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This project will enhance and modernize the mechanical inspection capabilities of receiving inspection both to improve the productivity of the operation and to eliminate lost transport time in sample parts movement.

This project will implement a new mechanical inspection capability in receiving inspection - an automated coordinate measuring machine to coordinate measuring machine to a computer which would allow "x", "y" and "z" coordinate dimensional to be taken with accuracy and without the time expenditure to align the part on the machine table.

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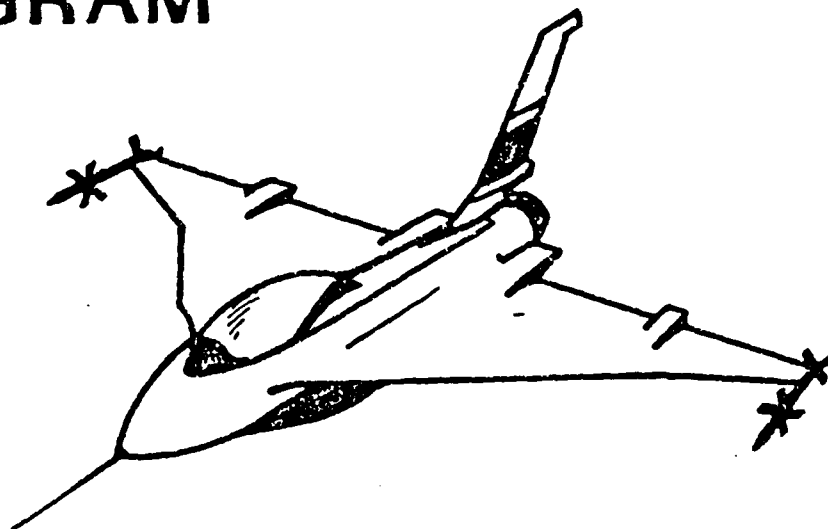
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**INDUSTRIAL  
TECHNOLOGY  
MODERNIZATION  
PROGRAM**



**FINAL TECHNICAL REPORT  
CATEGORY 1 PROJECT  
COORDINATE MEASURING SYSTEM**

**FEBRUARY 4, 1985**



**89 2 13 127**

**Tracor Aerospace**  
Aerospace Austin

**FINAL TECHNICAL REPORT  
CATEGORY I PROJECT  
COORDINATE MEASURING SYSTEM  
FOR RECEIVING INSPECTION  
TRACOR PROJECT 902**

February 4, 1985

GENERAL DYNAMICS PURCHASE ORDER NO. 1005505

CDRL ITEM: ITM 004



SUBMITTED TO:  
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COORDINATE MEASURING MACHINE

SUMMARY

The Coordinate Measuring project resulted from an analysis of the Receiving Inspection Area during Tracor's Phase I effort. It was observed during this period that an existing Boice coordinate measuring machine was servicing both Metal Services/Fabrication Inspection and Receiving Inspection. Receiving Inspection was currently performing approximately 2,250 mechanical lot inspections per year or sampling 15% of all lots received. With the machine's location in the Fabrication area, considerable time and energy was being expended in transporting lot samples to and from the Coordinate Measurment System (CMS). Furthermore, priority was given to the inspection of production parts. If Receiving Inspection had a need for the machine, the inspectors would be required to wait or perform their inspection on time-consuming surface plate setups. An analysis of the Receiving Inspection operation indicated that an additional Coordinate Measuring System would alleviate the congestion at the existing coordinate measuring machine while reducing Receiving Inspection cost and improving product quality.

The objective of the Phase II effort was to continue the analysis initiated during Phase I. This objective was accomplished by writing a set of equipment specifications and procurement and installation of a Boice Model B-401 Coordinate Measuring System. The final equipment arrangement relocated the existing CMS to Receiving Inspection and placed the new CMS in the Fabrication Shop. After installation, test, and debug, a post installation cost benefit analysis was performed on both improvements (i.e., Receiving Inspection and Fabrication). The cost analysis showed that the savings yielded internal rate of return of 2.752%. Because of the unfavorable return on

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investment, Tracor management decided not to enter into a formal business agreement but instead pass the accruing benefits/savings to its customers. Total project cost was \$105,028 with total savings of \$122,028 over a 13-year period.

