MECHANIZATION OF PROCUREMENT FUNCTIONS
(formal title)

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BY

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CHAPTER I

INTRODUCTION

Statement of the Problem

Control of purchasing and storage of purchased parts has in the past been a very costly and difficult operation within industry. The procedures and processes established by the corporations to perform these two functions, in most cases, were very cumbersome and required extensive records and reports.¹ This "record keeping", in addition to creating voluminous amounts of paper work, required the services of a great number of personnel as well as a large storage area for the records created. This waste of productive space, the cost of manpower, and most important; the delays created by a lack of up-to-date information as to the status of purchase requisitions and inventory control, led industry into a difficult problem. It was noted that a

greater and greater percentage of the available production area was being utilized for record keeping and office space, and that production was slowed due to lack of proper control in the purchasing and inventory functions. What the manager of industry needed was a means by which purchasing and inventory records could be processed and stored in a minimum amount of space with extremely rapid access time. An obvious solution to this problem was the use of high speed electronic computers.

The electronic computer has, in recent years, been viewed as a panacea for all ills in business and industry. Since the development of the first electronic computer in 1944, based on many principles and concepts of Charles Babbage,¹ more and more applications have been found for this "inanimate friend of all businessmen." Many studies, such as that of William Lewis Alden,² have been made presenting principles of, history of, and uses for electronic computers. These studies have been general in nature and did not indicate what financial advantage could be realized through proper utilization of these


computers. Just to have a computer "in the house" does not mean that substantial benefits may be obtained from it. Without careful and thorough feasibility studies before the actual installation, the anticipated savings in costs of labor, machine, space, and storage, etc., may never be realized. Using proper techniques, such as presented by Gregory and VanHorn, a computer can contribute its fair share to the profitability of a firm.

Hypothesis

Many accounting systems that were in use prior to the advent of electronic computers used various electric machinery to process the flow of documents. These included card readers, card sorters, paper tape machines, etc. Mechanization of a system utilizing one or more of these components could be more readily accomplished than a system that utilized none. Various document flows would remain the same, only the origination and processing medium would change. A computer could accomplish both of these operations more efficiently than an


electrically assisted system.

Since a computer basically replaces or augments the operating costs of direct labor and accounting machinery, the determination of cost savings for these two items is indicative of the effectiveness of mechanized systems. Procurement and inventory are two ideal areas for the application of an electronic computer.¹ It is the author's intention to analyze in detail one firm's experience with a computer application in support of the hypothesis:

"Mechanization of procurement and storage of controlled purchased parts results in savings of operating costs in comparison to electrically assisted manual methods."

Definition of Terms

Mechanization includes the collection, conversion, verification, rearranging, and processing of data by an electronic computer in order to output documents, reports, and instructions for various purposes.²


Purchasing in this study consists of the requirements determination, and the procurement of purchased vendor parts.

Storage in this study consists of the receiving, records auditing, and records accountability functions.

Controlled purchased parts are those vendor parts that due to their specific purpose, use, or dollar value must be controlled during all phases of their ordering, storage, and use.

Electrically assisted is the use of electric accounting machines to augment a manual accounting system.

Operating costs are those labor and machine costs associated with a particular function.

Method of Presentation

The main proof of the hypothesis is presented as a case study of results obtained at Lockheed Aircraft Corporation, California Company, Burbank, California. To present a comprehensive analysis of this company, the procurement and storage operations are broken down into five distinct functions. These are:

1. Material Requirements
2. Material Procurement
3. Receiving
4. Material Records Audit
5. Material Records Accountability
Each of these functions is considered separately as a chapter in this thesis. The detailed analysis of each presents the operating labor costs for the system prior to and after the conversion to mechanized means. Since some criteria must be utilized to minimize error induced by variation in volume of operation, the labor cost per transaction will also be developed for each functional area.

Since all five functions benefit from the mechanization, the machine costs are presented in terms of dollars per year for the entire material procurement and storage operation. By utilizing the transaction figures for the five functions considered, an average dollar per transaction machine cost is determined prior to and after mechanization.

The summation of the labor and machine cost per transaction figures for the five functional areas during the two years under study, yields two total costs that are compared to show the percentage reduction possible when an existing system is mechanized. A comparison of the before and after flow charts in the following chapters shows the extreme similarity in the operation of the two systems.
The manual systems were converted to mechanized means during 1955 and 1956. Since the costs developed for these periods are not indicative of the true costs of the systems, the years of 1954 (before) and 1957 (after) are chosen as the study years. All cost and transaction figures presented are for these two years.

Additional substantiation of the hypothesis is presented in the form of computer manufacturer's claims and development of computer applications at other firms. Whatever cost information that is available for these firms is also presented.

