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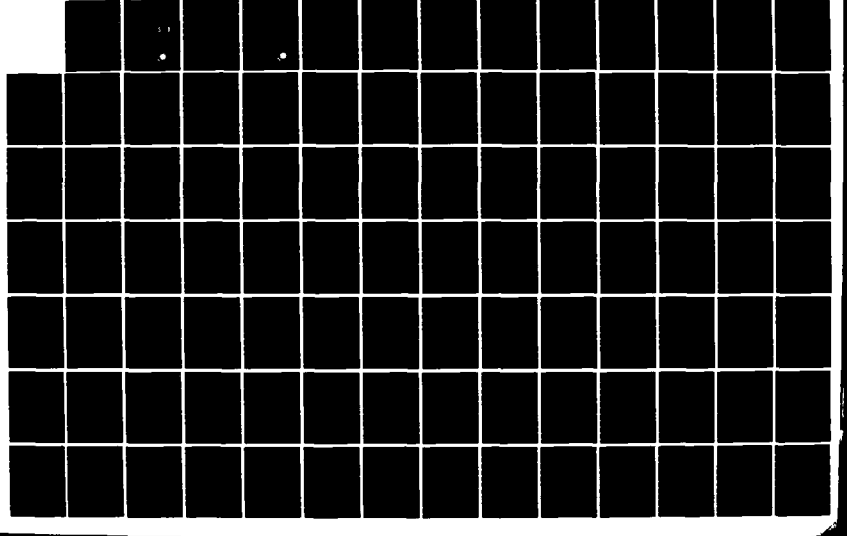

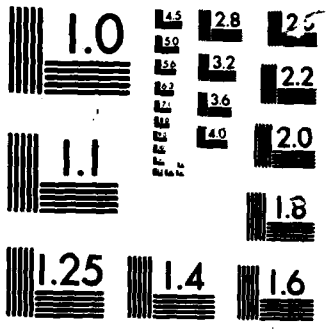
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COST SAVINGS ANALYSIS GUIDELINES FOR MANUFACTURING TECHNOLOGY PROJECTS

SYSCON Corporation
2828 Pennsylvania Ave, N.W.
Washington, D.C. 20007

28 June 1985

Final Report for 1985
Contract Number N00024-84-C-7078
Modification P00002, CLIN 0002AB

Prepared for
MANUFACTURING TECHNOLOGY OFFICE
Applied Technology Branch (AIR-5143)
Naval Air Systems Command
Washington, D.C. 20361

Manufacturing Technology Coordinator
NAVAL WEAPONS CENTER (Code 36404)
China Lake, CA 93555-6001

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

AD-A167788

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION: Unclassified	1b. RESTRICTIVE MARKINGS:
2a. SECURITY CLASSIFICATION AUTHORITY:	3. DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release; distribution is unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE:	
4. PERFORMING ORGANIZATION REPORT NUMBER(S):	5. MONITORING ORGANIZATION REPORT NUMBER(S):
6a. NAME OF PERFORMING ORGANIZATION: SYSCON Corporation; 6b. OFFICE SYMBOL (If applicable):	7a. NAME OF MONITORING ORGANIZATION: Naval Weapons Center (Code 36404)
6c. ADDRESS (City, State and ZIP Code): 1000 Thomas Jefferson Street, N.W. Washington, D.C. 20007	7b. ADDRESS (City, State and ZIP Code): China Lake, CA 93555-6001
8a. NAME OF FUNDING/SPONSORING ORGANIZATION: Applied Technology Branch; 8b. OFFICE SYMBOL (If applicable): AIR-5143	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER: N00024-84-C-7078 Modification P00002, CLIN 0002AB
8c. ADDRESS (City, State and ZIP Code): Naval Air Systems Command Washington, D.C. 20361	10. SOURCE OF FUNDING NOS: PROGRAM ELEMENT NO. 78011N; PROJECT NO. Z1050; TASK NO.; WORK UNIT NO.
11. TITLE (Include Security Classification): Cost Savings Analysis Guidelines (U)	
12. PERSONAL AUTHOR(S): Oberhettinger, David ; Mackintosh, Donald	
13a. TYPE OF REPORT: Final; 13b. TIME COVERED: FROM _____ TO _____; 14. DATE OF REPORT (Yr., Mo., Day): 28 June 85; 15. PAGE COUNT:	
16. SUPPLEMENTARY NOTATION:	
17. COSATI CODES: FIELD / GROUP / SUB. GR.	18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number): Cost Savings Analysis, Manufacturing Technology

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

A program was conducted to develop a cost/benefit analysis model for use in documenting the savings resulting from the performance of manufacturing technology projects sponsored by the Naval Air Systems Command.

The model which has been developed satisfies the following objectives: (a) sufficiently simple to use by personnel with no training in accounting or economics; (b) applicable to a wide range of manufacturing technology projects and the circumstances and environment in which their results are applied; and (c) uses data from existing accounting systems. The model consists of two methodologies. The first methodology, referred to as "Changed Price", is applied in those instances in which the price per unit charged to the Government is known for both the "before" and the "after" manufacturing process. The second methodology, referred to as "Changed Cost", is applied in those instances in which neither the "before" nor the "after" unit price can be readily identified, as in the case of producing a sheet metal skin for an aircraft access panel.

Step-by-step procedures and case studies are provided for both the "Changed Price" methodology and the "Changed Cost" methodology.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT: UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS ☐	21. ABSTRACT SECURITY CLASSIFICATION: Unclassifed
22a. NAME OF RESPONSIBLE INDIVIDUAL: Charles Newmyer	22b. TELEPHONE NUMBER (Include Area Code): (619) 939-1072; 22c. OFFICE SYMBOL: NAVWPNCEN (36404)

DD FORM 1473, 83 APR — EDITION OF 1 JAN 73 IS OBSOLETE.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

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FOREWORD

This document was prepared to assist Navy and contractor personnel in completing reports on cost savings obtained from the implementation of manufacturing technology (MT) projects funded by the Navy. Such reports are required by NAVMATINST 4800.36D, Manufacturing Technology Program. Guidelines are presented for the preparation of cost savings reports, which must be submitted annually beginning one year after project completion. The cost analysis procedures contained herein were developed to satisfy the following criteria:

- Must be sufficiently simple to permit use by personnel with no training in accounting or economics.
- Must be applicable to a wide range of MT projects and the circumstances and environment in which their results are applied.
- Must accurately assess cost savings using data from existing accounting systems maintained by government and industry.

Two separate cost savings analysis procedures are explained using an example of each. The "Changed Price" cost savings analysis procedure and format is designed for MT projects in which the unit price to the government is known for both the old and the new manufacturing process. The "Changed Cost" procedure and format is designed for MT projects in which neither the old nor the new unit price can be identified; consequently, changes in recurring and nonrecurring manufacturing costs, both positive (additional costs to the government) and negative (cost savings to the government) are used. This second format includes recurring costs such as direct labor, materials, and utilities, and nonrecurring costs such as equipment, buildings, and training. The use of one or the other of these procedures will satisfy any conceivable MT project cost analysis requirement.

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COST SAVINGS ANALYSIS GUIDELINES

1. INTRODUCTION

Cost savings reports on Navy-sponsored MT projects are required annually by NAVMATINST 4800.36D, Manufacturing Technology Program, for all completed MT projects, with the first report on a specific project due one year after completion of the project. Updates are to be prepared and submitted by 14 February of each year. The reports serve as a vehicle for documenting the success of the MT Program in achieving its primary objective: i.e., to reduce acquisition and life cycle costs of Navy weapon systems. A copy of the cost savings report format and NAVMATINST 4800.36D instructions are provided in Appendix A.

This document presents guidelines for contractors and Navy personnel to use in analyzing and reporting cost savings obtained from the implementation of manufacturing technology (MT) projects. The guidelines have been used to prepare cost savings reports for five Naval Air Systems Command (NAVAIR) funded MT projects which have been implemented by weapon system contractors and one report on a project implemented by a Naval Air Rework Facility (NAVAIREWORKFAC). The cost data used in the analyses were provided by the contractors and the NAVAIREWORKFAC personnel who completed the MT projects or implemented the results.

2. BACKGROUND

In general, MT project performing activities have failed to plan adequately for cost savings reporting. Because final payment on a contract is often made a full year or more prior to the date when the first cost savings report is due, contractors are drawn to new endeavors after a project is over,

and cost savings analysis takes low priority. Moreover, when a project is implemented, responsibility is generally transferred from engineering development personnel to production personnel who may be unfamiliar with MT Program requirements, may lack training in economic analysis, and may consider cost analysis outside their scope of activities. With poor planning, contractors may subsequently have difficulty in reclaiming accurate data on costs incurred under an old process or technology. This situation has been exacerbated by the fact that, until recently, MT project contracts contained no cost savings analysis or reporting requirements. In a 1979 review of the DoD MT Program, the General Accounting Office (GAO) emphasized that the military services should better track the implementation of MT project results and document program benefits.

Contractor participation in cost savings reporting is, of course, not only desirable but essential because Navy MT project managers do not have access to detailed manufacturing cost data. Additionally, the complexity of military weapon system production and cost accounting has largely stymied the use of a uniform cost reporting system. As modern naval weapon systems contain a large number of parts, all subject to periodic engineering change orders, savings in the production cost of a particular part are difficult to identify by examining changes in the procurement cost of the whole weapon system. An additional constraint has been the lack of common cost savings analysis procedures that can be applied to widely differing types of manufacturing technologies. To achieve timely and accurate reporting of cost savings, it is necessary to (1) clarify the type and format of data needed from contractors, and (2) institute procedures with which Navy MT Program managers can monitor contractor compliance.

3. COST SAVINGS ANALYSIS MODEL

A uniform framework has now been developed for analyzing and documenting the cost savings resulting from the implementation of MT projects. Only readily quantifiable manufacturing cost savings are measured, and the scope of the analysis is limited to actual or planned production. The model is flexible enough to accommodate differing manufacturing environments, yet it is comprehensive enough to permit tabulation of accurate, supportable cost information. It provides for two alternative cost analysis methodologies; the methodology appropriate to an MT project is selected based on the type of cost data available.

3.1 "Changed Price" methodology. Use of an abbreviated format for analysis of cost savings is feasible when an advanced manufacturing technology is applied to a discrete product made in quantity, such as an integrated circuit. Where the price per unit under both the old and new manufacturing method is known, it is unnecessary to detail costs and cost savings incurred by the manufacturer. All such costs and cost savings are assumed to be reflected in the new price charged the Navy.

When there is a known change in a unit price resulting directly from implementation of an MT project, an abbreviated format called Worksheet A is used. In such cases, all capital, operating, and implementation costs are reflected in the new price and, therefore, should not be subtracted from labor or other savings. Based on the accuracy of available out-year procurement and cost data, the analyst selects a time period (five years or longer) over which to identify cost savings and calculate the return on investment (ROI). In accordance with Navy instructions, this time period begins at the date of contract award for the MT project.

Step-by-step instructions follow for performing a "Changed Price" type analysis using the Worksheet A forms which were prepared for a sample MT project.

3.1.1 "Changed Price" sample project. NAVAIR manufacturing technology project A0650, "Gallium Arsenide Substrate Fabrication," was completed by M/A-COM Gallium Arsenide Products, Inc. (Burlington, MA), in March 1982. The new technology produces round, 3-inch diameter, gallium arsenide (GaAs) wafers by the liquid encapsulated Czochralski (LEC) process in quantities sufficient to meet the high demand for their use in advanced electronics. The small, irregularly shaped GaAs wafers produced by the old technology were expensive, of low purity, had low useable area, and could only be produced in small quantities. Following implementation of the new manufacturing technology, sales of processed GaAs wafers to military equipment manufacturers increased dramatically.

The cost savings resulting from this MT project can be calculated using the simplified "Changed Price" method of Worksheet A, because the price of the product using both the old and new technologies is known. Even though the wafers are sold to military equipment manufacturers rather than directly to the government and value is added before a final product is delivered to the Navy, the value added later does not negate the cost savings for the GaAs component of the weapon system. Since high quality GaAs wafers had not been readily available in significant quantities prior to implementation of the manufacturing technology, cost savings are based on the cost of making low quality wafers by the old method in the quantities now in demand.

3.1.1.1 Cost savings narrative. A narrative providing basic information on the MT project and its implementation is prepared as shown in Figure 1. In the narrative, a "Background" section (Item 1) summarizes the MT project objectives, and a "Cost Savings" section (Item 2) explains the source of the data used and justifies any important assumptions or caveats made by the analyst.

3.1.1.2 Table A-1. The table used to list annual cost savings is shown in Figure 2. The unit price charged to the government or to other military equipment suppliers during the project years in which the new technology is used are compared with the price charged under the old technology. Specifically, the unit price under the old manufacturing technology (Item 3), minus the unit price under the new manufacturing technology (Item 4), gives the cost savings per unit (Item 5).

[In this example, both material price savings per square inch and processing price savings per wafer resulted. These values, multiplied by the total raw material production and wafer production, respectively, for a given project year (Item 6), give the cost savings for that year (Item 7).]

The rationale for key entries should be explained in footnotes to the table, such as the footnotes for this sample project shown in Figure 3.

3.1.1.3 Data sources. The above data were obtained by contacting the MT project contractor. Since the project contractor is usually the first manufacturer to implement advanced manufacturing methods established by an MT project, it serves as a primary data source. Additional firms which have implemented the new methods may be identified through records of technology transfer activities, such as end-of-project demonstration rosters and final

A0650 (DNA 00650)

1

COST SAVINGS NARRATIVE

Background. Former techniques of producing gallium arsenide (GaAs) substrates resulted in materials that varied widely in crystalline quality and were contaminated frequently with many impurities. This MT effort was established to achieve a manufacturing capability which would yield large (greater than 2-inch diameter) round crystals of high purity semi-insulating GaAs through use of the liquid encapsulated Czochralski (LEC) crystal growth process.

The project was completed in March 1982 at a cost to NAVAIR, the only sponsor, of $528,000. The MT project contractor, M/A-COM Gallium Arsenide Products, Inc. (Burlington, MA), began implementation of the improved process prior to project completion. GaAs is in high demand for use in advanced electronic communication, countermeasure, and high speed computer devices; aerospace industry users include Raytheon, Motorola, Rockwell, Hughes, Honeywell, MSC, and United Technology.

Cost Savings. Cost savings to the government have resulted from the following:

2

Reduced Material Costs - Unprocessed GaAs wafers are now sold by M/A-COM for $21-28 per sq. in., depending on the size of the order - a price reduction of at least 60 percent.

Reduced Processing Costs - Processing costs at least $1,000 per wafer regardless of wafer size; hence, processing one 3-inch round wafer for $1,000, which replaces (equals the surface area of) five of the old 1.5-inch D-shaped wafers costing $5,000, results in an 80 percent processing cost savings.

Increased Device Yield - With "edge effect", a smaller fraction of the wafer is lost using large round wafers than with small D-shaped wafers when nominally equal total wafer areas are considered.

The Worksheet A format was used to calculate the annual cost savings because it is not necessary to factor in the capital investment in the crystal puller and other such implementation costs to the contractor. All such costs are reflected in the new wafer material and wafer processing prices.

The cost savings data in Table A-1 were obtained from Mr. John Vaughan, Business Center Manager, M/A-COM, Inc. M/A-COM, Inc. is the major U.S. supplier of GaAs. Although some is sold for commercial applications, most of their GaAs production is dedicated to DoD applications. According to Mr. Vaughan, at least one-third (33 percent) of total GaAs production goes to U.S. Navy applications, and this percentage is used for Table A-1. As noted in the footnotes to Table A-1, the estimates of wafer material cost savings per sq. in, wafer processing cost savings per wafer, and annual sales growth are also conservative.

Figure 1 - Cost Savings Narrative

A0650 (00650): 10-Year Cost Savings

WORKSHEET A - MT PROJECT IMPLEMENTATION COST SAVINGS

Table A-1 - Annual Cost Savings

Description of Item Affected by MT project: Manufacture of gallium arsenide (GaAs) wafers.

Project Year[1]	Unit Price Old MT	Unit Price New MT	Cost Savings Per Unit	No. Units (To Be) Procured	Annual Cost Savings
Sep 79* to Aug 80	$70/sq. in. (material cost) plus 5,000/equiv. wafer** (processing cost)	NA	0	0	0
Sep 80 to Aug 81	70/sq. in. plus 5,000/equiv. wafer	NA	0	0	0
Sep 81 to Aug 82	70/sq. in. plus 5,000/equiv. wafer	$30/sq. in.*** plus 1,000/wafer	$40/sq. in plus 4,000/wafer	6,000 sq. in.**** + 857 wafers	3,668,000
Sep 82 to Aug 83	70/sq. in. plus 5000/equiv. wafer	27.33/sq. in. plus 1,000/wafer	42.67/sq. in. plus 4,000/wafer	13,200 sq. in. + 1,886 wafers	8,107,244
Sep 83 to Aug 84	70/sq. in. plus 5,000/equiv. wafer	25.33/sq. in. plus 1,000/wafer	44.67/sq. in.plus 4,000/wafer	15,950 sq. in. + 2,279 wafers	9,828,487
Sep 84 to Aug 85	70/sq. in. plus 5,000/equiv. wafer	25/sq. in. plus 1,000/wafer	45/sq. in. plus 4,000/wafer	24,750 sq. in. + 3,536 wafers	15,257,750
Sep 85 to Aug 86	70/sq. in. plus 5,000/equiv. wafer	25/sq. in. plus 1,000/wafer	45/sq. in. plus 4,000/wafer	43,313 sq. in. + 6,188 wafers	26,701,085
Sep 86 to Aug 87	70/sq. in. plus 5,000/equiv. wafer	25/sq. in. plus 1,000/wafer	45/sq. in. plus 4,000/wafer	75,797 sq. in. + 10,828 wafers	46,722,865
Sep 87 to Aug 88	70/sq. in. plus 5,000/equiv. wafer	25/sq. in. plus 1,000/wafer	45/sq. in. plus 4,000/wafer	132,644 sq. in. +18,949 wafers	81,764,980
Sep 88 to Aug 89	70/sq. in. plus 5,000/equiv. wafer	25/sq. in. plus 1,000/wafer	45/sq. in. plus 4,000/wafer	232,128 sq. in. + 33,161 wafers	143,089,760

[1] The first project year is the 12-month period following the contract award for the MT project. This is because the Navy requires that the period used to calculate the ROI begin with the contract award date.