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### 1.0

#### ORIGINAL PROCEDURES

The original goal of this project was to enhance and modernize the mechanical inspection capabilities of Receiving Inspection, both to improve the productivity of the operation and to eliminate lost transport time in sample parts movement.

Previously, the Receiving Inspection operation performed inspections on about 15,000 material lots each year. Of the total lots received, 2,250 were mechanical lots requiring an average inspection time of 2.5 - 3 manhours per lot. Under the former arrangement both Metal Services/Fabrication Inspection and Receiving Inspection time-shared an existing Coordinate Measuring System. This resulted in Receiving Inspection personnel transporting the samples to and from the Coordinate Measuring System on the second floor some 150 yards away or preparing the samples on time-consuming surface plate setups. To alleviate time-sharing, transportation of parts, and/or surface plate inspection setups, Tracor proposed to investigate and if feasible install a second coordinate measuring machine.



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### 2.0 TECHNICAL APPROACH FOLLOWED

#### 2.1 Feasibility Studies

Feasibility studies were performed during the Phase II portion of the project with the following items accomplished:

- Evaluation of current procedures
- Identification of future inspection requirements of Receiving Inspection and Metal Services/Fabrication Shop
- Evaluation of possible alternatives
- Estimation of costs versus savings
- Identification of vendors and equipment

The studies showed that a modernized inspection capability for both Receiving Inspection and Metal Services/Fabrication Shops could be accomplished and should be located in a centralized area.

#### 2.2 Proposal Improvements

Upon completion of the feasibility studies and analyses of current methods, new ideas were reviewed and presented to management with recommendations. The overall reviews considered present and future needs for work areas, capacity and inspection capabilities. The review established that a modernized inspection capability for both Receiving Inspection and Metal Services/Fabrication Shops should be pursued and meet the following requirements:

- 1) Purchase a new coordinate measuring machine (CMM). Capabilities should be compatible with the existing

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Boice, thus minimizing part reprogramming and reducing the retrain of inspectors and maintenance personnel.

2) Increase the capability and flexibility of the new machine to inspect more complicated, tighter tolerance parts. Provide the CMM with computer data assist to permit ease of programming and retrieval of inspection results. Increase the work surface to permit multiple setups of smaller parts or inspection of large irregular parts.

3) Install the new machine in Fabrication where its larger work surface and state-of-the-art capabilities could be used to provide more timely inspection and support productions's needs.

4) Refurbish the existing Boice and equip it with a new "Z" axis arm, thereby permitting the inspection of larger parts and extending its useful life.

5) Relocate the rebuilt Boice to Receiving Inspection. This would upgrade the department's inspection capability and eliminate the need to transport parts to perform Receiving Inspection operations.

With these requirements in mind, Tracor was expected to gain the following benefits:

- Eliminate the transportation time to and from Receiving Inspection - Metal Services/Fabrication Shop areas.

- Permit multiple inspection setups in the Metal Services/Fabrication Shop areas, thereby reducing setup time.

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- Reduce rework in Metal Services/Fabrication Shop as a result of more timely inspection.

- Provide the Inspection organization with the availability of a backup system.

### 2.3 Selection of Equipment

During the feasibility studies, various CMM vendors were contacted to discuss equipment capability and availability. Discussions with the Boice representative revealed that a used Boice B-401 Coordinate Measuring System was on the market at a reduced cost of \$67,000. While the price was higher than originally forecasted for the project, the machine possessed additional capabilities which were considered beneficial to long-term commitments. In addition, the Boice B-401 was quite compatible with its sister Model 301. These factors influenced Tracor's management to procure the Boice B-401 for the Coordinate Measuring System project.

### 2.4 Implementation

In order to implement the new Boice and relocate the existing CMM, some facilities rearrangements were required in Building II for both Receiving Inspection and Metal Services/Fabrication Shop (Figure 1).