Sources of Information

The data utilized come from three sources. All data pertaining to the case study are obtained from published reports, official records, and personal interviews at Lockheed Aircraft Corporation, California Company, Burbank, California. The reports and records are found in the files of the Data Processing Planning Staff and the Materiel Systems Planning Staff. Interviews with Mr. Philip Grant of the Materiel Systems Planning Staff established various criteria required to present a comprehensive analysis of the two years under study.
Manufacturer's claims are obtained from literature created and distributed by various computer manufacturers.

All data pertaining to the development of computer applications are found in various published technical books and periodicals dealing with the subjects of business and computers.
CHAPTER II

MANUFACTURER'S CLAIMS

General

To provide a base for examining a series of detailed experiences of computer applications, it is the intention of this chapter to present the claims of computer manufacturers as to the applicability of their products to the various problems present in business today. These claims are often presented by the manufacturers as a study of a particular equipment system applied to a specific problem. These problems are encountered in all phases of business operations such as production, communications, material control, accounting, etc. The following examples will amplify the application of computers to these and other phases of operation.

Numerical Control of Machine Tools

This computer system provides a method of programming and accomplishing automatic milling machine

operation under numerical control. Numerically controlled machines can work with a high degree of accuracy, being capable of holding to tolerances as close as plus or minus .0002 inches. The advantages gained are increased productivity, reduction in lead time, reduction of production costs, closer control over dimensions, and optimization of spare parts inventory.

Inquiry and Readout for IBM Ramac Computer

The computer inquiry system described provides rapid and direct connection to a random access computer storing job status information. At the California Division of Lockheed Aircraft Corporation, Burbank, California, more than 60,000 open orders are in-plant at any single time. The computer follows the progress of each of these jobs through some 500 work load centers within the plant. Job status information must be made available to production and engineering personnel on an immediate basis to provide a smooth flow of work through the plant. An average of 800 job status inquiries is reached each day. Inquiry and readout is accomplished by paper tape equipment placed at various locations in the plant.

1Inquiry and Readout for IBM Ramac Computer, Form No. 3547, TELautograph Corp., Los Angeles, California.
It is felt (by TELautograph) that the inquiry system will open new areas of computer usefulness in such applications as:

**Sales Operations** - It will act as a communication media between the field and a central computer facility. Orders will be processed and inventory and shipping information returned to the field.

**Chain Stores** - Branch managers will be able to forward daily orders which the computer will process, producing the necessary paperwork to ship the merchandise.

**Insurance** - The data transmission system will make possible central data processing in national insurance operations.

**Wholesalers and Distributors** - Branch or retail operations connected to a central computer will send inquiries and receive answers on stock level, shipping data, and order status in a few seconds time.

**Branch Office Payroll** - The branch will transmit man/time data to the central computer and receive, within seconds, return signals which will create payroll checks on the branch receiver.
Data Processing Systems for the Textile Industry

The system described utilizes the IBM Ramac 1401 and Ramac 1410 Data Processing Systems to provide a scientific, total management data control system in weaving and finishing. The management areas incorporated into these systems include:

1. Sales and profit forecasting
2. Available for sale reporting
3. Optimum plant scheduling
4. Gross and net raw material calculations
5. Standard machine and labor requirement calculations
6. Warp and fill requirements
7. Warp status
8. Loom status and runout schedules
9. Cost recovery
10. Grading analysis and quality control
11. Cost accounting
12. Payroll
13. Dye and chemical inventory
14. In-process lot control
15. Finished inventory.

---

The systems described include not only application to operations of a company with one plant, but also to those of a company with multiple plants. In many cases the Ramac 1401 or 1410 more than pays for itself because of the ability of central management to operate the plant system as a whole, rather than as a series of parts.

Integrated Accounting for Federal Government

This data processing system provides a comprehensive and completely unified accounting system for a federal government agency. The major accounting areas of appropriation and allotment accounting, personnel, cost accounting, and payroll are merged into a unified system. In this system, the results obtained from one operation can be used as input for other functions required without further transcription or preparation. This system provides the following advantages:

1. **In-line processing** - Maintenance, in a single operation, of all related records.

2. **Comprehensive management data** - Standards and

---

operating statistics are economically converted into effective management reports.

3. **More effective forecasting** - Accurate and timely data for budget and production requirements.

4. **Management by exception** - Attention is automatically directed to critical areas for management analysis and action.

5. **Better personnel utilization** - More effective use of experienced personnel through the assignment of routine clerical operations to electronics.

6. **System capability** - Provides processing capacity for expanded application areas and future growth.

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**Manufacturing Control by the IBM Method**

Manufacturing control is the managerial activity of planning, executing, and evaluating the results of a program of material conversion. Administration of the functions of production management requires many records.