Figure 2 - Worksheet A

A0650 (00650): 10-Year Cost Savings

WORKSHEET A (CONT.)

* Contract award date.

** This MT project did not affect wafer processing costs. Processing costs typically remain in the range of $1,000-$10,000 per wafer, depending on the type of processing. The price, however, does not vary with wafer size; hence, processing one of the new 3-inch diameter wafers for $1,000 results in the same wafer area and yield as processing five of the old 1.5-inch D-shaped wafers for $5,000. A conservative estimate of processing cost savings (based on the most inexpensive processing) is, therefore, $4,000 per wafer.

*** Prior to Jan 82, GaAs substrate material was available in small quantities for $70 per square inch. By Jan 82, this price was reduced to $23 per square inch for bulk orders by large Navy contractors such as Raytheon and Honeywell. Given the mix of small and large orders, a conservative (high) estimate of the average selling price was $26 per square inch in Jan 83 and $25 per square inch beginning in Jan 84. The figures in this column are weighted accordingly for each project year. M/A-COM plans no further material price reductions because demand for GaAs wafers consistently exceeds their production capacity.

**** Production of significant quantities of GaAs wafers began, using the new technology, in Jan 82. Sales of 3-inch GaAs wafers during Jan 82 - Dec 82 were 30,000 square inches. NAVAIR applications are estimated at 30 percent of output. Sales increased approximately fifty percent during CY83 and another fifty percent during CY84. Sales are projected to increase throughout the period Jan 85 - Dec 89 at a rate of fifty percent per year, based on market studies conducted by M/A-COM. Thus, fifty percent annual growth is a conservative rate that does not include potential digital applications nor the formation of new companies to make GaAs products.

Figure 3 - Footnotes to Worksheet A

report accessions, or by contacting Navy field office experts in the technology field. In the case of this sample project, however, only the original MT project contractor has implemented the new methods.

Recent MT contracts contain specific requirements for MT project contractors to furnish cost saving data. For older MT projects and for Navy weapon system manufacturers who were not involved in the original MT project, it is necessary for the Navy to secure voluntary cooperation. For these older projects, data from manufacturers' existing accounting systems have proven adequate when knowledgeable company officials have assisted in identifying data characteristics and limitations.

3.1.1.4 Form 2. When Table A-1 is complete for the project years under study, both gross and net total cost savings may be calculated using Form 2 (Figure 4). Form 2 has three basic parts.

In the third paragraph marked "NAVAIR Investment," each year of incremental Navy MT project funding is listed by fiscal year and amount. Each year's funding is then discounted to determine its present value. This present value calculation reflects the economic principle that a dollar received today is worth more than a dollar received ten years from today. This is not due to inflation, but rather because the dollar, if received today, can be invested by the recipient to be worth more at the end of ten years. To determine the discount factor (Item 8), subtract the current fiscal year in which the analysis is prepared (Item 9) from the fiscal year the project was funded (Item 10). If the difference is a positive value, enter the corresponding value identified in the third footnote (Item 11). If the difference is a negative value, enter the reciprocal of the corresponding value (1/value) in the footnote.

NAVAIR MANUFACTURING TECHNOLOGY PROJECT COST SAVINGS ANALYSIS

FORM 2 - PROJECT COST SAVINGS (10-Year Cost Savings)

1. Project Title: Gallium Arsenide Substrate Fabrication

2. Project Number: A0650 (DNA 00650)

3. NAVAIR Investment:

a. Current Fiscal Year	b. Fiscal Years Funded	c. NAVAIR Funding By FY	d. Discount Factor	e. Present Value of Funding
1985	1979	528,000	1.689	891,792
(9)	(10)	(24)	(8)	
Present Value of Total NAVAIR Investment				891,792 (12)

4. Summary of Implementation & Operating Costs and Cost Savings[1] (from Worksheet A or B):

a. Project Year[2]	b. Recurring Costs/ Savings (13)	c. Discount Factor[3] (14)	d. Present Value of Recurring Costs/ Savings (15)	e. Present Value of Nonrecurring Costs/ Savings (16)	f. Present Value of Annual Costs/Savings (17)
1980	0	0	0	0	0
1981	0	0	0	0	0
1982	(3,668,000)	1.269	(4,654,692)	0	(4,654,692)
1983	(8,107,244)	1.153	(9,347,652)	0	(9,347,652)
1984	(9,828,487)	1.048	(10,300,254)	0	(10,300,254)
1985	(15,257,750)	1.000	(15,257,750)	0	(15,257,750)
1986	(26,701,085)	0.954	(25,472,835)	0	(25,472,835)
1987	(46,722,865)	0.867	(40,508,724)	0	(40,508,724)
1988	(81,764,980)	0.788	(64,430,804)	0	(64,430,804)
1989	(143,089,760)	0.717	(102,595,358)	0	(102,595,358)
(19) Present Value of Gross Total Costs/Cost Savings					(272,568,069) (18)

5. Net Total Cost Savings[4] (4f - 3e): Ten-year = $271,676,277

[1]Indicate cost savings (negative costs) on this table by enclosing in parentheses.
[2]Include years used to calculate ROI starting from the date of contract award.
[3]

If 4a-3a =	4c =	If 4a-3a =	4c =
1	0.954	6	0.592
2	0.867	7	0.538
3	0.788	8	0.489
4	0.717	9	0.445
5	0.652	10	0.405

(11)

[4]If costs exceed cost savings, this difference will be a negative value.

Figure 4 - Form 2-Project Cost Savings

[In the example, 1979 minus 1985 equals -6, and the reciprocal of the corresponding value 0.592 is 1.689.]

Any Army or Air Force funding for the MT project may also be entered in this section and enclosed in brackets; but non-Navy funds should not be included in the total (Item 12), as the total will be used later in these calculations to determine the return on the Navy's investment.

A second section of Form 2, marked Paragraph 4, is used to summarize the cost savings data developed in Table A-1 (or in the Tables B-1 through B-5 if the "Changed Cost" format is selected). The annual cost savings (Item 7) should be listed in this summary table as recurring savings (Item 13) and multiplied by the appropriate discount factor (Item 14) to derive their present value (Item 15).

[For this MT project, discounting is facilitated by the close correspondence between the beginning of the project year and the federal fiscal year. In accordance with the "Changed Price" format, no nonrecurring costs are considered, since the new price charged for GaAs material by M/A-COM, Inc. is assumed to reflect any implementation costs incurred by the company in switching to the new manufacturing technology. Since no nonrecurring costs or savings are relevant to the "Changed Price" format, zeros appear under Item 16, and the values in Item 15 are duplicated in Item 17 and totaled as Item 18.]

Throughout this table, all cost savings (negative costs) should be enclosed in parentheses to distinguish them from additional incurred costs.

The third section of Form 2, marked Paragraph 5, is used to derive the "bottom line" for the MT project. The gross total cost savings (Item 18) minus the total Navy investment (Item 12) equals the net total cost savings the Navy realizes from the MT project (Item 19) over the time period selected for the analysis.

3.1.1.5 Form 1. Essential findings from the cost savings analysis are listed on Form 1: Project Summary, shown in Figure 5. Most entries on this form are self-explanatory, with the exception of Items 20 to 23. Item 20 is the payback period - the time period, beginning with the date of MT contract award, needed for the discounted cost savings to equal the discounted Navy investment. To calculate the payback period, start with the first year's savings (at the top Item 17) and add the number of years' savings, and fraction of a final year's savings, to exactly equal the value in Item 12.

[In the example, the payback period is 2.19 years, because the Navy investment of $892,000 (Item 12) is equivalent to the first 2 years of Item 17 (zero) plus 19 percent of the third year ($4,655,000 x .19).]

The ROI (Item 21), together with the payback period, are important measures of MT program performance. Calculation of the ROI differs from the payback period calculation in that undiscounted figures are used. The formula is:

$$\text{ROI} = \frac{\text{Undiscounted Cost Savings - Undiscounted Navy Investment}}{\text{Undiscounted Navy Investment}}$$

Hence, the ROI includes only the return to the Navy and does not include any return to the manufacturer which may accrue from manufacturer investment in equipment or in other project implementation related items. To calculate the ROI, add the figures in Item 13 and subtract the sum of Item 24 (not to include any Army or Air Force funds). Then divide this difference by the sum of Item 24.

An estimate of additional contractor investment (Item 22) is required by the Navy as a measure of industry participation in the MT program. This value is the sum of undiscounted expenditures by the MT project contractor which are over and above those expenditures covered by Navy funding. Expenditures by other Navy weapon system manufacturers who implement the manufacturing

NAVAIR MANUFACTURING TECHNOLOGY PROJECT COST SAVINGS ANALYSIS

FORM 1: PROJECT SUMMARY

1. Project Title: Gallium Arsenide Substrate Fabrication

2. Project Number: A0650 (DMA 00650)

3. Fiscal Year Funded: 1979 4. Total NAVAIR Funding: $520,000

5. Analysis Prep. Date: Dec 84 6. Date of Previous Submission: Mar 84

7. Name of Preparer: R. A. Botta, AIR-5143

8. Organization Implementing MT: M/A-COM Gallium Arsenide Products
South Avenue
Burlington, MA 01803

Name & Title of Principal Contact: John Vaughan (617) 937-2816

9. Date of Contract Award: Sep 79 10. Date of Contract Completion: Mar 82

11. Brief Description of Conventional MT: Manufacture of small quantities of D-shaped, 1.5-inch diameter, GaAs wafers in silica vessels by the Bridgman technique.

12. Brief Description of Advanced MT: Manufacture of large quantities of improved quality, circular, 3-inch diameter, GaAs wafers in pyrolytic boron nitride (PBN) vessels by the liquid encapsulated Czochralski (LEC) process.

13. Outputs:

a. Discounted Net Cost Savings From Implementation of MT Project Results:

Ten-year period following contract award (in 1985 dollars) = $271,676,277.

b. Non-Quantified Benefits:

- GaAs substrate material is now available in quantity
- Greatly improved and consistent wafer purity
- Circular GaAs wafers are adaptable to the automatic wafer processing equipment now used for silicon wafers
- The greater access to GaAs material and improved ease of processing means that firms can now produce more complicated electronic circuits.

c. Additional Benefits Anticipated In Future:

- The improved quality and availability of GaAs at a reduced price will permit digital and other new applications.

20 d. Payback Period:
26.3 months (2.19 years)

22 e. Additional Contractor Investment:
Over $8 million (equip., bldg., engineering)

21 f. Return On Investment:
10-Year ROI = 633.74

23 g. Discounted Cumulative Gross Savings to Date:
$29,388,515

Figure 5 - Form 1: Project Summary

technology established by the MT project should also be included in Item 22. However, capital expenditures by industry which are not essential to implementation of the manufacturing technology should not be included.

Form 1 also provides a measure of cumulative gross savings to date (Item 23). This value is useful information because the gross total cost savings figure (Item 18) often includes projections for future years. Item 23 is calculated by adding the figures in Item 17, but only up to the analysis preparation date. Since the sum is a gross savings value, it is not necessary to subtract the Navy investment.

[In the example the preparation date is December 1984 and the project years run from September to August, therefore the gross savings to date are the discounted savings in years 1982-1984 plus four months of those in 1985. This equals $29,388,515 ($24,302,598 + $5,085,917).]

3.1.1.6 NAVMATINST 4800.36D form. A second summary form is prepared as shown in Figure 6. Where Form 1 was designed specifically to summarize data generated by the cost savings analysis procedures presented in this report, Figure 6 is required by NAVMATINST 4800.36D. Since Figure 6 may have a separate distribution, there are some redundant items in the two summary forms. The format and instructions for data entries for Figure 6 are contained in Appendix A.

3.1.2 Additional "Changed Price" sample project. An additional sample cost savings report, prepared for a NAVAIR MT project using the "Changed Price" format, is included in Appendix B.

3.2 "Changed Cost" methodology. An alternate format is used when the price change that resulted from implementation of MT project results in the manufacturing of a Navy procured component is not known. Such inability to

MANUFACTURING TECHNOLOGY PROJECT COST SAVINGS REPORT

1. PROJECT NO.:
   A0650 (DMA 00650)

2. PROJECT TITLE:
   Gallium Arsenide Substrate Fabrication

3. PERIOD COVERED:
   Sep 79 - Dec 84

4. APPLICATION:
   Implementing activities:
   - M/A-COM Gallium Arsenide Products
     South Avenue
     Burlington, MA 01803

   Candidate applications:
   - GaAs is in high demand for use in advanced electronic communication, countermeasure, and high speed computer devices.
   - Aerospace industry users include Raytheon, Motorola, Rockwell, Hughes, Honeywell, MSC, and United Technology.

5. TOTAL COST INCURRED:
   - $528,000 - *NAVAIR MT Project Cost*
   - Over $8 million - Contractor investment in capital equipment, real property, and engineering.

6. COST SAVINGS:
   - 10-Year (Sep 79 - Aug 89) = $271,676,277 (1985 dollars).
   - Supporting back-up date is presented in the following pages.

7. ACTIONS TAKEN OR RECOMMENDED AS A RESULT OF THE PROJECT:
   Major military equipment manufacturers are purchasing gallium arsenide substrate material. The quantities used will increase as new applications are developed. No further action is required to accrue benefits because the market is acquainted with the improved quality and availability, and reduced price of this product.

Figure 6 - NAVMATINST 4800.36D Report Format

readily identify a price differential is common with aircraft components, where cost performance reports available to the Navy fail to disaggregate the component price from the aircraft subsystem price. For example, the Navy knows the price of an F-14 and of every major F-14 subassembly, but not the price of a particular sheet metal access door which may have a reduced fabrication cost due to an MT project. In such cases, gross cost savings to the Navy can be determined only by identifying changed costs, i.e., identifying all labor, equipment, and material cost savings and then subtracting all project implementation costs to the manufacturer. The cooperation of the manufacturer is essential to obtaining detailed data on capital and operating costs and cost savings which accrue over the time period selected for the analysis.

Worksheet B provides the format for this more detailed cost analysis. Step-by-step instructions follow for performing a "Changed Cost" type analysis using the Worksheet B forms which were completed for a sample MT project.

3.2.1 "Changed Cost" sample project. NAVAIR manufacturing technology project A1349, "Precision Robotic Technology," was completed and implemented on an assembly line by Grumman Aerospace Corporation (Bethpage, N.Y.) in January 1984. The new manufacturing technology uses an automated robotic cell to drill and trim contoured aluminum airframe parts, such as skin sections and access panels, without templates to guide tooling. The old technology involved manual drilling and trimming using hand tools, a labor-intensive operation producing parts of varying quality. After a demonstration production run in January 1983, Grumman officials decided to install a complete robotic cell and to implement the new technology for production of naval aircraft.

The cost savings resulting from this MT project cannot be calculated by the abbreviated Worksheet A method because the sheet metal detail parts worked are subcomponents of larger aircraft assemblies, and the unit price charged to the government under the old or new manufacturing technology cannot be accurately determined. Therefore, Worksheet B is used to analyze cost changes in the switch to the new technology.

3.2.1.1 Cost savings narrative. Figure 7 is a narrative with the same form and function as described in Section 3.1.1.1.

3.2.1.2 Recurring costs. Recurring costs are costs such as labor, materials, and utilities, which are incurred in every project year. Recurring costs and cost savings are listed on Tables B-1 and B-2, as shown in Figure 8. Table B-1 is used for recurring labor, and Table B-2 for materials and utilities. Here again, cost savings (negative costs) are enclosed in parentheses to distinguish them from costs.

All changes in the amount of labor, including maintenance and other labor either newly incurred or saved, is listed (Item 25) and assigned an annual quantity of hours (Item 26). For MT projects where entries on Tables B-1 and B-2 vary from year to year, it may be necessary to prepare a separate copy of this worksheet for each project year. Figure 8 is the version completed for the second project year (Item 27). As in the Worksheet A format, the first project year must begin at the MT contract award date.