#### Metal Services/Fabrication Shop -

- 1) In order to centrally locate the Boice 401 for servicing the Machine and Sheet Metal areas, a portion of the Metal Services/Fabrication Shop was cleared by moving 12 pieces of machine shop equipment.

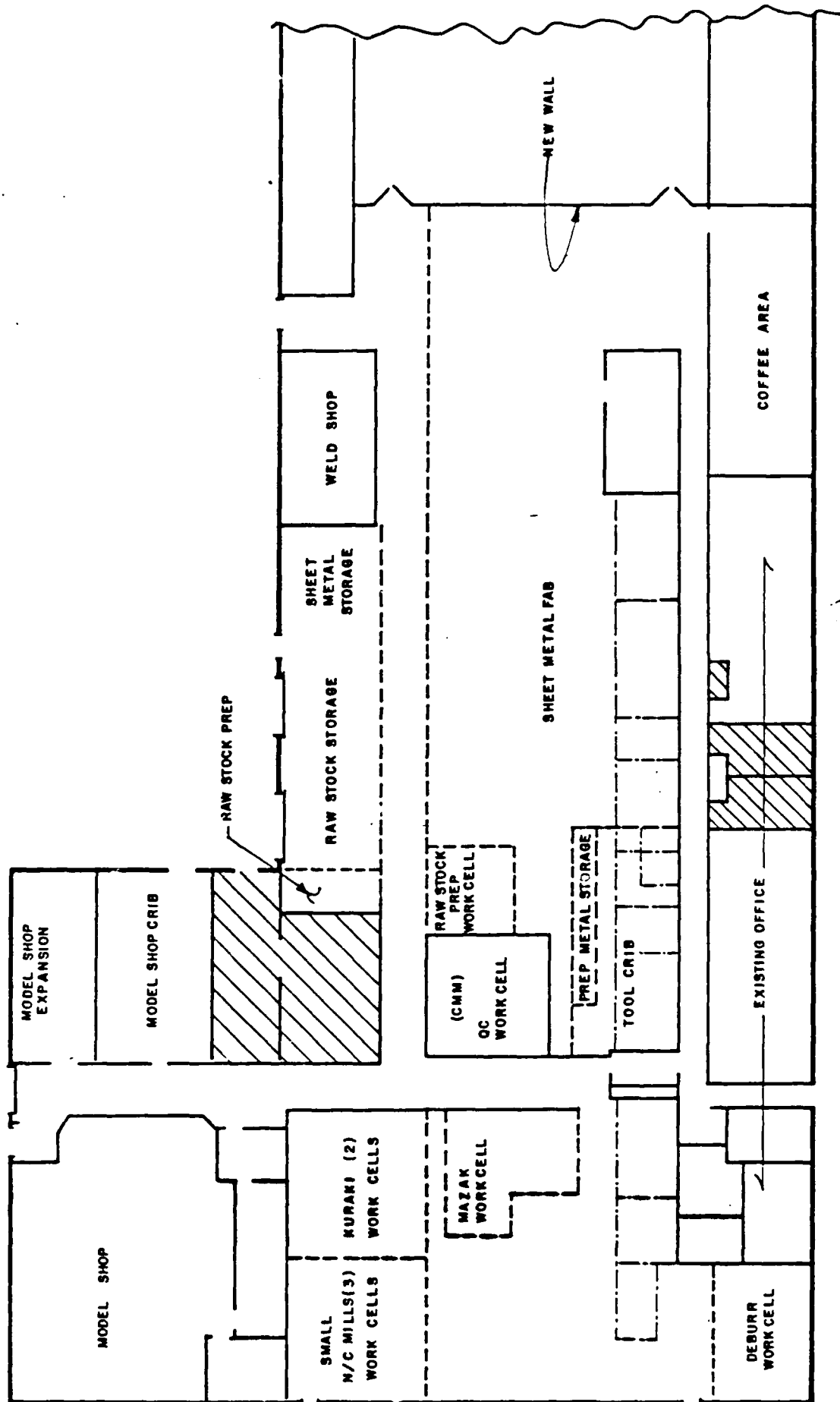


FIGURE- 1 METAL SERVICES/FABRICATION AREA - AFTER

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2) The Boice 401 was installed in a 20-foot square environmentally controlled room. Two (2) additional pieces of inspection equipment, a comparator and a surface plate were relocated and also installed in this room, thereby creating a consolidated inspection service area.