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\[1\text{Form No. 32-5608-2, International Business Machines Corp., 590 Madison Ave., New York, N. Y.}\]
and reports. Various systems have been developed by IBM for this purpose. All utilize, at one time or another, the punched IBM card for the transmission or processing of data.

The advantages given for IBM methods of manufacturing control are:

Complete forecasting statistics and analysis of current sales provide a sound basis for planning the production program.

Automatic calculation of requirements for materials, manpower, and facilities.

Stock status summary reports of all active raw material items and parts can be submitted to management daily, weekly, or monthly, as desired.

Equipment policies are established by up to date information concerning machine tool loads.

Control planning for the complete cycle of manufacturing operations can be reduced to a matter of days.

Clerical operations are reduced by eliminating the manual preparation of job cards, material requisitions, stock delivery cards, stock identification tags, move tickets, and tool requisitions.
General factory accounting is coordinated with the record-keeping operations essential to manufacturing control.

Revision of specifications to incorporate changes in engineering or manufacturing processes is simplified by IBM card unit records.

Control of manufacturing operations is aided by the availability of essential information more rapidly and accurately.

Parts Inventory Control (An Application of Datatron)

The problem a manufacturer faces each month is to determine how many of each of his 1000 products should be assembled. He must be sure of an adequate supply of 30,000 different parts to complete all assemblies and meet scheduled delivery dates.

The results of applying this data processing system to inventory control yields the following results:

Unallocated inventory balance has been reduced by the number of parts to be used during the month. Supplies on hand, plus those on order, have been checked for a predetermined order point.

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1Pamphlet No. 5-01-110, Electro Data a Division of Burroughs Corporation, Los Angeles, California.
Where required, reorder information with supplier code, part number, description, and quantity have been punched on cards.

The manufacturer can continue production assured that the necessary parts are on hand or have been ordered.

Periodically the inventory file will be updated by items received, by disbursements, and by additions and deletions.

Summary

A study of the several examples presented reveals a multitude of claims by the manufacturers for their equipment. These claims, when examined carefully, always condense to the main advantages of utilizing an Electronic Data Processing System.

A Data Processing System provides a compact and extremely accurate tool by which a business organization may collect, process, transmit, and control various component parts of the business entity. These parts may consist of machine tool operation, production control, budgetary control, and inventory control, to name just a few.

Some benefits gained include more rapid dissemination of reported information, reduction of storage space,
reduction in total manpower, reduction in inventory, and most important, better control over the total activities of the business.
CHAPTER III

HISTORY OF EAM AND MECHANIZED APPLICATIONS

General

The ENIAC (Electronic Numerical Integrator and Calculator), built between 1942 and 1946 at the University of Pennsylvania, was the first machine to use electronic tubes for calculating.¹ A surge of advancement in the "state of the art" resulted in the design and construction of 6000 units of about one hundred different models since 1949.² These computers found their way into industry and many organizations utilized them in the materials and materials handling areas. This chapter presents a brief history and summary of results of these computer applications.


²Ibid.

-19-
American Airlines\textsuperscript{1}

Since the determination of availability of passenger space was an inventory problem, American Airlines made use of the computer for an early stride in the area of materials (seating space) control. This system enabled the airline to keep an accurate up-to-date record of all seats available and all seats sold in the course of their business. Through proper utilization of this information, they were able to affect efficiencies in operations and sales, while improving service to their customers.

John Plain and Company, Chicago, Illinois\textsuperscript{2}

This company was engaged in business as a wholesale mail order house. During the period of the case study, it sold more than $300,000 in merchandise daily during peak seasons. The offices occupied thirteen floors of a building. Their inventory consisted of 8000 items from 1000 manufacturers, not including breakdown by size and color. During peak seasons, as many as 15,000 orders

\begin{itemize}
  \item \textsuperscript{1}E. C. Kellog, "Electronics; Push Button Inventory," \textit{Iron Age}, July 10, 1952, p. 92.
\end{itemize}
with an average of ten items per order were processed. This amounted to 150,000 inventory changes per day.

Mechanization of the inventory function resulted in the reduction of the labor force from 150 tally clerks to 10 computer operators. The installation of the computer saved much needed office space and provided a much closer control over the inventory balances. While very real gains were made that could be measured in dollars, the company believed that the dollars saved in operation were greatly outweighed by the intangible advantages gained. An interesting example of a type of "fringe benefit" is presented by M. Friedman, where an investment of $18,000 for EAM equipment caused a capital saving of $500,000. This saving resulted from more accurate control of inventory that eliminated the necessity of constructing additional warehouse facilities.

**Lockheed Aircraft Corporation, Burbank, California**

Lockheed converted from a punched card control procedure to electronic data processing in December 1954.