Productivity factors (Item 28) may be identified for one or more project years if justified by manufacturer supplied data. This factor allows for increases in worker productivity as they become more familiar with the new

COST SAVINGS NARRATIVE

A1349 (ONA 83249)

Background. Labor has been identified as a major cost driver in the manufacture of naval aircraft. Labor costs represent two-thirds of current airframe construction costs, with 70 percent of the labor cost related to structure fabrication. The efficiency of machining operations has been much improved through the use of numerical position and adaptive feed controls. Little progress has been made, however, in improving such basic labor intensive operations as sub-assembly drilling, trimming, forming, and deburring, or in controlling variable quality in these operations.

The integration of industrial robots into airframe structure fabrication may offer opportunities for eliminating these manual tasks while improving quality control and reducing material waste. Under a NAVAIR manufacturing technology (MT) project, Grumman Aerospace Corporation has designed, demonstrated, and implemented an automated robotic cell for drilling and trimming contoured sheet metal airframe parts, such as skin sections and access panels, without the need for templates to guide the tooling. The cell that Grumman installed in their production facility went on-line in June 1984. Full-scale production with the robotic cell began in August 1984, with 60 parts programmed for robotic machining at the end of 1984.

Cost Savings. Data on robotic cell labor and material requirements were obtained during a January 1983 demonstration production run lasting ten and one-half hours in which 63 contoured sheet metal detail parts such as panels, doors, and skin sections were drilled and routed by the demonstration cell. Comparable data on manual drilling and trimming were obtained from a Grumman study. Receipt of more accurate data from Grumman, based upon their experience with the production cell, is presently pending.

Cost elements included in the cost savings calculations presented on the following pages are as follows:

- Annual automated and manual drill/trim labor costs
- Annual automated cell maintenance labor cost
- Annual automated and manual drill bit and router cutter costs
- Grumman robotic cell capital cost
- Afterform Drilling/Trimming Facility capital improvement costs
- Cell operator training costs
- Part digitizing labor costs

The basis for the calculations is explained in footnotes to the tables.

The cost analysis focused on the cost of employing a production cell rather than on the cost of the demonstration cell. Hence, engineering development costs are not treated, and they are assumed to have been covered by the initial NAVAIR investment. Actually, the robotic cell was designed prior to Navy funding, which was used primarily for financing system integration. Also, no learning curve was factored into the calculations; a learning curve is implicit in the increasing number of parts produced each year by the single robotic cell.

Calculation of ten-year cost savings required the projection of cost savings for 20 part copies per year to the 1992 project year. This corresponds to aircraft projected to be delivered to the government in FY 1993. Current NAVAIR aircraft procurement plans forecast aircraft acquisitions only to FY 1989. It was considered reasonable, however, to assume production of 20 copies of the digitized aircraft parts for an additional four years.

The development of off-line teaching is expected to increase cost savings beyond the level estimated in this analysis. Presently, parts must be digitized on the identical robotic cell that is used to drill and trim the parts, thereby significantly reducing the machine-time available for production. Grumman officials are optimistic that a part digitizing technique similar to that used on numerical control devices will be feasible.

Cost savings calculations, based upon available data, for the ten-year period after contract award are presented on the following pages.

Figure 7 - Cost Savings Narrative

A1349 (DMA 83249): Jan 85 Revision

WORKSHEET B - NT PROJECT IMPLEMENTATION COSTS AND COST SAVINGS

27

Recurring Costs:

Table B-1 - Annual O&M Costs or Cost Savings: Personnel (Project Year 2: Oct 83-Sep 84)*

	O&M Labor Categories	Labor Hrs. (+ or -)	Productivity Factor	Hourly Rate	Overhead	Labor Cost per Year (+ or -)
Old:	Driller/Trimmer (24 parts x 20 copies x 31.9 min/part)**	(255)	1.00	51.78***	(included)	(13,204)
New:	Robotic Cell Operator (24 parts x 20 copies x 8.4 min/part)	67	1.00	53.11	(included)	3,558
	Robotic Cell Maintenance (1 hr/1,000 hrs)	0	1.00	53.11	(included)	0

25 26 28 29 30 31

Total Annual Additional Labor Cost Incurred By, or Labor Cost Saved By (in parens) New Technology (9,646) 32

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities (Project Year 2: Oct 83-Sep 84)

	Description of Items	Quantity per Year	Cost of Item (+ or -)	Handling Cost (+ or -)	Cost per Year (+ or -)
Old:	Utilities, Templates****	0	0	0	0
	Manual Router Cutters (480 parts at 2 parts/cutter)	240	(1.70)*****	0	(408)
	Manual Drill Bits (480 parts at 12 parts/bit)	40	(2.75)	0	(110)
New:	Robot Cutters (480 parts at 16 parts/cutter)	30	10.92	0	328
	Robot Drill Bits (480 parts at 21 parts/bit)	23	1.40	0	32

Total Annual Additional O&C Incurred By, or O&C Saved By (in parens) New Technology (158) 33

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, column 4b.) (9,804) 34

Figure 8 - Worksheet B - Tables B-1 and B-2

technology. Of course, increases in productivity could also have occurred over the same time period if the old technology had been retained.

The next entries on Table B-1 are the hourly rate (Item 29) assigned to the labor category and an overhead factor (Item 30). If the overhead rate is proprietary information, enter the total burdened rate in Item 29. The annual labor cost or cost savings is calculated by multiplying the values in Items 26, 28, 29, and 30, and entering the product in the last column (Item 31). The sum of the itemized annual costs in this column, treating cost savings as a negative value when performing addition, is the total annual labor cost or cost saving (Item 32).

[In the example, production of a given number of parts over the project year by the new manufacturing method, when compared with the higher labor hours which would have been required to make the same number of parts by the old method, results in over $9,646 in gross labor savings.]

Recurring costs other than labor are similarly listed in Table B-2 and the itemized annual costs totaled (Item 33). Since the number of parts vary from year to year in this example, separate copies of the recurring cost tables must be prepared for each project year. The data used to prepare these tables were obtained from the MT project contractor and attached to the cost savings report as addenda, which are included as Figures 9, 10, and 11. The total annual costs or cost savings for Table B-1 (Item 32) and Table B-2 (Item 33) are added and entered on the bottom of the page (Item 34). Key entries on these tables are explained in footnotes as shown in Figure 12.

3.2.1.3 Nonrecurring costs. Nonrecurring costs are defined here as costs which may be incurred in more than one project year, but are unlike cost items such as labor, materials, and utilities, which must be incurred in every productive project year. Nonrecurring costs and cost savings are listed on Tables B-3 and B-4 as shown in Figure 13.

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ADDENDUM 1 TO WORKSHEET B

Navy Five-Year Aircraft Procurement Plan

	FY 1985	FY 1986	FY 1987	FY 1988	FY 1989
F-14	24(2)	24(2)	12(2)	12(2)	24(2)
A-6E	6(1)	0	0	0	0
C-2	8(1)	8(1)	9(1)	0	0
EA-6B	6(1)	6(1)	6(1)	6(1)	6(1)
E-2C	6(1)	6(1)	6(1)	6(1)	6(1)
TOTAL PRODUCTION (inc. spares)	56	49	38	28	40

Note: The figure in parentheses indicates the estimated number of spares which Grumman will produce in addition to the procurement quantity.

Source: Aerospace Daily, February 13, 1984, p. 245.

Figure 9 - Addendum 1 to Worksheet B

ADDENDUM 2 to WORKSHEET B

Manual Drilling & Trimming of Aluminum Aircraft Parts

Part Size	Holes	Total Inches Routed	Drill/Trim Time (Min.)
G	210	148	43.2
F	65	190	36.4
E	29	168	30.0
E	40	174	30.4
D	6	162	19.7

Average Manual Drill + Trim Time Per Part: 31.9

Figure 10 - Addendum 2 to Worksheet B

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ADDENDUM 3 TO WORKSHEET B

Robotic Cell Demonstration Run on Aluminum Aircraft Parts

Part No.	Work Sta.	Part Size	Holes	Total Inches Routed	Digitize Time (Hrs.)	Drill/Trim Time (Min.)	Quantity Processed
A51B18007-11	NO. 1	E	32	191.5	10.2	10.1	20
A51B20168-11	NO. 4	E	17	106.5	14.3	10.1	4
A51B18019-11	NO. 3	C	4	78.0	6.1	5.9	20
A51B20013-11	NO. 2	E	4	126.0	6.8	7.3	8

Average Digitize Time: 9.4 hours

Average Robot Drill & Trim Time Per Part: 8.4 minutes

Figure 11 - Addendum 3 to Worksheet B

WORKSHEET B (CONT.)

Table B-1 + B-2 (Cont.)

*Since the contract award date was 27 Sep 82, project years run from October to the following September. Due to the 10 to 12 month lead time between the afterform drilling/trimming operation and aircraft delivery, the Oct 83 to Sep 84 project year corresponds to FY85 on Addendum 1, the Oct 84 to Sep 85 project year corresponds to FY86, etc.

**A computer run of candidate aluminum parts for Grumman-produced aircraft identified an approximate total of 2,450 parts, although not all parts have a configuration suited to robotic drilling and trimming. Grumman has estimated that a minimum of 1,000 different parts can be programmed in one year (2 shifts, 6 days per week) if the robot is used only to digitize and no parts are produced. Due to unavoidable structural variations between presumably similar robot arms, Grumman must digitize and produce parts on the same robot. From June through December 1984, Grumman digitized 60 parts and fabricated an average of 20 copies of each part. In a 15 January 1985 telecon, Mr. Jerry Halpern projected that Grumman will digitize an additional 100 parts each year and make 20 copies of each part in the robot's repertory. Addendum 1 shows annual procurements of more than enough aircraft to provide the 20 copies. Since implementation of the robotic cell did not begin until June 1984, only 24 parts are indicated for the Oct 83 to Sep 84 project year. The "old" and "new" production times per parts are taken from Addenda 2 and 3, respectively.

***Rather than use proprietary Grumman labor rates, AIR-52411 identified a 1984 average burdened hourly rate for three major naval aircraft manufacturers of $51.78. Consequently, a burdened standard labor hour in the second project year (10/83 - 09/84) costs $51.78, and a burdened overtime labor hour at time and one-half costs about $61.19. The $53.11 hourly rate used in Table B-1 for labor under the new technology over the course of project year 2 was weighted to include some labor at the overtime rate; it reflects Grumman's plans to operate the robotic cell for 2 shifts plus 600 hours per year overtime, or 4240 hours per year. NAVAIR's forward pricing agreement with Grumman calls for a yearly increase in the burdened labor rates of 6 percent.

****It is presently estimated that the cost of electricity and other utilities is about the same using either manufacturing method. The cost of templates used in the "old" method also roughly balances the cost of the part holding fixtures used in the "new" technology. Grumman is now working on simplifying the modification of part holding fixtures. This would bring additional cost savings.

*****Manual cutter and drill bit costs were obtained from Grumman. Robotic cutter and drill bit costs are based on prices quoted by industrial equipment suppliers for average annual bulk quantities.

Figure 12 - Footnotes to Worksheet B

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WORKSHEET B (CONT.)

Nonrecurring Costs:

Table B-3 - Investment Costs: Equipment & Buildings

Project Year Incurred	Description of Item	Cost of New Item	Discount Factor	P.V. of Investment	P.V. of T.V. of Item	P.V. of Net Investment
1984	Grumman Robotic Cell*	470,000	1.048	492,560	25,286	467,274
1984	Reinforced Concrete Pad: 40' x 40' x 12"	6,000	1.048	6,288	2,066	4,222
1984	Air Conditioned Computer Shack	1,000	1.048	1,048	215	833
1984-1992	Afterform Drilling/Trimming Facility Building**	0		0	0	0

Project Year:	Total Present Value of Net Investment for each Project Year:	Project Year:	Total Present Value of Net Investment for each Project Year:
1983	0	1988	0
1984	472,329	1989	0
1985	0	1990	0
1986	0	1991	0
1987	0	1992	0

Table B-4 - Training and Other Nonrecurring Costs/Cost Savings

Project Year Incurred	Description of Item	Unit Cost (+ or -)	Quantity	Discount Factor	P.V. of Cost (+ or -)
1984-1985	Training of Asst. Robotic Operator/Programmer (10 weeks)		18,566	1.048 and 1.000	18,910
1984-1992	Digitizing of Parts***	53.11/hr to 84.65/hr	452,079	1.048 to 0.538	407,377

Project Year:	Total Present Value of Costs for each Project Year:	Project Year:	Total Present Value of Costs for each Project Year:
1983	0	1988	49,673
1984	20,069	1989	47,906
1985	70,141	1990	46,174
1986	53,519	1991	44,440
1987	51,556	1992	42,809

Figure 13 - Tables B-3 and B-4 (Nonrecurring Costs)

Table B-3 is used to account for contractor investment costs such as equipment, buildings, and other facilities. However, long term capital costs incurred by a Navy weapon system manufacturer which are not directly related to implementation and operation of the new manufacturing technology are not to be accounted for.

[In the example, Grumman purchased an ASEA robot for the purpose of modifying it to perform an MT project related function, a legitimate MT project implementation cost which appears in Table B-3.]

Also, Navy MT project funding should be assumed to cover all the costs of the original MT project completed by the contractor under contract to the Navy MT Office.

[Prior to MT project completion, Grumman expended some of its own resources for the laboratory scale demonstration of the manufacturing technology which were in addition to the amount of the Navy MT project funding, an expense which should be considered unrelated to the scope of a cost savings analysis.]

Using Table B-3, investment costs are itemized (Item 35), and the project year in which they are incurred (Item 36) is identified. The acquisition cost of each item is specified (Item 37) and multiplied by the appropriate discount factor (Item 38) to give the present value of the investment (Item 39).

Where the investments have a longer economic life span than their operating period specified in the cost savings analysis, it is necessary to adjust Item 39 to reflect a terminal value for the investment. NAVFAC publication P-442, Economic Analysis Handbook, provides the following economic life guidelines:

ADP Equipment..... 8 years

Permanent Buildings.....25 years

Semipermanent Buildings, non-wood.....25 years

Semipermanent Buildings, wood.....20 years

Temporary or Rehabilitated Buildings.....15 years

Operating Equipment.....10 years

Utilities.....25 years

Use of an accelerated depreciation schedule is not recommended because it may result in an unrealistically low short term ROI, and also it is not applicable to organic Navy activities.

[In the example, the robotic cell (Item 35) was purchased for $470,000. Although this piece of operating equipment has an economic life of 10 years, this cost savings analysis covers a period of time within which the equipment is used for only 9 years - from October 1983 to September 1992. Consequently, the cell will have a terminal value in FY92 of one-tenth of its purchase price, or $47,000. The 7-year discount factor from FY92 to FY85, the year this sample analysis was prepared, is 0.538 (Item 11), giving a discounted terminal value (Item 40) of $25,286. This value (Item 40) is then subtracted from the discounted investment (Item 39) to give the discounted net investment (Item 41). Similar operations were performed for the concrete pad, with an economic life of 25 years, and the computer shack, with a life of 15 years.]

A generic formula for this calculation is:

$$\text{Item 40} = \frac{\text{Item 37 value}}{\text{Economic Life}} \times (\text{Econ. Life - Yrs. Used}) \times \text{Discount Factor}$$

The net investment entries (Item 41) are summarized in the spaces provided (Item 42) according to the project year the cost was incurred.

Table B-4 is used for listing training and other miscellaneous nonrecurring costs or cost savings items which do not have a terminal value.

[In the example, the 10-week training program (Item 43) took place within portions of 2 project years, and therefore 2 separate discount factors were applied to portions of the $18,566 cost. Also, in order for the robotic cell to drill and trim aircraft parts, each part must be programmed, or digitized. This one-time cost was incurred over a number of project years, each with different hourly rates and discount factors, and the entry on Table B-4 is a summary of the part digitizing schedule.]

The discounted cost entries (Item 44) are summarized in the spaces provided (Item 45) according to the project year the costs were incurred. Footnotes to Tables B-3 and B-4, including the digitizing schedule referenced above, are prepared as shown in Figure 14.

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WORKSHEET 8 (CONT.)

Table B-3 + B-4 (Cont.)

* The Grumman Robotic Cell cost includes the Model IRb-60 robot, DEC 11/34 minicomputer, Model S-1 controller and related hardware, work stations, Rockwell Model 21LD001C drill and Model ERM2400 router units, Accu-lube Model LS-10-150-3 lubrication unit, automatic tool coupler system, wrist and base brakes, base mount and tracks, and pneumatic and electrical facilities. The cost associated with modifying part holding fixtures is dealt with in a footnote to Table B-2.

** Use of the robotic cell saves about 10 percent of the floor space required for manual operations. Due to disruptions that occurred during implementation (laying the concrete pad and installing equipment), however, no cost savings are claimed.

*** The digitizing cost of the annual number of parts to be digitized has been individually discounted for each year as follows:

Project Yr.	New Parts	Digitizing Time	Labor Cost	Discount Factor	Present Value of Cost
1984	24	9.4 hrs.	53.11	1.048	12,557
1985	111	9.4 hrs.	56.30	1.000	58,743
1986	100	9.4 hrs.	59.68	0.954	53,519
1987	100	9.4 hrs.	63.26	0.867	51,556
1988	100	9.4 hrs.	67.06	0.788	49,673
1989	100	9.4 hrs.	71.08	0.717	47,906
1990	100	9.4 hrs.	75.34	0.652	46,174
1991	100	9.4 hrs.	79.86	0.592	44,440
1992	100	9.4 hrs.	84.65	0.538	42,809
Total Discounted Digitizing Cost					407,377

Figure 14 - Footnotes to Tables B-3 and B-4

Figure 15 is the final form in the Worksheet B format. Where Table B-3 was used to list assets which are newly acquired by a manufacturer, Figure 15 is used to list any assets which are transferred within the manufacturer's organization. Blank A (Item 46) may be used to enter the discounted value of any existing manufacturer assets (as opposed to new capital investments) which were not utilized under the conventional manufacturing technology, but are committed to use in production under the new technology. Blank B (Item 47) may be used to enter as a negative value (cost savings) the discounted value of any assets which were utilized under the old technology, but are now available for uses unrelated to the MT project or for other disposal. These two values (Items 46 and 47) are added, and then divided by the number of project years used in the cost savings analysis (Item 48) to derive an annual present value of existing assets (Item 49).