3) The Inspection Services area with the Boice 401 installed and set up for multiple inspections is shown in Figures 2 and 3.

### Receiving Inspection -

1) The Boice 301 was removed from Metal Services/Fabrication Shop area, overhauled to incorporate a new "Z" axis and placed in the Receiving Inspection area. The area shaded in Figure 4 is the Receiving Inspection area where the overhauled Boice was installed.

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Figure 2. INSPECTION SERVICE AREA WITH BOICE 401CMS

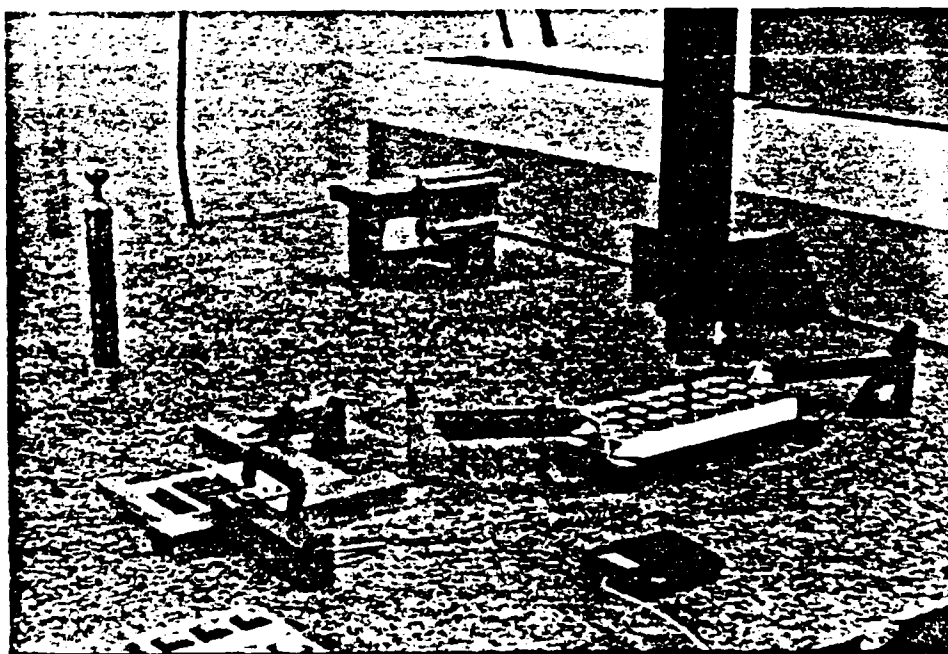


Figure 3. BOICE 401CMS WITH MULTIPLE INSPECTION SET-UPS

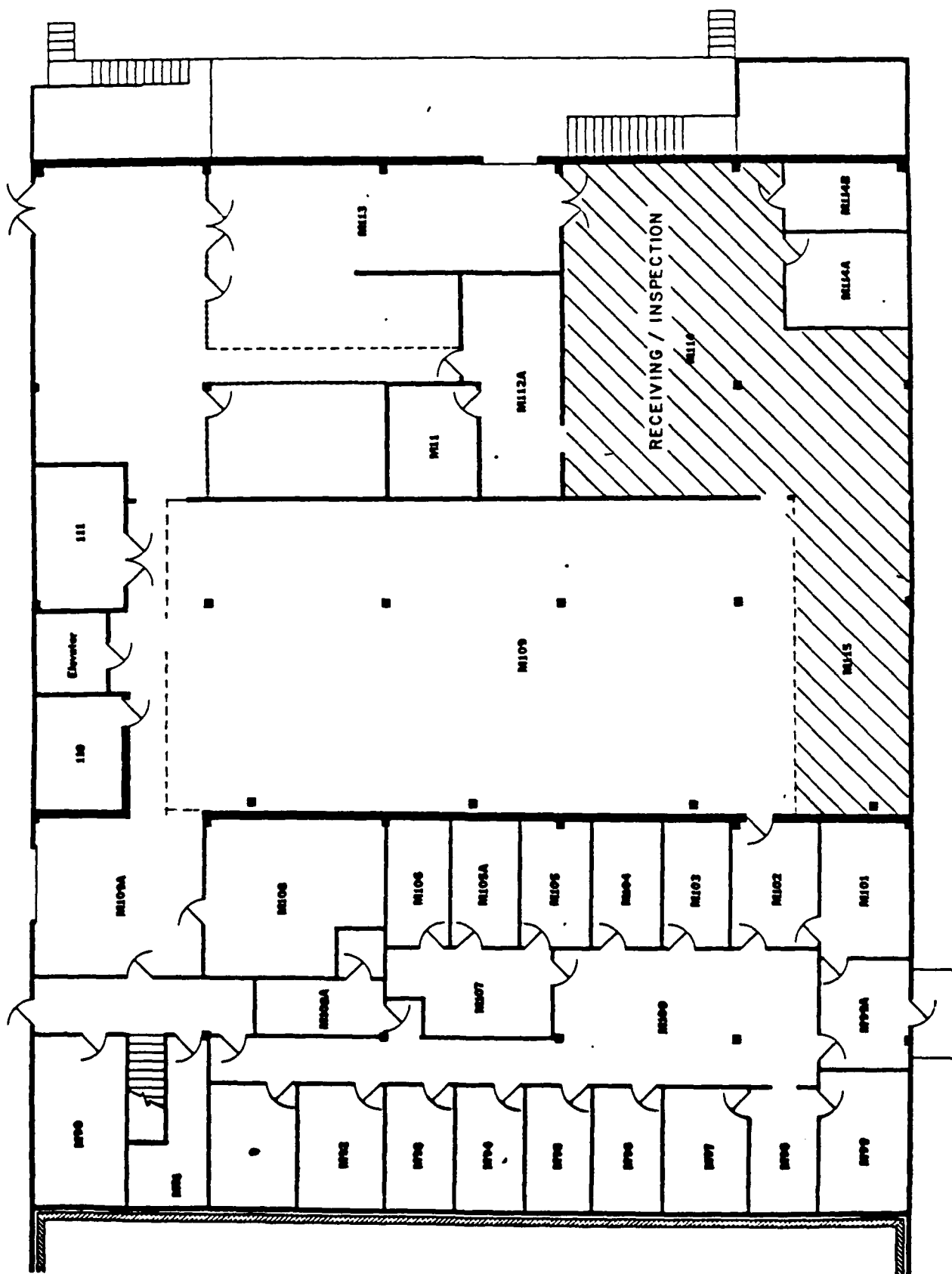


FIGURE - 4 RECEIVING / INSPECTION

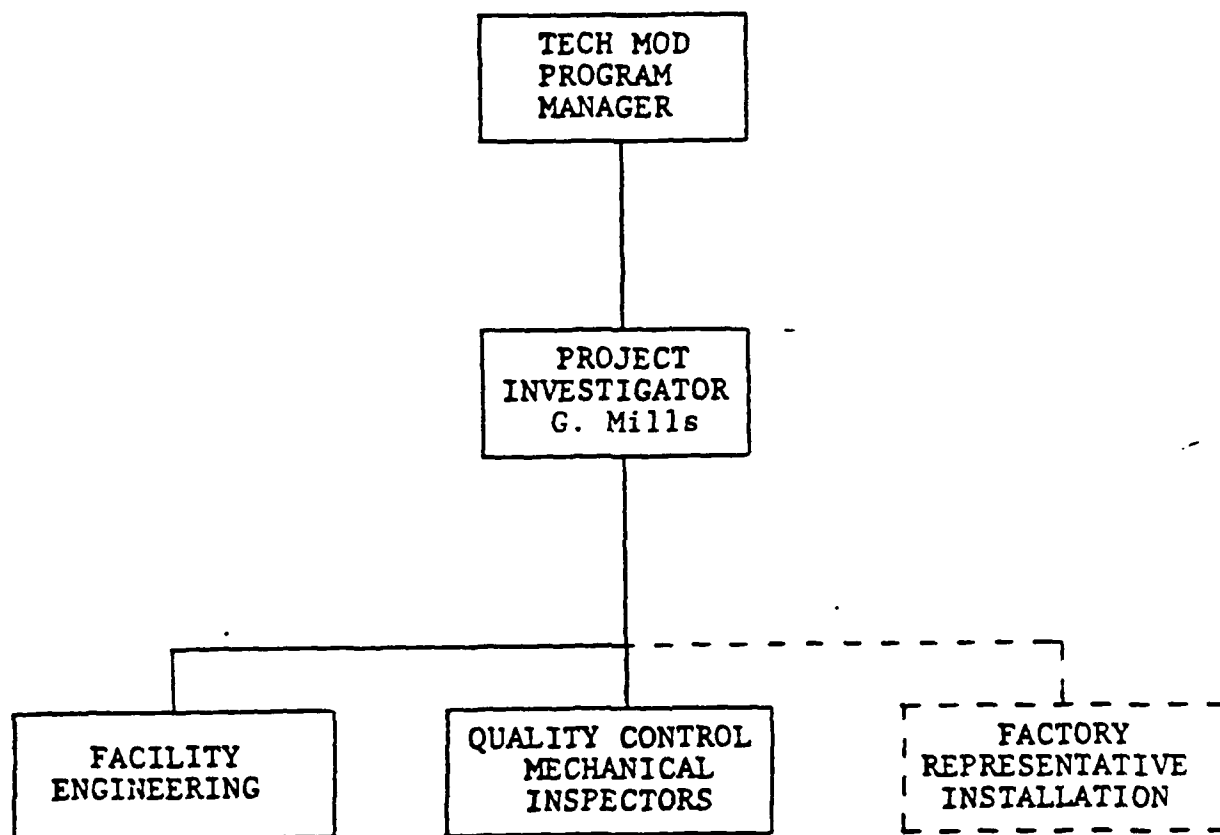
3.0

PROJECT MANAGEMENT

