practices; and the complexities of weapon system development. These disparities prevent the adoption of a standard method of validating post implementation cost savings. Tech Mod initiatives vary from the change of a single operation (e.g., a new machine), to the change of an entire process which impacts the method of manufacturing, scheduling, expediting, shipping, inventory management and the roles of the employees involved (e.g., Circuit Board Kitting). A single Tech Mod cost validation method, applicable throughout the defense aerospace industry, would require industry-wide implementation of an automated accounting system based upon the manufacturing process. In addition, the realignment of all manufacturing cost elements would be required in order to capture their true contribution to the product. Under these conditions, a standard method of measurement would be close to reality; however, differences would persist due to dissimilarities in products.

### B. DECISION TO IMPLEMENT

Throughout Phase I (factory analysis), studies will be performed to determine potential savings from productivity enhancements. A Business Agreement is entered into between the contractor and the government prior to Phase II (developmental and validation) negotiations. The Business Agreement establishes the groundrules for the Tech Mod. Savings projections must be sufficiently definitized so that ROI expectations and incentive arrangements can be a part of the Business Arrangement.

As the Tech Mod progresses into Phase II the estimate on savings and the ROI will become firmer. The final estimate completed prior to Phase III (implementation) negotiations, will determine whether the project will be undertaken.

Throughout the process factors such as savings, ROI, budget adjustments, time to implement, post implementation measurement method, and the risk of not achieving the savings must be evaluated. The decision to implement, i.e., enter Phase III, will be based on the above factors.

#### C. VALIDATION

The NAVPRO, AFPRO or DCAS should be intimately involved with the Tech Mod and should perform the post implementation validation for the program office. In many cases, the computed savings will be shared between the contractor and the program office until the investment is recovered and a negotiated ROI achieved by the contractor. Because of this, the validation process may require the review of the data over an extended period. Typically Tech Mods require a "break-in" period of time in which the new process, machine, or method is brought on line. This learning process may encompass individuals, software adjustment, machine positioning, or a series of changes designed to fine tune the operation. It is after the process stabilizes that actual measurement of costs will provide an accurate validation of the savings. The validation of costs will provide data for future negotiations as well as confirmation that the savings estimated prior to implementation are being achieved.

#### D. SAVINGS VALIDATION PLAN

The pre-implementation negotiations should include the establishment of the requirement for a savings validation plan. This plan should identify the savings to be shared and the methodology developed to track the savings. It should also

include how the actual "as is" cost baseline will be established and how the actual "to be" costs will be measured. It should also provide when and by whom the measurements will be accomplished.

## VI. IMPLEMENTATION

The objective of the Tech Mod program is to create a win/win situation where both the government and contractor gain from the program. The government gains through reduced weapon system costs, improved quality, and increased industrial capacity, while the contractor gains through increased productivity, modernization and an enhanced competitiveness. Over structure or over regulation of the program can cause the program to lose its present attractiveness, therefore requirements levied on the program must be carefully weighed. The post implementation cost savings validation requirements must be weighed against the estimated cost savings expected.

The validation method matrix provided in Chapter V was designed to assist the program office manufacturing and contracting personnel in determining the appropriate type of post implementation validation for a specific Tech Mod. It is therefore recommended that this matrix be made available to all program offices as a tool to assist in Tech Mod cost savings measurement decisions. Appendix A provides a forwarding letter to each program office.

Presently there appears to be little crossfeed of information on current post implementation cost savings measurement methods being employed by the contractors in Phase III. A review of the various validation methods identified herein, and the factors to be considered when structuring the Phase III contract, should assist program offices in making their decision on the type of measurement of the actual cost savings that should be required or is possible.

## VII. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

### A. SUMMARY

The methods of measurement of post implementation cost savings presently being utilized by contractors were analyzed. In addition, the potential of other methods was evaluated. It was determined that, due to uniqueness of individual companies, no single validation methodology could be developed and applied to all Tech Mods. The variations between contractors in data bases, automation, accounting systems, manufacturing methods, documentation, and management principles when merged with the differences in programs such as complexity, type of contract, reason for Tech Mod, program length, size, and type of weapon system, supported the determination that no single methodology would be appropriate for measuring the post implementation cost savings.