3.2.1.4 Nonrecurring cost summary. Table B-5 (Figure 15), is used to summarize the nonrecurring costs and cost savings which were developed in the previous section. The project year costs from Table B-3 (Item 42) are transferred to the first row (Item 50) of Table B-5; the costs from Table B-4 (Item 45) are transferred to the second row (Item 51); and the value in Blank D (Item 49) is entered for each project year on the third row (Item 52). The costs assigned to each project year are then totaled (Item 53). If the number of project years exceeds the seven spaces provided on Table B-5, additional tables may be used (Figure 16).

3.2.1.5 Form 2. When Tables B-1 through B-5 are complete for the project years under study, both gross and net cost savings may be calculated using Form 2, included as Figure 17. Completion of Form 2 under the "Changed

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WORKSHEET B (CONT.)

Present Value of Existing Assets Newly Committed to Production(+) (46)	N.A. (A)	Project Duration (Years) Used in Calculations (48)	9 (C)
Present Value of Disposed Assets From Old MT (Enter as a negative value) (47)	N.A. (B)	Annual Present Value of Existing Assets ([A+B]/C) (49)	0 (D)

Table B-5 - Summary of Nonrecurring Costs/Savings

	Project Years						
	1984	1985	1986	1987	1988	1989	1990
Total P.V. of Net Investment By Year Cost Incurred (from Table B-3) (50)	472,329	0	0	0	0	0	0
Total P.V. of Other Nonrecurring Costs/ Cost Savings By Year Cost Incurred (from Table B-4) (51)	20,069	70,141	53,519	51,556	49,673	47,906	46,174
Annual Present Value of Existing Assets (Enter Value D) (52)	0	0	0	0	0	0	0
Present Value of Nonrecurring Costs (Enter on Form 2, Column 4e.) (53)	492,398	70,141	53,519	51,556	49,673	47,906	46,174

Source of Cost Savings Data: Manual MT: A Grumman time and motion study provided the data in Addendum 2. Automated MT: A 10 1/2 hour demonstration run by Grumman in January 1983 produced 63 parts and the data in Addendum 3. Responses from Grumman to requests for additional data permitted the completion of the initial report, on this MT project. All data used in this report were available to Grumman from existing records.

Figure 15 - Table B-5, Summary of Nonrecurring Costs/Savings

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WORKSHEET B (CONT.)

Present Value of Existing Assets Newly Committed to Production[6](+)	(A)	Project Duration (Years) Used in Calculations	(C)
Present Value of Disposed Assets From Old MT[7] (Enter as a negative value)	(B)	Annual Present Value of Existing Assets ([A+B]/C)	(D)

Table B-5 - Summary of Nonrecurring Costs/Savings (Cont.)

	Project Years						
	1991	1992	19__	19__	19__	19__	19__
Total P.V. of Net Investment By Year Cost Incurred (from Table B-3)	0	0					
Total P.V. of Other Nonrecurring Costs/ Cost Savings By Year Cost Incurred (from Table B-4)	44,440	42,809					
Annual Present Value of Existing Assets (Enter Value D)	0	0					
Present Value of Nonrecurring Costs (Enter on Form 2, Column 4e.)	44,440	42,809					

Source of Cost Savings Data: (Continued from previous page) A study of this MT project is presently being conducted by NAVSURFWPNCEN on behalf of NAVMAT, and additional data on project costs is expected to become available in early 1985.

Figure 16 - Table B-5, Summary of Nonrecurring Costs/Savings (Cont.)

NAVAIR MANUFACTURING TECHNOLOGY PROJECT COST SAVINGS ANALYSIS

FORM 2 - PROJECT COST SAVINGS (10-Year Cost Savings)

1. Project Title: Precision Robotic Technology

2. Project Number: A1349 (DMA 83249)

3. NAVAIR Investment:

a. Current Fiscal Year	b. Fiscal Years Funded	c. NAVAIR Funding By FY	d. Discount Factor	e. Present Value of Funding
1985	1982	650,000	1.269	824,850
			Present Value of Total NAVAIR Investment	824,850

4. Summary of Implementation & Operating Costs and Cost Savings[1] (from Worksheet A or B):

a. Project Year[2]	b. Recurring Costs/ Savings	c. Discount Factor[3]	d. Present Value of Recurring Costs/ Savings	e. Present Value of Nonrecurring Costs/ Savings	f. Present Value of Annual Costs/Savings
1983	0	0	0	0	0
1984	(9,804)	1.048	(10,275)	492,398	482,123
1985	(58,429)	1.000	(58,429)	70,141	11,712
1986	(107,612)	0.954	(102,662)	53,519	(49,143)
1987	(162,476)	0.867	(140,867)	51,556	(89,311)
1988	(223,525)	0.788	(176,138)	49,673	(126,465)
1989	(291,100)	0.717	(208,719)	47,906	(160,813)
1990	(366,016)	0.652	(238,642)	46,174	(192,468)
1991	(448,891)	0.592	(265,743)	44,440	(221,303)
1992	(537,873)	0.538	(289,376)	42,809	(246,567)
			Present Value of Gross Total Costs/Cost Savings		(592,235)

5. Net Total Cost Savings[4] (4f - 3e): Ten-year = -$232,615

[1]Indicate cost savings (negative costs) on this table by enclosing in parentheses.
[2]Include years used to calculate ROI starting from the date of contract award.
[3]If 4a-3a = 1, then 4c = 0.954 If 4a-3a = 6, then 4c = 0.592
" 2 " 0.867 " 7 " 0.538
" 3 " 0.788 " 8 " 0.489
" 4 " 0.717 " 9 " 0.445
" 5 " 0.652 " 10 " 0.405
[4]If costs exceed cost savings, this difference will be a negative value.

Figure 17 - Form 2 - Project Cost Savings

Cost" format is identical to the "Changed Price" format (Figure 4), except that nonrecurring costs or cost savings are entered (Item 54). Since these values have already been discounted, they are tranferred directly from Table B-5 (Item 53).

3.2.1.6 Form 1. After gross and net cost savings are calculated, a copy of Form 1 is completed (Figure 18). In this example, the payback period exceeds 10 years.

3.2.1.7 NAVMATINST 4800.36D form. A standard Navy summary form was prepared for this sample project, as shown in Figure 19.

3.2.2 Additional "Changed Cost" sample project. An additional sample cost savings report, prepared for a NAVAIR MT project using the "Changed Cost" format, is included in Appendix C.

4. RECOMMENDATIONS

By using set formats for cost savings analysis of MT projects (Appendix D contains reproducible formats), the government and weapon system contractors will have a common understanding of the type of data needed for accurate analysis. If project personnel are acquainted with data requirements early in a project, they will be able to collect cost data on both the conventional and advanced manufacturing technologies. After a change in production methods, it is difficult for manufacturers to reconstruct costs under the old technology.

Although the model formats proposed here may need modification or may not be useable for some MT projects, the type of data and explanatory information shown in the sample analyses will be needed for all projects.

NAVAIR MANUFACTURING TECHNOLOGY PROJECT COST SAVINGS ANALYSIS

FORM 1: PROJECT SUMMARY

1. Project Title: Precision Robotic Technology

2. Project Number: A1349 (DNA 83249)

3. Fiscal Year Funded: 1982

4. Total NAVAIR Funding: $650,000

5. Analysis Prep. Date: Dec 84

6. Date of Previous Submission: Jan 84

7. Name of Preparer: R. A. Retta, AIR-5143

8. Organization Implementing MT: Grumman Aerospace Corp.
Bethpage, New York 11714

Name & Title of Principal Contact: Armand Small, Group Head,
Advanced Fabrication Systems

9. Date of Contract Award: 27 Sep 82

10. Date of Contract Completion: Jan 84

11. Brief Description of Conventional MT: Manual drilling and routing of aluminum aircraft detail parts using templates and hand held tools.

12. Brief Description of Advanced MT: Automated drilling and routing of aluminum aircraft detail parts using a computer guided robotic cell consisting of a track mounted robotic arm that moves between four work stations. No templates are needed to guide the tooling.

13. Outputs:

a. Discounted Net Cost Savings From Implementation of MT Project Results:

Ten year period following contract award (in 1985 dollars) = $232,615.

b. Non-Quantified Benefits:

- production of consistently high quality parts.
- Reduced rework and part deterioration.
- Increased availability of aircraft to the Government.
- Reduced training and turnover of skilled workers.
- Improved working conditions and safety.

c. Additional Benefits Anticipated In Future:

- Improved cost savings from use of off-line digitizing.

d. Payback Period:
In excess of ten years

e. Additional Contractor Investment:
$477,000, plus engineering development costs

f. Return On Investment:

10-Year ROI = 0.51

g. Discounted Cumulative Gross Savings to Date:
None

Figure 18 - Form 1: Project Summary

MANUFACTURING TECHNOLOGY PROJECT COST SAVINGS REPORT

1. PROJECT NO.:
   A1349 (DNA 83249)

2. PROJECT TITLE:
   Precision Robotic Technology

3. PERIOD COVERED:
   Sep 82 - Jan 85

4. APPLICATION:
   Implementing activities:
   - Grumman Aerospace Corporation
     Bethpage, NY 11714

   Candidate applications include:
   - F-14
   - A-6E
   - C-2
   - EA-6B
   - E-2C

5. TOTAL COST INCURRED:
   - $650,000 - NAVAIR MT project cost.
   - Contractor investment was $477,000 for capital equipment and real property improvements, plus an unspecified amount of engineering development costs.

6. COST SAVINGS:
   - 10-Year (Oct 82 - Sep 92) = -$232,615 (1985 dollars)*
   - Supporting back-up data for these cost savings figures are on the following pages

7. ACTIONS TAKEN OR RECOMMENDED AS A RESULT OF THE PROJECT:
   Production scale implementation of the manufacturing technology developed in this project began in August 1984 on sheet metal parts. The project results have been disseminated, and a February 1984 end-of-project demonstration was heavily attended. Implementation by Grumman of the precision robotic technology on the fabrication of composite parts is currently under study. No further action is necessary.

   *This figure reflects the net cost savings to NAVAIR from implementation of the Grumman robotic cell in sheet metal part production only. The gross savings for the same period are $592,235. Additional, and roughly equivalent, gross cost savings are expected to accrue from implementation in composite part production.

Figure 19 - NAVMATINST 4800.36D Report Format

Furthermore, these procedures use data typically found in manufacturers' accounting systems, they are applicable to a wide range of MT projects including those of other SYSCOMs and military services, and minimal training in accounting or cost analysis is needed to prepare reports.

The procedures for cost savings analysis of Navy MT projects suggested in this document provide a basis for issuing guidelines to clarify contractor reporting requirements. Clear guidelines will ease the problem of obtaining data from contractors. When a reporting format and guidelines are finalized, a copy should be distributed to each contractor several months before the annual cost savings report is due. Navy MT Office personnel should participate in the reporting process by responding to questions from contractors, reviewing draft reports, and ensuring that the reports are entered into the appropriate Navy management information systems.

In addition, new contracts now require that the contractor furnish data on the cost of a unit of production under both the old and new manufacturing technology. Appropriate safeguards will maintain the confidentiality of proprietary information. Navy personnel should be designated to scrutinize new contracts to ensure that contractor reporting requirements are clearly identified.

This requirement has been drafted in the form of a DD Form 1423, Contract Data Requirements List (CDRL). The DD Form 1664, Data Item Description, referenced in the CDRL contains requirements which are based upon the guidelines recommended in this document. Both draft forms are contained in Appendix E. In addition, a cost savings data collection task has been drafted for future inclusion in all NAVAIR MT project work statements. Adoption of both documents will greatly facilitate cost savings reporting.

APPENDIX A

EXCERPT FROM NAVMATINST 4800.36D

FORMAT AND INSTRUCTIONS FOR MANUFACTURING TECHNOLOGY PROJECT COST SAVINGS REPORT

MANUFACTURING TECHNOLOGY PROJECT COST SAVINGS REPORT

PROJECT NO. _____(1) _____

PROJECT TITLE _____(2) _____

PERIOD COVERED _____(3) _____

APPLICATION _____(4) _____

TOTAL COST INCURRED _____(5) _____

COST SAVINGS _____(6) _____

1. Project No. Insert the project identification number assigned.

2. Project Title. Enter the title of the project exactly as stated on the approved Project Proposal Brief Form (NAVMAT 4800/2).

3. Period Covered. Insert the dates of the period covered by the report. If final report, so state.

4. Application. List the name and address of the Government installation and/or the contractor facility where the project's results are being applied to effect cost savings, and describe the specific applications.

5. Total Cost Incurred. Provide the detailed cost related to the application of the project results with supporting back-up data. Include all project funding, required implementation costs, capital investments required, training costs, etc.

6. Cost Savings. Provide detailed cost savings resulting from the application of the project with supporting back-up data.

7. Actions Taken or Recommended as a Result of the Project. State what actions have been taken or are required to accrue the benefits of this project. Include recommendations for other commands/services application of this project.

APPENDIX B

ADDITIONAL "CHANGED PRICE" EXAMPLE

MANUFACTURING TECHNOLOGY PROJECT COST SAVINGS REPORT

1. PROJECT NO.:
   A0475 (DNA 00475)

2. PROJECT TITLE:
   Fine Blanking for Fluidic Circuits

3. PERIOD COVERED:
   Jun 78 - Dec 89

4. APPLICATION:
   Implementing activities:
   - Garrett Pneumatic Systems Division
     1300 W. Warner Road
     Tempe, AZ 85282

   Candidate applications include:
   - AV-8B gun drive
   - F/A-18 environmental control system
   - F/A-18 auxiliary power turbine inlet guide vane control
   - Sidewinder (AIM-9M) and Maverick missiles

5. TOTAL COST INCURRED:
   - $234,000 - NAVAIR MT project cost.
   - Contractor costs not available.

6. COST SAVINGS:
   - 12-Year (Jun 78 - May 90) = $820,715 (1985 dollars)

7. ACTIONS TAKEN OR RECOMMENDED AS A RESULT OF THE PROJECT:
   Implementation of the manufacturing technology established in this project was begun in 1981, with production of limited quantities beginning in January 1983. The project results have been disseminated and there is potential for implementation by the other military services. Significant cost savings are expected to accrue beginning in 1987 and 1988 with the production of fluidic circuits for use in large numbers of Maverick and Sidewinder missiles. Implementation is also planned for the Air Force Maverick missile, and Garrett is actively marketing fluidic circuits. No further action is necessary.

NAVAIR MANUFACTURING TECHNOLOGY PROJECT COST SAVINGS ANALYSIS

FORM 1: PROJECT SUMMARY

1. Project Title: Fine Blanking for Fluidic Circuits

2. Project Number: A0475 (DNA 00475)

3. Fiscal Year Funded: 1978

4. Total NAVAIR Funding: $234,000

5. Analysis Prep. Date: Aug 85

6. Date of Previous Submission: Dec 84

7. Name of Preparer: Brian Scolpino

8. Organization Implementing MT: Garrett Pneumatic Systems Division
1300 W. Warner Road
Tempe, AZ 85282

Name & Title of Principal Contact: James Roundy (602) 893-5799

9. Date of Contract Award: Jun 78

10. Date of Contract Completion: Dec 80

11. Brief Description of Conventional MT: Close tolerance photochemical etching of fluidic laminates.

12. Brief Description of Advanced MT: Fine blanking and precision stamping produces high quality, mass producible laminates for fluidic circuits.

13. Outputs:

a. Discounted Net Cost Savings From Implementation of MT Project Results:

Twelve-year period following contract award (in 1985 dollars) = $820,715.

b. Non-Quantified Benefits:

- Improvement in circuit performance by a factor of 10
- Production of a laminate suited to automated assembly
- Demonstration of a new method for making high precision parts which can be applied to other products
- Increased availability of fluidic circuits
- Increased weapon system reliability

c. Additional Benefits Anticipated In Future:

- Greatly expanded scope of fluidic circuit applications, including substitution for some electronic circuits.

d. Payback Period:
10 years, 2 months (10.19 years)

e. Additional Contractor Investment:
Information not available

f. Return On Investment:
12-Year ROI = 6.43

g. Discounted Cumulative Gross Savings to Date:
$57,468

A0475 (DNA 00475)

COST SAVINGS NARRATIVE

BACKGROUND. When used aboard military aircraft and missiles, fluidic circuits perform many of the same functions as electronic circuits, but are practically impervious to shock, heat, and electromagnetic pulse (EMP). Former production methods for the manufacture of fluidic laminates, which are assembled in stacks to produce fluidic circuits, required photochemical etching with the attendant requirements for very close control of acid concentration, bath time, and metal type and thickness. This MT project was funded to establish precision stamping and fine blanking processes as alternative means of consistently mass producing high quality, low cost fluidic laminates with consistent and repeatable performance characteristics for use in fluidic control systems.