The Project Investigator for this project was Gordon Mills, Quality Engineer. He was supported by Facility Engineering, Quality Control, Mechanical Inspection, and Factory Representatives (manufacturer of Coordinate Measurement Machine). His responsibilities included project management, cost, schedule, and technical conformances. The organization of the project is depicted in Figure 5, and an example of the Project Master Schedule used in accomplishing the project is shown in Figure 6.



Project: Tech Mod, Cat I, Coordinate Measuring System for  
Receiving Inspection



PROGRAM MANAGEMENT

Figure 5



PROJECT: Coordinate Measuring System  
PROJECT INVESTIGATOR: G. Mills

CHART TYPE: PROJECT MASTER SCHEDULE

PAGE 2 OF 3

REVISION DATE: 01/24/03 CHARGE NO.: 902-02

TASK	ACTION	MANHOURS		"D" FIELD	MONTHS								
		BUDGET	ACT		JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.
V. DESIGN SYSTEM/FACILITY													
A. Prepare Facility Layouts	FE/QC				8								
VI. COST/BENEFIT ANALYSIS													
A. Approved Production/Delivery Schedule	CO/PD				A-A								
B. Cost Element Identification/Time Phase	CA/GA/P				A-A								
C. Saving Elements (LRU/System/Hr)	CA/GA/P				A-A								
D. Financial Analysis	CA/GA/P					A-A							
VII. SUBMIT PHASE III PROPOSAL	CO/P								A				
VIII. PREPARE IMPLEMENTATION PLANS													
A. Equipment Listing	QC/QE				B								
B. C.E. Justifications, Facilities Improvement requests and P/R's	B/QC/FE				9								
C. Schedule on Facility Installation	FE				B								
D. Schedule on CMM Installation	FE/FS/QC/DPH				B								