A matrix of the factors to be evaluated and the methods of post implementation cost savings measurement were developed. This was designed to assist the program office in evaluating the need and method to be utilized in measuring the post implementation cost savings.

The decision of whether or not to approve a Tech Mod project, after completion of Phase I and Phase II by the contractor, is the most important decision in the entire Tech Mod process. It is at this point that the concentration of effort by the program office, AFPRO/NAVPRO and DCAS should occur. The availability of data to assist in making the decision is critical. It may be as long as two years from the time the decision to proceed is made (contract signed) until the results are measurable. This delay may be caused by capital equipment purchase lead time, installation time and break-in time.

The estimate of the cost savings utilized as justification for the project will be the principle deciding element. This estimate will assist in the determination of price reduction, share arrangement, and possible budget reduction. Therefore the estimate of savings should be validated by an independent assessment.

## B. CONCLUSIONS

The facility to measure the cost savings of Tech Mod programs is a requirement of both the DoD and the defense industry. However, the limited number of Tech Mod initiatives which have attained Phase III, coupled with the programmatic variables unique to individual programs, dictate against the identification of a generic measurement methodology appropriate for universal utility.

Although an argument can be made which supports a consistent cost management structure, which would facilitate the measurement of Tech Mod cost savings and be applicable across the defense industry, practical management and cost considerations mitigate against such an ambitious undertaking.

In view of the multitude of variables which pertain to the measurement of Tech Mod cost savings, the identification and dissemination of Tech Mod evaluation factors which permit the validation of savings is an important first step in supporting Program Managers' responsibilities in the Tech Mod area.

## C. RECOMMENDATIONS

The following recommendations, are provided:

- o Provide the matrix to the program offices to assist in the evaluation of Tech Mod/IMIP measurement requirement decisions
- o Develop guidance for the program offices in the following areas:

- Cost baseline "as is" and new method "to be" cost estimate methodology
  - Budget impact analysis - under and over estimation of saving
  - Incentive experience and opportunities
  - Return on investment criteria
- o Develop a Tech Mod/IMIP experience data base and provide program offices in all Services crossfeed data through trend analysis and status reports.



APPENDIX A

Reply to     To Be Determined  
Attn of:  
Subject:     Tech Mod/IMIP Post Implementation Cost Savings Measurement  
To:           All Program Offices

1. One of the major DoD objectives is to modernize defense factories and improve the industrial base. Weapon systems have increased in complexity, however, our manufacturing processes have not kept pace. As a result, many aerospace contractors are manufacturing new technology weapon systems with equipment purchased in the 50's and earlier. Tech Mod/IMIP is one of the tools being utilized to improve productivity, reduce weapon system cost and improve the industrial base.

2. There are now more than eighty contractors involved in the Tech Mod/IMIP program. Most are in Phase I or II and have yet to make the decision to implement the project. The decision to require the contractor to measure actual savings should not be made lightly.

3. The attached matrix provides the methods of post implementation cost savings validation available and the factors to be considered when determining the appropriate method. Each project has unique features which must be evaluated. NAVPRO or AFPRO and DCAS offices should be involved in the Tech Mod/IMIP project from the very beginning and should provide your validation.

TECH MOD MEASUREMENT MATRIX

MEASUREMENT METHODS	FACTORS								TYPE OF CONTRACT	
	PURPOSE	IMPACT	SIZE	SAVINGS	TIME	BENEFIT	PHASE 1 & 2 FUNDING	DATA	SHARED SAVINGS	COST
	COST REDUCTION LEAD TIME ADDITION QUALITY	SINGLE PROCESS MULTIPLE PROCESS ENTIRE MANUFACTURING SYSTEM	SINGLE TECH MOD MULTIPLE TECH MODS	1M- 10-50M 50M+	LESS THAN 1YRS MORE THAN 1YRS	SINGLE PROGRAM MULTIPLE PROGRAMS	GOVERNMENT CONTRACTOR SHARED	MANUAL LIMITED AUTOMATION AUTOMATED		FIXED PRICE
NO VALIDATION				•			•			•
CPR FORMULA	•		•						•	•
STUDY		•	•	•				•		
AUTOMATED TRACKING	•	•	•	•		•		•	•	
NEW COST ACCOUNTING SYSTEM	•	•	•	•		•		•	•	

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APPENDIX B

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