The project was completed in December 1980 at a cost to NAVAIR, the sole sponsor, of $234,000. The MT project contractor, Garrett Pneumatic Systems Division (Garrett Corp., Phoenix, AZ), began implementation of the fine blanking and precision stamping processes for manufacture of significant quantities of thier fluidic circuits in January 1983. Since precision stamping provides similar results at a somewhat lower cost than fine blanking, only the precision stamping process shall be used by Garrett for NAVIAR applications, and this process shall be used in conjunction with a high production rate automatic circuit assembly method (funded by NAVAIR as MT Project A0652) which has entered implementation at Garrett facilities.

Applications for fine blanked or precision stamped fluidic circuits have been limited to date to the F/A-18 environmental control system for electronics cooling, the F/A-18 auxiliary power turbine inlet guide vane controls, and Sidewinder and Maverick missiles. Full qualification of the Maverick missile and design qualification of the Sidewinder missile is expected by the end of this fiscal year, and production qualification of Sidewinder is expected by the end of FY86. Beginning in FY87, fluidic systems will become an increasingly common component of missiles.

COST SAVINGS. Conventional manufacturing methods have been adequate for the limited quantity and variety of fluidic circuits required for military applications. With the increased demand for these devices resulting from their qualification for aircraft and missile applications, however, significant cost savings are anticipated from the use of the improved production methods.

The Worksheet A format was used to calculate annual cost savings because detailed data on recurring and nonrecurring costs are not presently available from Garrett. Garrett's position is that their current contractual committments do not provide funding for the data collection and analysis necessary to complete the more detailed (Worksheet B) cost savings analysis format. Hence, it is not presently possible to independently conform Garrett's estimate of unit cost savings.

The Cost Savings Per Unit figures in Tables A-1 are Garrett's estimated unit cost savings to the Navy which can be directly attributed to this MT project. They represent cost savings per unit over a 12-month period in which circuit production times have been averaged to reflect varying laminate production times. The unit cost savings estimates are conservative as they do not account for inflation nor for new applications which are likely to develop beyond the F/A-18, Sidewinder and Maverick circuit procurement quantities identified in Addendum 1. The procurement quantities idendified in Addendum 1 reflect NAVAIR applications for Garrett Corp. fluidic circuits which are presently under contract or under negotiation with prime contractors. The cost savings data in Tables A-1 were obtained from Mr. James Roundy, Manugacturing Technology Office, and Mr. Lawrence E. Scheer, formerly of the Manufacturing Technology Office, Garrett Pneumatic Systems Division.

The Garrett Manufacturing Technology Office is supportive of NAVIAR's interest in obtaining more detailed recurring and nonrecurring cost information, but suggests that such efforts could best be addressed by a separate program or contract. According to the project manager, current data on labor hours for cleaning, assembling, brazing, and other production steps are not consistent; and it was necessary for him to weight and interpret the data to obtain the estimates listed in Addendum 1 and used in Tables A-1. As full scale implementation of the new production method gets underway, however, more data on capital and labor costs directly attributable to project implementation should become available.

Cost savings based upon available data for the twelve-year period after contract award are presented on the following pages.

NAVAIR MANUFACTURING TECHNOLOGY PROJECT COST SAVINGS ANALYSIS

FORM 2 - PROJECT COST SAVINGS (12-Year Cost Savings)

1. Project Title: Fine Blanking for Fluidic Circuits

2. Project Number: A0475 (DNA 0047)

3. NAVAIR Investment:

a. Current Fiscal Year	b. Fiscal Years Funded	c. NAVAIR Funding By FY	d. Discount Factor	e. Present Value of Funding
1985	1978	234,000	1.859	435,006
		Present Value of Total NAVAIR Investment		435,006

4. Summary of Implementation & Operating Costs and Cost Savings[1] (from Worksheet A or B):

a. Project Year[2]	b. Recurring Costs/ Savings	c. Discount Factor[3]	d. Present Value of Recurring Costs/ Savings	e. Present Value of Nonrecurring Costs/ Savings	f. Present Value of Annual Costs/Savings
1979	0	0	0	0	0
1980	0	0	0	0	0
1981	0	0	0	0	0
1982	0	0	0	0	0
1983	(6,930)	1.153	(7,990)	0	(7,990)
1984	(23,375)	1.048	(24,497)	0	(24,497)
1985	(22,935)	1.000	(22,935)	0	(22,935)
1986	(8,580)	0.954	(8,185)	0	(8,185)
1987	(38,720)	0.867	(33,570)	0	(33,570)
1988	(296,120)	0.788	(233,343)	0	(233,343)
1989	(762,630)	0.717	(546,806)	0	(546,806)
1990	(580,360)	0.652	(378,395)	0	(378,395)
			Present Value of Gross Total Costs/Cost Savings		(1,255,721)

5. Net Total Cost Savings[4] (4f - 3e): Twelve-year = $820,715

1 Indicate cost savings (negative costs) by enclosing in parentheses.

2 Include years used to calculate ROI starting from the contract award date.

3 If 4a-3a = 1, then 4c = 0.954 If 4a-3a = 6, then 4c = 0.592
" 2 " 0.867 " 7 " 0.538
" 3 " 0.788 " 8 " 0.489
" 4 " 0.717 " 9 " 0.445
" 5 " 0.652 " 10 " 0.405

4 If costs exceed cost savings, this difference will be a negative value.

A0475 (DNA 00475): 12-Year Cost Savings

WORKSHEET A - MT PROJECT IMPLEMENTATION COST SAVINGS

TABLE A-1 - Annual Cost Savings

Description of Item Affected by MT Project: Fluidic circuits for F/A-18 applications

Project Year[1]	Unit Price Old MT	Unit Price New MT	Cost Savings Per Unit	No. Units (To Be) Procured	Annual Cost Savings
Jun 78* to May 79	DNA**	NA	0	0	0
Jun 79 to May 80	DNA	NA	0	0	0
Jun 80 to May 81	DNA	NA	0	0	0
Jun 81 to May 82	DNA	NA	0	0	0
Jun 82 to May 83	DNA	DNA***	55	63****	3,465
Jun 83 to May 84	DNA	DNA	55	171	9,405
Jun 84 to May 85	DNA	DNA	55	154	8,470
Jun 85 to May 86	DNA	DNA	55	90	4,950
Jun 86 to May 87	DNA	DNA	55	90	4,950
Jun 87 to May 88	DNA	DNA	55	90	4,950
Jun 88 to May 89	DNA	DNA	55	90	4,950
Jun 89 to May 90	DNA	DNA	55	52	2,860

1 The first project year is the 12-month period following the contract award for the MT project. This is because the Navy requires that the period used to calculate the ROI begin with the contract award date.

A0475 (DNA 00475): 12-Year Cost Savings

WORKSHEET A - MT PROJECT IMPLEMENTATION COST SAVINGS

TABLE A-1 - Annual Cost Savings

Description of Item Affected by MT Project: Fluidic circuits for Sidewinder applications

Project Year[1]	Unit Price Old MT	Unit Price New MT	Cost Savings Per Unit	No. Units (To Be) Procured	Annual Cost Savings
Jun 78* to May 79	DNA**	NA	0	0	0
Jun 79 to May 80	DNA	NA	0	0	0
Jun 80 to May 81	DNA	NA	0	0	0
Jun 81 to May 82	DNA	NA	0	0	0
Jun 82 to May 83	DNA	DNA***	55	63****	3,465
Jun 83 to May 84	DNA	DNA	55	212	11,660
Jun 84 to May 85	DNA	DNA	55	192	10,560
Jun 85 to May 86	DNA	DNA	55	40	2,200
Jun 86 to May 87	DNA	DNA	55	40	2,200
Jun 87 to May 88	DNA	DNA	55	857	47,135
Jun 88 to May 89	DNA	DNA	55	3,666	201,630
Jun 89 to May 90	DNA	DNA	55	3,500	192,500

1 The first project year is the 12-month period following the contract award for the MT project. This is because the Navy requires that the period used to calculate the ROI begin with the contract award date.

A0475 (DNA 00475): 12-Year Cost Savings

WORKSHEET A - MT PROJECT IMPLEMENTATION COST SAVINGS

TABLE A-1 - Annual Cost Savings

Description of Item Affected by MT Project: Fluidic circuits for Maverick applications

Project Year[1]	Unit Price Old MT	Unit Price New MT	Cost Savings Per Unit	No. Units (To Be) Procured	Annual Cost Savings
Jun 78* to May 79	DNA**	NA	0	0	0
Jun 79 to May 80	DNA	NA	0	0	0
Jun 80 to May 81	DNA	NA	0	0	0
Jun 81 to May 82	DNA	NA	0	0	0
Jun 82 to May 83	DNA	DNA***	55	0	0
Jun 83 to May 84	DNA	DNA	55	42****	2,310
Jun 84 to May 85	DNA	DNA	55	71	3,905
Jun 85 to May 86	DNA	DNA	55	26	1,430
Jun 86 to May 87	DNA	DNA	55	574	31,570
Jun 87 to May 88	DNA	DNA	55	4,437	244,035
Jun 88 to May 89	DNA	DNA	55	10,110	556,050
Jun 89 to May 90	DNA	DNA	55	7,000	385,000

1 The first project year is the 12-month period following the contract award for the MT project. This is because the Navy requires that the period used to calculate the ROI begin with the contract award date.

A0475 (DNA 00475): 12-Year Cost Savings

* The contract for the MT project was awarded in June 1978, thus each project year dates from June. The project results were not implemented and no auditable cost savings accrued until January 1983.

** The data are not available (DNA). Garrett Corporation furnished cost data in the form of cost savings per fluidic circuit only. Reliable data on unit prices under the conventional manufacturing technology are presently unavailable from Garrett as explained in the Cost Savings Narrative.

*** The data are not available (DNA). Garrett Corporation is unwilling to quote the unit price under the new manufacturing technology at this time.

**** Since the project years used for Table A-1 run from June to May, while annual unit procurement figures (provided in Addendum 1) correspond to the calendar year, the figures in the "No. Units Procured" column have been adjusted to correspond to the June to May project year:

	Calendar Year Totals	Project Year Equivalent
F/A-18		
1979	0	0
1980	0	0
1981	0	0
1982	0	0
1983	150	63
1984	200	171
1985	90	154
1986	90	90
1987	90	90
1988	90	90
1989	90	90
1990	0	52
Sidewinder		
1979	0	0
1980	0	0
1981	0	0
1982	0	0
1983	150	63
1984	300	212
1985	40	192
1986	40	40
1987	40	40
1988	2,000	857
1989	6,000	3,666
1990	0	3,500

A0475 (DNA 00475): 12-Year Cost Savings

Maverick		
1979	0	0
1980	0	0
1981	0	0
1982	0	0
1983	0	0
1984	100	42
1985	30	71
1986	20	26
1987	1,350	574
1988	8,760	4,437
1989	12,000	10,110
1990	0	7,000

ADDENDUM 1

FINE BLANKING OR PRECISION STAMPING APPLICATIONS UNDER CONTRACT

A0475 (DNA 00475): 12-Year Cost Savings

ADDENDUM 1

Fine Blanking or Precision Stamping Applications Under Contract*

APPLICATION	CY	SYSTEM QUANTITY	COMPONENT QUANTITY	UNIT MT SAVINGS	ANNUAL MT SAVINGS ($)
F-18	1983	150	150	55	8,250
	1984	200	200	55	11,000
	1985	90	90	55	4,950
	1986	90	90	55	4,950
	1987	90	90	55	4,950
	1988	90	90	55	4,950
	1989	90	90	55	4,950
SIDEWINDER	1983	75	150	55	8,250
	1984	150	300	55	16,500
	1985	20	40	55	2,200
	1986	20	40	55	2,200
	1987	20	40	55	2,200
	1988	1,000	2,000	55	110,000
	1989	3,000	6,000	55	330,000
MAVERICK	1983	0	0	NA	0
	1984	25	100	55	5,500
	1985	7	30	55	1,650
	1986	5	20	55	1,100
	1987	340	1,350	55	74,250
	1988	2,200	8,760	55	481,800
	1989	3,000	12,000	55	660,000
TOTAL	1983	225	300		16,500
	1984	375	600		33,000
	1985	117	160		8,800
	1986	115	160		8,250
	1987	450	1,480		81,400
	1988	3,290	10,850		596,750
	1989	6,090	18,090		994,950

*These data were furnished by Mr. James Roundy, Manufacturing Technology Office, and Mr. Lawrence E. Scheer, formerly of the Manufacturing Technology Office, Garrett Pneumatic Systems Division, in August and November 1984. The production and cost savings figures for 1985-89 were revised by Mr. Roundy in June 1985 based on conservative projections.

APPENDIX C

ADDITIONAL "CHANGED COST" EXAMPLE

MANUFACTURING TECHNOLOGY PROJECT COST SAVINGS REPORT

1. PROJECT NO.:
   A0703 (DNA 00703)

2. PROJECT TITLE:
   Critical Aircraft Bearing Refurbishment

3. PERIOD COVERED:
   Aug 80-Jan 85

4. APPLICATION:
   Implementing activities:
   - NAVAIREWORKFAC-North Island (Code 341)
     Building 341
     San Diego, CA 92135

   Candidate applications include:
   - J52, TF34, J79, and LM2500 engine bearings.
   - H-46 helicopter swashplate bearings.

5. TOTAL COST INCURRED:
   - $240,000 - NAVAIR MT project cost.
   - Capital equipment costs are not yet available.

6. COST SAVINGS:
   - 5-Year (Sep 80-Aug 85) = -$300,077 (1985 dollars)
   - 10-Year (Sep 80-Aug 90) = $7,483,655 (1985 dollars)
   - Supporting back-up data for these cost savings figures are on the following pages.

7. ACTIONS TAKEN OR RECOMMENDED AS A RESULT OF THE PROJECT:
   Implementation of the manufacturing technology developed in this project began in December 1982 with refurbishment of J52 engine bearings. Dissemination of project results will occur principally by means of a technical manual to update bearing rework procedures. The manual will be published concurrent with the FY85 completion of NAVAIR MT project A1447 (DNA 83347), Bearing Diagnostics and Refurbishment.

   Barriers which have delayed accrual of the benefits of this project include:
   - Acquiring additional funding for capital equipment and supplies purchases.
   - Qualification of bearings (in addition to J52 bearings) for refurbishment.
   - NAVAIR approval for publication of an updated Aviation Supply Office (ASO) Field Instruction (FASOINST 4030.5) which identifies 192 bearing refurbishment candidates and directs shipment of these used bearings to North Island.
   - Revision of the National Stock Number (NSN) Maintenance and Repair (M&R) codes to change bearings from consumable to repairable.

NAVAIR MANUFACTURING TECHNOLOGY PROJECT COST SAVINGS ANALYSIS

FORM 1: PROJECT SUMMARY

1. Project Title: Critical Aircraft Bearing Refurbishment

2. Project Number: A0703 (DNA 00703)

3. Fiscal Year Funded: 1980

4. Total NAVAIR Funding: $240,000

5. Analysis Prep. Date: Dec 84

6. Date of Previous Submission: None

7. Name of Preparer: R. A. Retta, AIR-5143

8. Organization Implementing MT: NAVAIREWORKFAC-North Island (Code 341)
Bldg 341
San Diego, CA 92135

Name & Title of Principal Contact: Gary Kuhlman, Bearing Section Chief

9. Date of Contract Award: Aug 80

10. Date of Contract Completion: Sep 82

11. Brief Description of Conventional MT: Old bearings, including expensive jet engine mainshaft bearings, were disposed of as scrap. Replacements were new bearings procured from bearing manufacturers.

12. Brief Description of Advanced MT: Salvageable used bearings are cleaned, inspected, reground, replated, outfitted with new balls or rollers, reassembled, adjusted to blueprint specifications, tested,and shipped back to the rework depots.

13. Outputs:

a. Discounted Net Cost Savings From Implementation of MT Project Results:

Five years following contract award (in 1985 dollars) =-$300,077.
Ten years following contract award (in 1985 dollars) = $7,483,655.

b. Non-Quantified Benefits:

- Reduced supply problems from long lead times in the bearing industry.
- Improved management of strategic materials in short supply by eliminating material waste.

c. Additional Benefits Anticipated In Future:

- Additional bearings qualified for rework.

d. Payback Period:
5 years, 3 months (5.23 years)

e. Additional Contractor Investment:
None to date

f. Return On Investment:
5-Year ROI = -0.68
10-Year ROI = 43.81

g. Discounted Cumulative Gross Savings to Date:
$42,685

A0703 (DNA 00703)

COST SAVINGS NARRATIVE

Background. As a result of NAVAIR MT project A0703 (DNA 00703), "Critical Aircraft Bearing Refurbishment," production processes have been developed for refurbishing used, rejected rolling element bearings used in gas turbine engines, transmissions, and gear trains for Navy aircraft and some ships. Presently, many expensive, critical, rolling element bearings are scrapped by aircraft maintenance and overhaul facilities because of nonconformance to dimensional tolerances and defect limits. This has caused two problems: (1) supply problems due to long lead times within the bearing industry; and (2) increasing costs due to the dramatic rise in the purchase price of bearings in recent years.