PE - Buyer  
 ME - Budget Control  
 MS - Budget Supervisor  
 C - Consultant  
 CA - Cost Accounting  
 CB - Contract Officer  
 P - Personnel  
 PE - Design Engr  
 PM - Pfr. Primary Mfg.  
 QZ - Facilities Engr  
 FR - Factory Rep.  
 FS - Facilities Service  
 CA - General Accounting  
 CM - Metrology  
 ME - Manufacturing Engr  
 MS - Model Shop  
 MCP - MC Programmer  
 SMC - Sr. Mfg. Engr  
 CP - Proposals  
 PI - Project Investigator  
 PD - Production Director  
 PP - Production Planner  
 PA - Programmer  
 QC - Quality Control  
 QE - Quality Engr  
 RE - Reliability Engr  
 TD - Tool Designer  
 ME - Mfg. Test Engr  
 TMO - Tech Mod Office

Approved Functions

PROJECT: Coordinate Measuring System  
PROJECT INVESTIGATOR: G. Mills

CHART TYPE: PROJECT MASTER SCHEDULE

REVISION DATE: 01/24/83 CHARGE NO.: 902-02

PAGE 3 OF 3

TASK	ACTION	MANHOURS		"D" FIELD	MONTHS								
		BUDGET	ACT		JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.
IX. <u>PROCURE AND INSTALL CAPITAL EQUIP.</u> A. Issue FIRs and P.R.'s  B. Move new CRM  C. Move old CRM  D. Operator Training E. Receive and Install  F. Debug CRM's and Calibration Coordination (Tracor Metrology & Factory Rep.)	PI					9							
	FE/FS/ FR						15						
	FE/FS/ FR							18 (To be accelerated; if possible)					
	QC						14	20					
	FE/FS/ FR						14-16						
	FR/M							14					
X. RELEASE TO PA	THO						14						

(To be accelerated; if possible)

\*g - Buyer  
 BC - Budget Control  
 BS - Block Supervisor  
 C - Consultant  
 \*Overhead Functions  
 \*QA - Cost Accounting  
 \*CO - Contract Officer  
 \*D - Draftsman  
 \*E - Design Engr  
 \*PM - Dir. Primary Mfg.  
 \*FE - Facilities Engr  
 \*F - Factory Rep  
 \*S - Facilities Service  
 \*QA - General Accounting  
 \*M - Metrology  
 \*M - Manufacturing Engr  
 \*S - Model Shop  
 \*CP - MC Programmer  
 \*S - Sr. Mfg. Engr  
 \*P - Proposal  
 \*PI - Project Investigator  
 \*PD - Production Director  
 \*PP - Production Planner  
 \*PB - Programmer  
 \*QC - Quality Control  
 \*QE - Quality Engr  
 \*RE - Reliability Engr  
 \*TD - Tool Designer  
 \*ME - Mfg. Test Engr  
 \*MO - Tech Mtd Office

4.0

COST BENEFIT ANALYSIS

A detailed cost benefit analysis was made to document the anticipated savings to be accrued by implementing the Coordinate Measuring System project. Studies were conducted for each part that was projected across the Boice B-401 machine, and the savings were computed by comparing present and proposed times. Also, savings were realized in three (3) areas listed below:

1) Removed transportation time from Receiving Inspection to Metal Services/Fabrication Shop. This time, 15 minutes per lot of material, has been eliminated. With approximately 375 lots moved yearly, this results in a saving of 94 hours of inspectors time per year.

2) Use of multiple inspection setups in the Metal Services/Fabrication Shop. The larger work space now available on the Boice 401 permits as many as four (4) setups to be in place at one time. It is estimated that this will result in 360 hours of inspectors time per year.

3) Reduction in rework as a result of more timely inspection. The constant access to the CMS, while parts are being machined, will provide operators with more timely information on the quality of parts being made, preventing rework of parts already made. Currently 2200 hours of rework are being used per year. It is estimated that this time will be reduced by 15% or 329 hours per year.

Total project cost was \$105,778. Total savings were \$122,028, which were projected over a 13-year period. Inserting this information into Tracor's cash flow model, a project IRR of 2.752% was computed. Because of this unfavorable

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return on investment, Tracor's management decided not to enter into a project business agreement, but to pass all savings to the customers, and terminate the project.