This MT project developed equipment and procedures for rebuilding used or rejected bearings to a serviceable condition. A first phase in the NAVAIR bearing refurbishment effort, it was completed in September 1982 with a total cost to the government of $240,000.

As a result of this project, many tons of critical, short-supply bearings will be salvaged for reuse. The Naval Air Rework Facility-North Island (San Diego, CA) completed the MT project and will take the lead in bearing refurbishment for NAVAIR. The other rework depots will ship used bearings to North Island, and refurbished bearings will be returned to the depots.

Since project completion, North Island has refurbished over 100 J52 engine No. 1 mainshaft bearings. Refurbishment of additional bearings by North Island awaits additional funding for capital equipment purchases, qualification of the additional bearings for refurbishment, NAVAIR approval for publication of an updated Aviation Supply Office (ASO) Field Instruction (FASOINST 4030.5) which identifies 192 bearing refurbishment candidates and directs shipment of these used bearings to North Island, and a revision of the National Stock Number (NSN) Maintenance and Repair (M&R) codes to change the classification of bearings from "consumable," to "repairable." Refurbished TF34, J52, J79, and LM2500 engine mainshaft bearings are presently in the prototype phase and the TF34, J79, and J52 No. 4, 4 1/2, and 6 bearings have successfully completed engine tests.

Cost Savings. Rework of the J52 No. 1 bearing began in December 1982, and continues. The schedule for rework of additional bearings is presently uncertain. The cost savings analysis is based on an assumption that North Island can begin refurbishment of the annual quantities of J52, TF34, J79, and LM2500 engine bearings, and H-46 helicopter swashplate bearings identified in Addendum 1 in FY86. North Island has experienced an unexpected delay in obtaining NAVAIR approval of the new field instruction and M&R codes, and funding problems have delayed acquisition of the necessary equipment and supplies. In the event of further delays, the commencement of full production and the accrual of major cost savings may be set back again. The annual quantity estimates are considered conservative, assuming full production.

Cost savings are achieved as a result of the low cost of labor and replacement parts needed to refurbish used bearings as compared to the high cost of procuring new bearings. North Island has found the labor cost of refurbishing various bearings to be constant; rework cost variations between bearings are related principally to the number of replaceable parts, as identified in Addendum 1. Significantly greater cost savings per unit may be achieved because over one-half of the rework labor time identified in this analysis is required for grinding and replating outer and inner bearing surfaces; initial results suggest that this rework step may be unnecessary for a significant, but as yet unidentified, percentage of used bearings.

A second, three-year long MT project, A1447 (DNA 83347), began in FY 1983 and will further advance the Level II refurbishment techniques, develop additional Level III regrinding techniques, and produce a generic manual on bearing rework procedures.

Project cost savings calculations for the five year and ten year periods after contract award are presented on the following pages.

NAVAIR MANUFACTURING TECHNOLOGY PROJECT COST SAVINGS ANALYSIS

FORM 2 - PROJECT COST SAVINGS (10-Year Cost Savings)

1. Project Title: Critical Aircraft Bearing Refurbishment

2. Project Number: A0703 (DNA 00703)

3. NAVAIR Investment:

a. Current Fiscal Year	b. Fiscal Years Funded	c. NAVAIR Funding By FY	d. Discount Factor	e. Present Value of Funding
1985	1980	240,000	1.534	368,160
		Present Value of Total NAVAIR Investment		368,160

4. Summary of Implementation & Operating Costs and Cost Savings[1] (from Worksheet A or B):

a. Project Year[2]	b. Recurring Costs/ Savings	c. Discount Factor[3]	d. Present Value of Recurring Costs/ Savings	e. Present Value of Nonrecurring Costs/ Savings	f. Present Value of Annual Costs/Savings
1981	0	1.395	0	0	0
1982	0	1.269	0	0	0
1983	(15,147)	1.153	(17,464)	11,530	(5,934)
1984	(22,950)	1.048	(24,052)	0	(24,052)
1985	(38,097)	1.000	(38,097)	0	(38,097)
1986	(2,135,810)	0.954	(2,037,563)	712,520	(1,325,043)
1987	(2,135,810)	0.867	(1,851,747)	0	(1,851,747)
1988	(2,135,810)	0.788	(1,683,018)	0	(1,683,018)
1989	(2,135,810)	0.717	(1,531,376)	0	(1,531,376)
1990	(2,135,810)	0.652	(1,392,548)	0	(1,392,548)
		Present Value of Gross Total Costs/Cost Savings			(7,851,815)

5. Net Total Cost Savings[4] (4f - 3e): Ten-year = $7,483,655

[1]Indicate cost savings (negative costs) on this table by enclosing in parentheses.
[2]Include years used to calculate ROI starting from the date of contract award.
[3]If 4a-3a = 1, then 4c = 0.954 If 4a-3a = 6, then 4c = 0.592
" 2 " 0.867 " 7 " 0.538
" 3 " 0.788 " 8 " 0.489
" 4 " 0.717 " 9 " 0.445
" 5 " 0.652 " 10 " 0.405
[4]If costs exceed cost savings, this difference will be a negative value.

AO703 (DNA 00703): 10-Year Cost Savings

GUIDELINES USED IN COMPLETING THE FOLLOWING WORKSHEET B TABLES B-1 THROUGH B-5

1 Maintenance labor incurred by or saved by the new technology should be included. (Table B-1)

2 Effectiveness factors may be identified for one or more project years. This factor allows for increases in worker productivity as they become more familiar with the new technology. For example, if a unit of output in a given project year can be produced in 90 percent of the time that was required in the base project year, the labor hours in Table B-1 are multiplied by 0.90. (Note that an increase in effectiveness could also have occurred over the same time period if the old technology had been retained.) (Table B-1)

3 If the overhead rate is not known, use 90 percent for engineering labor and 175 percent for manufacturing labor. If the hourly rate and overhead data are proprietary, indicate total labor cost only. (Table B-1)

4 Table B-3 is used to list equipment expenses charged to production; capital investments which are reflected in the overhead cost are not to be entered here. Costs in Tables B-3 and B-4 are discounted from the project year in which they were incurred to the current year. (Tables B-3 and B-4)

5 The terminal value (T.V.) of an item is calculated by straight-line depreciation of its cost over the economic life span specified below in order to determine the worth remaining at the end of the period used to calculate the ROI. The present value (P.V.) of this amount is entered. NAVFAC P-442 provides the following economic life guidelines:

ADP Equipment	8 years
Permanent Buildings	25 years
Semipermanent Buildings, non-wood	25 years
Semipermanent Buildings, wood	20 years
Temporary or Rehabilitated Buildings	15 years
Operating Equipment	10 years
Utilities	25 years

Use of an accelerated depreciation schedule is not recommended because it may result in an unrealistically low short-term ROI. (Table B-3)

6 The discounted value of any existing contractor assets (as opposed to new capital investments) that were not utilized under the old technology, but are being committed to use in production under the new technology, is estimated and entered on this line. (Table B-5)

7 The discounted value of any contractor assets that were utilized under the old technology, but are now available for uses unrelated to the project or for other disposal, is estimated and entered on this line. (Table B-5)

A0703 (DNA 00703): 10-Year Cost Savings

WORKSHEET B - MT PROJECT IMPLEMENTATION COSTS AND COST SAVINGS

Recurring Costs: J52 Engine Bearing Refurbishment - Sep 82-Aug 83

Table B-1 - Annual O&M Costs or Cost Savings: Personnel

O&M Labor Categories[1]	Labor Hrs. (+ or -)	Effectiveness Factor[2]	Hourly Rate	Overhead[3]	Labor Cost per Year (+ or -)
J52 No. 1 Bearing Rework(1)	3.0/brg(2)	1.0(3)	50.00(4)	Included	(33 brg) 4,950

Total Annual Additional Labor Cost Incurred By or Labor Cost Saved By (in parens) New Technology 4,950

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities

Description of Items	Quantity per Year	Cost of Item (+ or -)	Handling Cost (+ or -)	Cost per Year (+ or -)
J52 No. 1 Roller Elements	26 elmt/brg	9.00(5)	Included in Table B-1, Labor Hrs.	(33 brg) 7,722

Total Annual Additional ODC Incurred By or ODC Saved By (in parens) New Technology 7,722

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, Column 4b.)

See next page

A0703 (DNA 00703): 10-Year Cost Savings

WORKSHEET B - MT PROJECT IMPLEMENTATION COSTS AND COST SAVINGS

Recurring Costs: J52 Engine Bearing Refurbishment - Sep 82-Aug 83 (Cont.)

Table B-1 - Annual O&M Costs or Cost Savings: Personnel

O&M Labor Categories[1]	Labor Hrs. (+ or -)	Effectiveness Factor[2]	Hourly Rate	Overhead[3]	Labor Cost per Year (+ or -)

Total Annual Additional Labor Cost Incurred By or Labor Cost Saved By (in parens) New Technology _____

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities

Description of Items	Quantity per Year	Cost of Item (+ or -)	Handling Cost (+ or -)	Cost per Year (+ or -)
J52 No. 1 Bearings - New	33	(843)[6]	Negligible[7]	(27,819)

Total Annual Additional ODC Incurred By or ODC Saved By (in parens) New Technology (27,819)

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, Column 4b.) (15,147)

A0703 (DNA 00703): 10-Year Cost Savings

WORKSHEET B - MT PROJECT IMPLEMENTATION COSTS AND COST SAVINGS

Recurring Costs: J52 Engine Bearing Refurbishment - Sep 83-Aug 84

Table B-1 - Annual O&M Costs or Cost Savings: Personnel

O&M Labor Categories[1]	Labor Hrs. (+ or -)	Effectiveness Factor[2]	Hourly Rate	Overhead[3]	Labor Cost per Year (+ or -)
J52 No. 1 Bearing Rework(1)	3.0/brg(2)	1.0(3)	50.00(4)	Included	(50 brg) 7,500

Total Annual Additional Labor Cost Incurred By or Labor Cost Saved By (in parens) New Technology 7,500

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities

Description of Items	Quantity per Year	(x) Cost of Item (+ or -)	(+) Handling Cost (+ or -)	(=) Cost per Year (+ or -)
J52 No. 1 Roller Elements	26 elmt/brg	9.00(5)	Included in Table B-1, Labor Hrs.	(50 brg) 11,700

Total Annual Additional ODC Incurred By or ODC Saved By (in parens) New Technology 11,700

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, Column 4b.)

See next page

A0703 (DNA 00703): 10-Year Cost Savings

WORKSHEET B - MT PROJECT IMPLEMENTATION COSTS AND COST SAVINGS

Recurring Costs: J52 Engine Bearing Refurbishment - Sep 83-Aug 84 (Cont.)

Table B-1 - Annual O&M Costs or Cost Savings: Personnel

O&M Labor Categories[1]	Labor Hrs. (+ or -)	Effectiveness Factor[2]	Hourly Rate	Overhead[3]	Labor Cost per Year (+ or -)

Total Annual Additional Labor Cost Incurred By or Labor Cost Saved By (in parens) New Technology _____

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities

Description of Items	Quantity per Year	Cost of Item (+ or -)	Handling Cost (+ or -)	Cost per Year (+ or -)
J52 No. 1 Bearings - New	50	(843)[6]	Negligible[7]	(42,150)

Total Annual Additional ODC Incurred By or ODC Saved By (in parens) New Technology (42,150)

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, Column 4b.) (22,950)

DNA 00703: 10-Year Cost Savings

WORKSHEET B - MT PROJECT IMPLEMENTATION COSTS AND COST SAVINGS

Recurring Costs: J52 Engine Bearing Refurbishment - Sep 84-Aug 85

Table B-1 - Annual O&M Costs or Cost Savings: Personnel

O&M Labor Categories[1]	Labor Hrs. (+ or -)	Effectiveness Factor[2]	Hourly Rate	Overhead[3]	Labor Cost per Year (+ or -)
J52 No. 1 Bearing Rework(1)	3.0/brg(2)	1.0(3)	50.00(4)	Included	(83 brg/yr) 12,450

Total Annual Additional Labor Cost Incurred By or Labor Cost Saved By (in parens) New Technology 12,450

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities

Description of Items	Quantity per Year	Cost of Item (+ or -)	Handling Cost (+ or -)	Cost per Year (+ or -)
J52 No. 1 Roller Elements	26 elmt/brg	9.00(5)	Included in Table B-1, Labor Hrs.	(83 brg/yr)19,422

Total Annual Additional ODC Incurred By or ODC Saved By (in parens) New Technology 19,422

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, Column 4b.)

See next page

DNA 00703: 10-Year Cost Savings

WORKSHEET B - MT PROJECT IMPLEMENTATION COSTS AND COST SAVINGS

Recurring Costs: J52 Engine Bearing Refurbishment - Sep 84-Aug 85 (Cont.)

Table B-1 - Annual O&M Costs or Cost Savings: Personnel

O&M Labor Categories[1]	Labor Hrs. (+ or -)	Effectiveness Factor[2]	Hourly Rate	Overhead[3]	Labor Cost per Year (+ or -)

Total Annual Additional Labor Cost Incurred By or Labor Cost Saved By (in parens) New Technology _____

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities

Description of Items	Quantity per Year	Cost of Item (+ or -)	Handling Cost (+ or -)	Cost per Year (+ or -)
J52 No. 1 Bearing - New	83	(843)(6)	Negligible(7)	(69,969)

Total Annual Additional ODC Incurred By or ODC Saved By (in parens) New Technology (69,969)

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, Column 4b.) (38,097)

A0703 (DNA 00703): 10-Year Cost Savings

WORKSHEET B - MT PROJECT IMPLEMENTATION COSTS AND COST SAVINGS

Recurring Costs: J52 Engine Bearings Refurbishment - Sep 85-Aug 90

Table B-1 - Annual O&M Costs or Cost Savings: Personnel

O&M Labor Categories[1]	Labor Hrs. (+ or -)	Effectiveness Factor[2]	Hourly Rate	Overhead[3]	Labor Cost per Year (+ or -)
J52 No. 1 Bearing Rework[(1)]	3.0/brg[(2)]	1.0[(3)]	50.00[(4)]	Included	(100 brg/yr)15,000
J52 No. 2 Bearing Rework	3.0/brg	1.0	50.00	Included	(50 brg/yr) 7,500
J52 No. 3 Bearing Rework	3.0/brg	1.0	50.00	Included	(50 brg/yr) 7,500
J52 No. 4 Bearing Rework	3.0/brg	1.0	50.00	Included	(50 brg/yr) 7,500
J52 No. 4 1/2 Bearing Rework	3.0/brg	1.0	50.00	Included	(50 brg/yr) 7,500
J52 No. 5 Bearing Rework	3.0/brg	1.0	50.00	Included	(50 brg/yr) 7,500
J52 No. 6 Bearing Rework	3.0/brg	1.0	50.00	Included	(50 brg/yr) 7,500

Total Annual Additional Labor Cost Incurred By or Labor Cost Saved By (in parens) New Technology 60,000

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities

Description of Items	Quantity per Year	(x) Cost of Item (+ or -)	(+) Handling Cost (+ or -)	(=) Cost per Year (+ or -)
J52 No. 1 Roller Elements	26 elmt/brg	9.00[(5)]	Included in Table B-1, Labor Hrs.	(100 brg/yr) 23,400
J52 No. 2 Ball Elements	42 elmt/brg	3.00		(50 brg/yr) 6,300
J52 No. 3 Ball Elements	15 elmt/brg	3.00		(50 brg/yr) 2,250
J52 No. 4 Ball Elements	42 elmt/brg	3.00		(50 brg/yr) 6,300
J52 No. 4 1/2 Roller Elements	32 elmt/brg	9.00		(50 brg/yr)14,400
J52 No. 5 Roller Elements	30 elmt/brg	9.00		(50 brg/yr)13,500
J52 No. 6 Roller Elements	28 elmt/brg	9.00		(50 brg/yr)12,600

Total Annual Additional ODC Incurred By or ODC Saved By (in parens) New Technology 78,750

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, Column 4b.) See next page

A0703 (DNA 00703): 10-Year Cost Savings

WORKSHEET B - MT PROJECT IMPLEMENTATION COSTS AND COST SAVINGS

Recurring Costs: J52 Engine Bearings Refurbishment - Sep 85-Aug 90 (Cont.)

Table B-1 - Annual O&M Costs or Cost Savings: Personnel

O&M Labor Categories[1]	Labor Hrs. (+ or -)	Effectiveness Factor[2]	Hourly Rate	Overhead[3]	Labor Cost per Year (+ or -)

Total Annual Additional Labor Cost Incurred By or Labor Cost Saved By (in parens) New Technology _____

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities (Cont.)

Description of Items	Quantity per Year	Cost of Item (+ or -)	Handling Cost (+ or -)	Cost per Year (+ or -)
J52 No. 1 Bearing - New	100	(843)[6]		(84,300)
J52 No. 2 Bearing - New	50	(2,846)		(143,300)
J52 No. 3 Bearing - New	50	(859)		(42,950)
J52 No. 4 Bearing - New	50	(2,846)	Negligible[7]	(142,300)
J52 No. 4 1/2 Bearing - New	50	(618)		(30,900)
J52 No. 5 Bearing - New	50	(1,671)		(83,550)
J52 No. 6 Bearing - New	50	(1,653)		(82,650)

Total Annual Additional ODC Incurred By or ODC Saved By (in parens) New Technology (608,950)

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, Column 4b.) (470,200)

A0703 (DNA 00703): 10-Year Cost Savings

WORKSHEET B - MT PROJECT IMPLEMENTATION COSTS AND COST SAVINGS

Recurring Costs: TF34 Engine Bearings Refurbishment - Sep 85-Aug 90

Table B-1 - Annual O&M Costs or Cost Savings: Personnel

O&M Labor Categories[1]	Labor Hrs. (+ or -)	Effectiveness Factor[2]	Hourly Rate	Overhead[3]	Labor Cost per Year (+ or -)
TF34 No. 1 Bearing Rework[(1)]	3.0/brg[(2)]	1.0[(3)]	50.00[(4)]	Included	(50 brg/yr) 7,500
TF34 No. 2 Bearing Rework	3.0/brg	1.0	50.00	Included	(100 brg/yr)15,000
TF34 No. 3 Bearing Rework	3.0/brg	1.0	50.00	Included	(100 brg/yr)15,000
TF34 No. 4 Bearing Rework	3.0/brg	1.0	50.00	Included	(50 brg/yr) 7,500
TF34 No. 5 Bearing Rework	3.0/brg	1.0	50.00	Included	(50 brg/yr) 7,500
TF34 No. 6 Bearing Rework	3.0/brg	1.0	50.00	Included	(50 brg/yr) 7,500
TF34 No. 7 Bearing Rework	3.0/brg	1.0	50.00	Included	(50 brg/yr) 7,500

Total Annual Additional Labor Cost Incurred By or Labor Cost Saved By (in parens) New Technology 67,500

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities

Description of Items	Quantity per Year	Cost of Item (+ or -)	Handling Cost (+ or -)	Cost per Year (+ or -)
TF34 No. 1 Ball Elements	22 elmt/brg	3.00[(5)]	Included in Table B-1, Labor Hrs.	(50 brg/yr) 3,300
TF34 No. 2 Roller Elements	26 elmt/brg	9.00		(100 brg/yr.) 23,400
TF34 No. 3 Ball Elements	20 elmt/brg	3.00		(100 brg/yr)6,000
TF34 No. 4 Roller Elements	22 elmt/brg	9.00		(50 brg/yr) 9,900
TF34 No. 5 Roller Elements	22 elmt/brg	9.00		(50 brg/yr) 9,900
TF34 No. 6 Roller Elements	22 elmt/brg	9.00		(50 brg/yr) 9,900
TF34 No. 7 Roller Elements	22 elmt/brg	9.00		(50 brg/yr) 9,900

Total Annual Additional ODC Incurred By or ODC Saved By (in parens) New Technology 72,300

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, Column 4b.)

See next page

A0703 (DNA 00703): 10-Year Cost Savings

WORKSHEET B - MT PROJECT IMPLEMENTATION COSTS AND COST SAVINGS

Recurring Costs: TF34 Engine Bearings Refurbishment - Sep 85-Aug 90 (Cont.)

Table B-1 - Annual O&M Costs or Cost Savings: Personnel

O&M Labor Categories[1]	Labor Hrs. (+ or -)	Effectiveness Factor[2]	Hourly Rate	Overhead[3]	Labor Cost per Year (+ or -)

Total Annual Additional Labor Cost Incurred By or Labor Cost Saved By (in parens) New Technology _____

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities

Description of Items	Quantity per Year	Cost of Item (+ or -)	Handling Cost (+ or -)	Cost per Year (+ or -)
TF34 No. 1 Bearing - New	50	(1,900)[6]		(95,000)
TF34 No. 2 Bearing - New	100	(800)		(80,000)
TF34 No. 3 Bearing - New	100	(700)		(70,000)
TF34 No. 4 Bearing - New	50	(1,100)	Negligible[7]	(55,000)
TF34 No. 5 Bearing - New	50	(670)		(33,500)
TF34 No. 6 Bearing - New	50	(900)		(45,000)
TF34 No. 7 Bearing - New	50	(1,150)		(57,500)

Total Annual Additional ODC Incurred By or ODC Saved By (in parens) New Technology (436,000)

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, Column 4b.) (296,200)

A0703 (DNA 00703): 10-Year Cost Savings

WORKSHEET B - MT PROJECT IMPLEMENTATION COSTS AND COST SAVINGS

Recurring Costs: J79 Engine Bearings Refurbishment - Sep 85-Aug 90

Table B-1 - Annual O&M Costs or Cost Savings: Personnel

O&M Labor Categories[1]	Labor Hrs. (+ or -)	Effectiveness Factor[2]	Hourly Rate	Overhead[3]	Labor Cost per Year (+ or -)
J79 No. 1 Bearing Rework[(1)]	3.0/brg[(2)]	1.0[(3)]	50.00[(4)]	Included	(100 brg/yr)15,000
J79 No. 2 Bearing Rework	3.0/brg	1.0	50.00	Included	(50 brg/yr) 7,500
J79 No. 3 Bearing Rework	3.0/brg	1.0	50.00	Included	(185 brg/yr)27,750

Total Annual Additional Labor Cost Incurred By or Labor Cost Saved By (in parens) New Technology 50,250

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities

Description of Items	Quantity per Year	Cost of Item (+ or -)	Handling Cost (+ or -)	Cost per Year (+ or -)
J79 No. 1 Roller Elements	24 elmt/brg	9.00[(5)]	Included in Table B-1, Labor Hrs.	(100 brg/yr) 21,600
J79 No. 2 Ball Elements	24 elmt/brg	3.00		(50 brg/yr) 3,600
J79 No. 3 Roller Elements	28 elmt/brg	9.00		(185 brg/yr) 46,620

Total Annual Additional ODC Incurred By or ODC Saved By (in parens) New Technology 71,820

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, Column 4b.) See next page

A0703 (DNA 00703): 10-Year Cost Savings

WORKSHEET B - MT PROJECT IMPLEMENTATION COSTS AND COST SAVINGS

Recurring Costs: J79 Engine Bearings Refurbishment - Sep 85-Aug 90 (Cont.)

Table B-1 - Annual O&M Costs or Cost Savings: Personnel

O&M Labor Categories[1]	Labor Hrs. (+ or -)	Effectiveness Factor[2]	Hourly Rate	Overhead[3]	Labor Cost per Year (+ or -)

Total Annual Additional Labor Cost Incurred By or Labor Cost Saved By (in parens) New Technology _____

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities

Description of Items	Quantity per Year	Cost of Item (+ or -)	Handling Cost (+ or -)	Cost per Year (+ or -)
J79 No. 1 Bearing - New	100	(240)[6]		(24,000)
J79 No. 2 Bearing - New	50	(1,420)	Negligible[7]	(71,000)
J79 No. 3 Bearing - New	185	(312)		(57,720)

Total Annual Additional ODC Incurred By or ODC Saved By (in parens) New Technology (152,720)

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, Column 4b.) (30,650)

A0703 (DNA 00703): 10-Year Cost Savings

WORKSHEET B - MT PROJECT IMPLEMENTATION COSTS AND COST SAVINGS

Recurring Costs: H-46 Heli. Swashplate Bearing Refurbishment - Sep 85-Aug 90

Table B-1 - Annual O&M Costs or Cost Savings: Personnel

O&M Labor Categories[1]	Labor Hrs. (+ or -)	Effectiveness Factor[2]	Hourly Rate	Overhead[3]	Labor Cost per Year (+ or -)
H46 Swashplate Bearing Rework(1)	3.0/brg(2)	1.0(3)	50.00(4)	Included	(50 brg/yr) 7,500

Total Annual Additional Labor Cost Incurred By or Labor Cost Saved By (in parens) New Technology 7,500

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities

Description of Items	Quantity per Year	Cost of Item (+ or -)	Handling Cost (+ or -)	Cost per Year (+ or -)
H46 Swashplate Ball Elements	196 elmt/brg	0.55(5)	Included in Table B-1, Labor Hrs.	(50 brg/yr) 5,390

Total Annual Additional ODC Incurred By or ODC Saved By (in parens) New Technology 5,390

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, Column 4b.)

See next page

A0703 (DNA 00703): 10-Year Cost Savings

WORKSHEET B - MT PROJECT IMPLEMENTATION COSTS AND COST SAVINGS

Recurring Costs: H-46 Heli. Swashplate Bearing Refurbishment - Sep 85-Aug 90 (Cont.)

Table B-1 - Annual O&M Costs or Cost Savings: Personnel

O&M Labor Categories[1]	Labor Hrs. (+ or -)	Effectiveness Factor[2]	Hourly Rate	Overhead[3]	Labor Cost per Year (+ or -)

Total Annual Additional Labor Cost Incurred By or Labor Cost Saved By (in parens) New Technology _____

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities

Description of Items	Quantity per Year	Cost of Item (+ or -)	Handling Cost (+ or -)	Cost per Year (+ or -)
H46 Swashplate Bearing - New	50	(6,300)[6]	Negligible[7]	(315,000)

Total Annual Additional ODC Incurred By or ODC Saved By (in parens) New Technology (315,000)

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, Column 4b.) (302,110)

A0703 (DNA 00703): 10-Year Cost Savings

WORKSHEET B - MT PROJECT IMPLEMENTATION COSTS AND COST SAVINGS

Recurring Costs: LM2500 Engine (TF39) Bearings Refurbishment - NAVSEA - Sep 85-Aug 90

Table B-1 - Annual O&M Costs or Cost Savings: Personnel

O&M Labor Categories[1]	Labor Hrs. (+ or -)	Effectiveness Factor[2]	Hourly Rate	Overhead[3]	Labor Cost per Year (+ or -)
LM2500 No. 3 Bearing Rework(1)	3.0/brg(2)	1.0(3)	50.00(4)	Included	(50 brg/yr) 7,500
LM2500 No. 4(B) Bearing Rework	3.0/brg	1.0	50.00	Included	(50 brg/yr) 7,500
LM2500 No. 4(R) Bearing Rework	3.0/brg	1.0	50.00	Included	(50 brg/yr) 7,500
LM2500 No. 5 Bearing Rework	3.0/brg	1.0	50.00	Included	(50 brg/yr) 7,500
LM2500 No. 6 Bearing Rework	3.0/brg	1.0	50.00	Included	(50 brg/yr) 7,500
LM2500 No. 7(B) Bearing Rework	3.0/brg	1.0	50.00	Included	(50 brg/yr) 7,500
LM2500 No. 7(R) Bearing Rework	3.0/brg	1.0	50.00	Included	(50 brg/yr) 7,500

Total Annual Additional Labor Cost Incurred By or Labor Cost Saved By (in parens) New Technology 52,500

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities

Description of Items	Quantity per Year	Cost of Item (+ or -)	Handling Cost (+ or -)	Cost per Year (+ or -)
LM2500 No. 3 Roller Elements	40 elmt/brg	9.00(5)		(50 brg/yr)18,000
LM2500 No. 4 Ball Elements	24 elmt/brg	3.00		(50 brg/yr) 3,600
LM2500 No. 4 Roller Elements	36 elmt/brg	9.00	Included in	(50 brg/yr)16,200
LM2500 No. 5 Roller Elements	40 elmt/brg	9.00	Table B-1,	(50 brg/yr)18,000
LM2500 No. 6 Roller Elements	32 elmt/brg	9.00	Labor Hrs.	(50 brg/yr)14,400
LM2500 No. 7 Ball Elements	19 elmt/brg	3.00		(50 brg/yr) 2,850
LM2500 No. 7 Roller Elements	44 elmt/brg	9.00		(50 brg/yr)19,800

Total Annual Additional ODC Incurred By or ODC Saved By (in parens) New Technology 92,850

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, Column 4b.)

See next page

A0703 (DNA 00703): 10-Year Cost Savings

WORKSHEET B - MT PROJECT IMPLEMENTATION COSTS AND COST SAVINGS

Recurring Costs: LM2500 Engine (TF39) Bearings Refurbishment - NAVSEA - Sep 85-Aug 90 (Cont.)

Table B-1 - Annual O&M Costs or Cost Savings: Personnel

O&M Labor Categories[1]	Labor Hrs. (+ or -)	Effectiveness Factor[2]	Hourly Rate	Overhead[3]	Labor Cost per Year (+ or -)

Total Annual Additional Labor Cost Incurred By or Labor Cost Saved By (in parens) New Technology _____

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities

Description of Items	Quantity per Year	Cost of Item (+ or -)	Handling Cost (+ or -)	Cost per Year (+ or -)
LM2500 No. 3 Bearing - New	50	(1,787)[6]		(89,350)
LM2500 No. 4(B) Bearing - New	50	(2,133)		(106,650)
LM2500 No. 4(R) Bearing - New	50	(1,080)		(54,000)
LM2500 No. 5 Bearing - New	50	(2,060)	Negligible[7]	(103,000)
LM2500 No. 6 Bearing - New	50	(1,430)		(71,500)
LM2500 No. 7(B) Bearing - New	50	(13,380)		(669,000)
LM2500 No. 7(R) Bearing - New	50	(1,770)		(88,500)

Total Annual Additional ODC Incurred By or ODC Saved By (in parens) New Technology (1,182,000)

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, Column 4b.) (1,036,650)

Sum of '86-'90 annual recurring costs: (2,135,810)

A0703 (DNA 00703): 10-Year Cost Savings

WORKSHEET B (CONT.)

Table B-1 & B-2 (Cont.)

(1) Bearings which are candidates for Level II rework are listed in this column instead of labor categories. Labor categories are not relevant because the NAVAIRWORKFAC North Island Bearing Shop charges NAVAIR a flat hourly rate (see Table B-1, Footnote 4) for all work performed in the shop.

(2) Level II bearing rework consists of the following steps for each bearing:

1.	Cleaning and visual inspection	12 min.
2.	Disassembly and reassembly	36 min.
3.	Grinding and replating outside diameters (ODs) and inside diameters (IDs)	96 min.
4.	Stripping and replating retainers	18 min.
5.	Bearing handling, packing, and shipping	18 min.
	TOTAL	180 min. (3.0 hrs.)

The 12 minutes allotted for Step 1 includes the time required to inspect bearings that are found to be unsalvageable. From 10 to 70 percent of bearings entering the shop are salvageable; the median recovery rate is estimated to be 40 percent. The Step 3 labor time is conservative as it assumes that all bearing ODs and IDs must be ground and replated; experience to date shows this to be not always necessary, but too few bearings have been processed for statistical analysis. The only other Level II rework recurring cost is for replacement of new rolling elements (the old elements cannot be repaired); this part cost appears in Table B-2.

(3) The initial lower worker effectiveness is covered by a one-time fee charged by the Bearing Shop for each new bearing which is a candidate for rework. This fee covers machine setup costs, including the full cost of learning how to rework the new bearing. Since Bearing Shop workers are presently fully experienced with all bearing machining techniques, no significant learning curve is presently anticipated. The one-time fee appears in Table B-4.

(4) The NAVAIREWORKFAC North Island Bearing Shop charges a flat rate of $50 per hour. This includes:

Wages
Materials
Utilities
Overhead
G&A.

(5) The average price of a roller is $9.00; the average price of a ball is $3.00.

(6) These new bearing purchase prices are listed here since they represent the cost savings from bearings which can be refurbished, and need no longer be purchased. They are based on FY83 Navy contract procurement data, not the Master Component Repair List (MCRL). In recent years, the prices for bearings have increased dramatically (a H-46 swashplate bearing has risen from $500 in 1971 to $6300 in 1984 and a J79 No. 2 mainshaft bearing from $300 to $1420) but are expected to increase in future years at a rate no greater that that of Level II rework costs.

(7) Were all bearings of a given type salvageable, substantial costs would be avoided in the form of hundreds of labor hours for procurement and supply. Since an estimated 60 percent of bearings of a given type cannot be refurbished and must be procured, however, bids must still be processed and bearings stocked, and negligible handling cost savings are anticipated.

A0703 (DNA 00703): 10-Year Cost Savings

Nonrecurring Costs[4]:

WORKSHEET B (CONT.)

Table B-3 - Investment Costs: Equipment & Buildings

Project Year Incurred	Description of Item[1]	Cost of New Item	Discount Factor	P.V. of Investment	P.V. of T.V. of Item[5]	P.V. of Net Investment
1986	Ball bearing honing machine	350,000	0.954	333,900	114,100	219,800
	Centerless roller brg. hone	200,000	0.954	190,800	65,200	125,600
	Crossgroove surface finish gage	125,000	0.954	119,250	40,750	78,500
	Induction heating equip.	35,000	0.954	33,390	11,410	21,980
	Sunnen cylinder hone	20,000	0.954	19,080	6,520	12,560
	Speed lathe	8,000	0.954	7,632	2,608	5,024
	Precision drill press	5,000	0.954	4,770	1,630	3,140
	Vacuum skin pack machine	12,000	0.954	11,448	3,912	7,536
	Stylus plating equip.	15,000	0.954	14,310	4,890	9,420

Project Year:	Total Present Value of Net Investment for Each Project Year:	Project Year:	Total Present Value of Net Investment for Each Project Year:
1981	0	1986	483,560
1982	0	1987	0
1983	0	1988	0
1984	0	1989	0
1985	0	1990	0

Table B-4 - Training and Other Nonrecurring Costs/Cost Savings

Project Year Incurred	Description of Item[2]	Unit Cost (+ or -)	Quantity	Discount Factor	P.V. of Cost (+ or -)
1983	One-time set up fee for J52 No. 1 brg.	10,000	1	1.153	11,530
1986	One-time set up fee for J52 (No. 2-6), TF34, J79, H46, and LM2500 brgs.	10,000	24	0.954	228,960

Project Year:	Total Present Value of Net Investment for Each Project Year:	Project Year:	Total Present Value of Net Investment for Each Project Year:
1981	0	1986	228,960
1982	0	1987	0
1983	11,530	1988	0
1984	0	1989	0
1985	0	1990	0

WORKSHEET B (CONT.)

Table B-3 & B-4 (Cont.)

(1) The Bearing Shop has identified purchase of capital equipment items valuated at $770,000 as necessary for full scale refurbishing operations. A 1986 expansion in the number and variety of bearings to be reworked is contingent upon FY86 special funding for these items. The following special tools and test equipment are presently in use at the Bearing Shop and pre-date funding of A0703 (DNA 00703):

- Roller bearing disassembly/reassembly press
- Ball bearing disassembly/reassembly press
- Roller drop gauge
- Tang pincer
- Deriveting tool
- Small roller bearing disassembly press
- Speed lathe plus centering cone set.

Other equipment was purchased using MT project funds.

(2) The Bearing Shop charges a one-time set-up fee of $10,000 per bearing. This fee covers the measurement of rolling elements to derive a statistical size range, retooling, and initial (learning) production inefficiences (learning curve).

A0703 (DNA 00703): 10-Year Cost Savings

WORKSHEET B (CONT.)

Present Value of Existing Assets Newly Committed to Production[6]	0 (A)	Project Duration (Years) Used in Calculations	0 (C)
Present Value of Disposed Assets From Old MT[7] (Enter as a negative value)	0 (B)	Annual Present Value of Existing Assets ([A+B]/C)	0 (D)

Table B-5 - Summary of Nonrecurring Costs/Savings

	Project Years						
	1981	1982	1983	1984	1985	1986	19__
Total P.V. of Net Investment By Year Cost Incurred (from Table B-3)	0	0	0	0	0	483,560	
Total P.V. of Other Nonrecurring Costs/ Cost Savings By Year Cost Incurred (from Table B-4)	0	0	11,530	0	0	228,960	
Annual Present Value of Existing Assets (Enter Value D)	0	0	0	0	0	0	
Present Value of Nonrecurring Costs (Enter on Form 2, Column 4e.)	0	0	11,530	0	0	712,520	

Source of Cost Savings Data: Data on current bearing purchase prices were obtained from Navy procurement contracts. Data on the new MT were obtained from a NAVAIREWORKFAC-North Island analysis of bearing rework labor requirements and costs for the bearings which are the subject of this report.

ADDENDUM 1

Bearing Refurbishment Cost Comparison Data

ADDENDUM 1

Bearing Refurbishment Cost Comparison Data

MT Application	No. Rolling Elements	Level II Rework Costs*	New Bearing Price	Cost Avoidance Per Bearing	Annual Rework Quantities
J52 No. 1	26	384	843	459	100
No. 2	42	276	2,846	2,570	50
No. 3	15	195	859	664	50
No. 4	42	276	2,846	2,570	50
No. 4 1/2	32	438	618	180	50
No. 5	30	420	1,671	1,251	50
No. 6	28	402	1,653	1,251	50
TF34 No. 1	22	216	1,900	1,684	50
No. 2	26	384	800	416	100
No. 3	20	210	700	490	100
No. 4	22	348	1,100	752	50
No. 5	22	348	670	322	50
No. 6	22	348	900	552	50
No. 7	22	348	1,150	802	50

ADDENDUM 1 (Continued)

Bearing Refurbishment Cost Comparison Data

MT Application	No. Rolling Elements	Level II Rework Costs*	New Bearing Price	Cost Avoidance Per Bearing	Annual Rework Quantities
J79 No. 1	24	366	240	(126)	100
No. 2	24	222	1,420	1,198	50
No. 3	28	402	312	(90)	185
H-46 Swashplate	196	258	6,300	6,042	50
LM2500					
No. 3	40	510	1,787	1,277	50
No. 4(B)	24	222	2,133	1,911	50
No. 4(R)	36	474	1080	606	50
No. 5	40	510	2060	1550	50
No. 6	32	438	1,430	992	50
No. 7(B)	19	207	13,380	13,173	50
No. 7(R)	44	546	1,770	1,224	50

* Rework costs are based on maximum rework efforts, which include $9.00 per roller or $3.00 per ball ($0.55 per ball for H-46) and $150.00 for the following:

1.	Clean and visual inspect	$10.00
2.	Disassembly and reassembly	30.00
3.	Grind and replate OD's and ID's	80.00
4.	Strip and replate retainers	15.00
5.	Bearing handling, packing, and shipping	15.00
	TOTAL	$150.00

Source: Gary Kuhlman, Bearing Section Chief, Naval Air Rework Facility - North Island, August 1984

APPENDIX D

REPRODUCIBLE FORMATS

MANUFACTURING TECHNOLOGY PROJECT COST SAVINGS REPORT

1. PROJECT NO.:

2. PROJECT TITLE:

3. PERIOD COVERED:

4. APPLICATION:
   Implementing activities:
   -

   Candidate applications include:
   -
   -
   -
   -

5. TOTAL COST INCURRED:
   -
   -

6. COST SAVINGS:
   -
   -
   -

7. ACTIONS TAKEN OR RECOMMENDED AS A RESULT OF THE PROJECT:

NAVAIR MANUFACTURING TECHNOLOGY PROJECT COST SAVINGS ANALYSIS

FORM 1: PROJECT SUMMARY

1. Project Title:

2. Project Number:

3. Fiscal Year Funded:

4. Total NAVAIR Funding:

5. Analysis Prep. Date:

6. Date of Previous Submission:

7. Name of Preparer:

8. Organization Implementing MT:

Name & Title of Principal Contact:

9. Date of Contract Award:

10. Date of Contract Completion:

11. Brief Description of Conventional MT:

12. Brief Description of Advanced MT:

13. Outputs:

a. Discounted Net Cost Savings From Implementation of MT Project Results:

b. Non-Quantified Benefits:

c. Additional Benefits Anticipated In Future:

d. Payback Period:

e. Additional Contractor Investment:

f. Return On Investment:

g. Discounted Cumulative Gross Savings to Date:

NAVAIR MANUFACTURING TECHNOLOGY PROJECT COST SAVINGS ANALYSIS

FORM 2 - PROJECT COST SAVINGS

1. Project Title:

2. Project Number:

3. NAVAIR Investment:

a. Current Fiscal Year	b. Fiscal Years Funded	c. NAVAIR Funding By FY	d. Discount Factor	e. Present Value of Funding
			Present Value of Total NAVAIR Investment	

4. Summary of Implementation & Operating Costs and Cost Savings[1] (from Worksheet A or B):

a. Project Year[2]	b. Recurring Costs/ Savings	c. Discount Factor[3]	d. Present Value of Recurring Costs/ Savings	e. Present Value of Nonrecurring Costs/ Savings	f. Present Value of Annual Costs/Savings
19					
19					
19					
19					
19					
			Present Value of Gross Total Costs/Cost Savings		

5. Net Total Cost Savings[4] (4f-3e):

[1]Indicate cost savings (negative costs) on this table by enclosing in parentheses.
[2]Include years used to calculate ROI starting from the date of contract award.
[3]If 4a-3a = 1, then 4c = 0.954 If 4a-3a = 6, then 4c = 0.592
" 2 " 0.867 " 7 " 0.538
" 3 " 0.788 " 8 " 0.489
" 4 " 0.717 " 9 " 0.445
" 5 " 0.652 " 10 " 0.405
[4] If costs exceed cost savings, this difference will be a negative value.

WORKSHEET A - MT PROJECT IMPLEMENTATION COST SAVINGS

Table A-1 - Annual Cost Savings

Description of Item Affected by MT Project:

Project Year [1]	Unit Price Old MT	Unit Price New MT	Cost Savings Per Unit	No. Units (To Be) Procured	Annual Cost Savings
____ to ____					
____ to ____					
____ to ____					
____ to ____					
____ to ____					
____ to ____					
____ to ____					
____ to ____					
____ to ____					
____ to ____					

[1] The first project year is the 12-month period following the contract award for the MT project. This is because the Navy requires that the period used to calculate the ROI begin with the contract award date.

WORKSHEET B - (CONT.)

Recurring Costs:

Table B-1 - Annual O&M Costs or Cost Savings: Personnel

O&M Labor Categories	Labor Hrs. (+ or -)	Productivity Factor	Hourly Rate	Overhead	Labor Cost per Year (+ or -)

Total Annual Additional Labor Cost Incurred By, or Labor Cost Saved By (in parens) New Technology _____

Table B-2 - Annual O&M Costs or Cost Savings: Materials & Utilities

Description of Items	Quantity per Year	Cost of Item (+ or -)	Handling Cost (+ or -)	Cost per Year (+ or -)

Total Annual Additional ODC Incurred By, or ODC Saved By (in parens) New Technology _____

Total Annual Recurring Costs or Cost Savings (Enter for applicable project years on Form 2, column 4b.) _____

Nonrecurring Costs :

WORKSHEET B (CONT.)

Table B-3 - Investment Costs: Equipment & Buildings

Project Year Incurred	Description of Item	Cost of New Item	Discount Factor	P.V. of Investment	P.V. of T.V. of Item	P.V. of Net Investment

Project Year: Total Present Value of Net Investment for Each Project Year:

19__
19__
19__
19__
19__

Table B-4 - Training and Other Nonrecurring Costs/Cost Savings

Project Year Incurred	Description of Item	Unit Cost (+ or -)	Quantity	Discount Factor	P.V. of Cost (+ or -)

Project Year: Total Present Value of Costs for Each Project Year:

19__
19__
19__
19__

WORKSHEET B (CONT.)

Present Value of Existing Assets Newly Committed to Production _____ (A)

Present Value of Disposed Assets From Old MT (Enter as a negative value) _____ (B)

Project Duration (Years) Used in Calculations _____ (C)

Annual Present Value of Existing Assets ([A+B]/C) _____ (D)

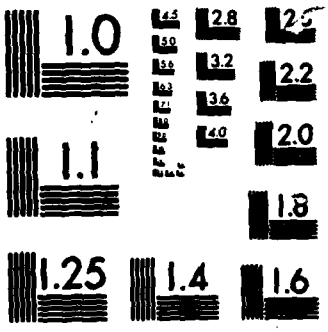
Table B-5 - Summary of Nonrecurring Costs/Savings

	Project Years						
	19__	19__	19__	19__	19__	19__	19__
Total P.V. of Net Investment By Year Cost Incurred (from Table B-3)							
Total P.V. of Other Nonrecurring Costs/ Cost Savings By Year Cost Incurred (from Table B-4)							
Annual Present Value of Existing Assets (Enter Value D)							
Present Value of Nonrecurring Costs (Enter on Form 2, Column 4e.)							

Source of Cost Savings Data: _____

AD-A167 708 COST SAVINGS ANALYSIS GUIDELINES FOR MANUFACTURING TECHNOLOGY PROJECTS(U) SYSCON CORP WASHINGTON DC D OBERHETTINGER ET AL. 28 JUN 85 N00024-84-C-7078 2/2

UNCLASSIFIED F/G 14/1 NL



MICROCOPY CHART

APPENDIX E

DRAFT CONTRACT DATA REQUIREMENTS LIST (CDRL)

ATCH NR _____ TO EXHIBIT _____

TO CONTRACT/PR _____

CONTRACT DATA REQUIREMENTS LIST

CATEGORY E (END ITEM)

SYSTEM/ITEM MANUFACTURING TECHNOLOGY

CONTRACTOR _____

1. SEQUENCE NUMBER	2. TITLE OR DESCRIPTION OF DATA / 3. SUBTITLE	6. TECHNICAL OFFICE	10. FREQUENCY	12. DATE OF 1ST SUBMISSION	14. DISTRIBUTION AND ADDRESSEES (Addressee – Regular Copies/Repro Copies)	
4. AUTHORITY (Data Item Number)	5. CONTRACT REFERENCE	7. DDESS REQ / 8. APP CODE (A) / 9. INPUT TO IAC (X)	11. AS OF DATE	13. DATE OF SUBSEQUENT SUBM/EVENT IO		
1. A001	2. Progress Report-Letter Type 3. Quarterly	6. AIR-5143	10. QTRLY	12. See 16	14. AIR-5143 NAEC-ESSD -9313	3/0 2/0
4. DI-A-2090A (See Blk 16)	5.	7. LT / 8. / 9.	11. 0	13. See 16		15. TOTAL 5/0
16. REMARKS Block 4: Quarterly progress report shall be in accordance with format contained in NAVMAT Inst. 4800.36D, dtd July '79 (attached) Block 12: Report shall be due on 1st day of each calender quarter from DAC.						
1. A002	2. Final Report 3. Cost Savings Validation	6. AIR-5143	10. OTIME	12. See 16	14. AIR-5143 NAEC-ESSD -9313	3/0 2/0
4. DI-A-5030B (See Blk 16)	5.	7. LT / 8. / 9.	11. 0	13. See 16 See 16		15. TOTAL 5/0
16. REMARKS Blocks 4, 12 & 13: Delete para 1c, fiscal data applies. Cost savings validation shall be conducted IAW the attached document "Guidelines for Cost Savings Analysis of MT Projects". Delete para 2.						
1. A003	2. Final Report/End of Project 3. Demonstration Procedures	6. AIR-5143	10. See 16	12. See 16	14. AIR-5143 NAEC-ESSD -9313	3/0 2/0
4. DI-A-5030B (See Blk 16)	5.	7. DD / 8. A / 9.	11. See 16	13. See 16		15. TOTAL 5/0
16. REMARKS Block 4: Delete para 2. Contractor format acceptable. Para 1 applies less fiscal and planning data. Preliminary copies shall be submitted to AIR-5143 30 days after completion of project. Final to be submitted 30 days following approval of						
1.	2. 3.	6.	10.	12.	14.	
4. CONTINUATION OF A003	5.	7. / 8. / 9.	11.	13.		15. TOTAL
16. REMARKS preliminary report. Distribution will be IAW list provided with the approved preliminary report. Blocks 4, 12 & 13: Written demonstration procedures shall be submitted						

PREPARED BY	DATE	APPROVED BY	DATE

DD FORM 1 JUN 86 1423 S/N 0102-014-1503 REPLACES EDITION OF 1 APR 80, WHICH IS OBSOLETE. PAGE ____ OF ____ PAGES

DATA ITEM DESCRIPTION	2. IDENTIFICATION NOS.	
	AGENCY	NUMBER
1. TITLE Final Report	NSA	DI-A-5030B
3. DESCRIPTION/PURPOSE To summarize in one document, all work performed under the contract and to present complete fiscal data for the contract.	4. APPROVAL DATE 1976 February 14	
	5. OFFICE OF PRIMARY RESPONSIBILITY NSA - R	
	6. DDC REQUIRED	
	8. APPROVAL LIMITATION	
7. APPLICATION/INTERRELATIONSHIP To apprise the Government in a comprehensive finalized document of the requisite requirements specified under the contract. Companion Data Item Descriptions are: DI-A-5000 Man Hours Expenditure Chart DI-A-5001 Funds Expenditure Chart DI-A-5003 Funds Expenditure Report	9. REFERENCES (Mandatory as cited in Block 10)	
	MCSL NUMBER(S)	

10. PREPARATION INSTRUCTIONS

1. The Final Report shall clearly summarize all work performed under the contract and shall contain the following information:

a. Table of Contents

b. Brief summary of all work done, including that yielding negative results or positive results not used. All information shall be referenced to the appropriate Progress Report, or section of the Final Report, where the subject is discussed in detail.

c. The body of the report shall describe all work accomplished, including, as applicable, theoretical studies, experimental work, mechanical design, theory of operation, test procedures, test results, and those drawings, charts, graphs, illustrations, or other expository material needed to clarify the presentation. It shall also include all fiscal and planning data prepared in accordance with the companion data item descriptions.

d. When test equipment has been designed and constructed for use on this contract, a listing of all such equipment is to be included. This listing shall include all associated drawings and lists. It shall be referenced in the report and is to be included as an appendix thereto.

DD FORM 1 JUN 68 1664

e. Conclusions, recommendations and proposals.

f. An appendix of all expository materials not necessarily included in the text of the report, which shall be identified by appropriate titles and symbols on the face, if feasible, if not, upon the back thereof.

2. The report shall be prepared as follows:

a. It shall be typewritten and is to be duplicated in non-fading ink on 8" x 10 1/2" or 8 1/2" x 11" paper and suitably bound between durable covers.

b. The data indicated below shall be contained on the title page in a 3 1/2" x 1 1/2" rectangle located three inches from top of the page and two and one-half inches from its unfastened edge:

(1) Type of report, final.

(2) Purchase description title.

(3) Contract number.

(4) Dates of the reporting period.

Security classification, distribution limitation markings and other necessary information shall also be included on the title page.

*U.S. GOVERNMENT PRINTING OFFICE: 1976—603-765/3967

END

DTIC

6-86