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The control system considered four points:

1. What parts are required?
2. How many are required?
3. Where are the parts required?
4. What contracts require the parts?

Rental cost of the computer was 35% greater than the punch card equipment that it replaced, but a net reduction of 39 employees in the tabulating department was effected. In addition, seven to eight people were no longer required for checking and controlling in the Production Control Department. Approximately $60,000 savings in supplies (primarily punched cards) was realized in the first year of operation.

The net savings realized in the first year was $200,000 when no allowance was made for amortizing installation costs. When amortization was considered, the break even point for the new operation was reached by the end of the first year.

Retail Store Chain\(^1\)

This retail chain had a home office and six hundred

stores grouped into six regions at the time of this study. They employed approximately 1,000 employees at the home office with 36,000 in the stores. The yearly sales were $400 million with an average sale of $1. Their stock turnover was five times in one year with 10-30,000 items in inventory.

After the computer installation, inventory reduction was affected along with the reduction in the staff of each store of from two to six people as well as a reduction in the home office staff of one hundred people. The net savings realized per year was $2,480,000.

Certified Grocers of California\(^1\)

This firm installed Datatrons in 1957. At the time, it was one of the largest independently owned food merchandizing organizations in the United States. Treasurer-Controller Price estimates a savings of $1 million in materials and labor over a five year period.

Columbia Records\(^2\)

All visual accounting records were abandoned along


with all transfer posting operations. Six clerks, four comptometer operators, and one National Cash Register operator were no longer needed in this area. The computer was able to accept orders from customers and determine production schedules required to fill all orders. An additional operation kept account of all royalties due to performers.

Summary

Chapters II and III, statistically speaking, create a "Universe" of claims by manufacturers and results of specific applications of mechanized equipment. This "Universe" is created in order to extract and examine one "Sample" of a mechanized application while considering only the operating costs of the function. Since the claims cited in Chapter II and the experiences cited in Chapter III, do indicate reductions in operating costs after mechanization, they will lend support to the detailed analysis presented to establish the validity of the hypothesis presented on page 4.
CHAPTER IV

MATERIAL REQUIREMENTS FUNCTION

Description of the Function

The Material Requirements Function is performed by authority granted to the Procurement Records and Services Department by the Director of Materiel. This function is the first performed in the procedure established at the California Division, Lockheed Aircraft Corporation, Burbank, California to purchase and store Controlled Purchased Parts.

The purposes for this function are contained in the Operations Functions and Responsibilities Statement presented as Appendix I on page 74. The primary purpose is to provide detailed material requirements to the Material Procurement Function for further processing. The parts listings utilized to accomplish this are received from Engineering and Production Control. These documents are sequenced, extended, filed, and then processed into requirement data that is supplied to the
Material Procurement and Material Records Audit Functions.

A secondary function is to accept advance material orders and requests to purchase from Change Control and requests for investigation from Material Procurement. These documents are processed and output as requirements to Material Procurement, documentation to Material Records Audit, and results of investigation to Material Procurement.

Figure 1 depicts the system as it existed prior to mechanization.

Discussion of Conversion

Figure 2 depicts the system that existed after the initial mechanization. This function maintains the same basic flow diagram, with a substitution of tape equipment being made for the normal tabulating equipment used previously. The inputs utilized are still in the form of Parts Requirement Cards that are processed and then stored in the General Files. Where these files were used before to prepare Material Requirement Cards on tabulating equipment, under the mechanized system they are processed on card to tape machinery to provide a tape of detailed requirements for utilization by Material Procurement in their D.P.C. run.
FIG. 1 - BEFORE - MATERIAL REQUIREMENTS

TOTAL PERSONNEL = 12

1. RECIPIENTING DESK
2. GENERAL FILES
   - PUNCH CARD PROCESS

1. SERVICE KIT & SPARES EXTENSION
2. KEY PUNCH

1. REQUIREMENTS INVESTIGATION
2. REQUIREMENTS INVESTIGATION

1. ADDRESSOGRAPH
2. KARDEX INFORMATION

1. INTERVIEW WITH PHILIP GRANT, CALIFORNIA DIVISION, LOCKHEED AIRCRAFT CORP., BURBANK, CALIF. JUNE 1962
FIG. 2 - AFTER - MATERIAL REQUIREMENTS ¹

TOTAL PERSONNEL = 9 1/2

1 INTEGRATED DATA PROCESSING FOR MATERIAL AS OF JULY 1, 1959, CALIF. DIV., LOCKHEED AIRCRAFT CORP., BURBANK, CALIF.
Summary of Labor Cost Data

Study of the two flow charts presented on pages 27 and 28 shows that the total number of personnel was reduced from twelve to nine and one-half in the two time periods under study. The direct labor cost was $48,526.40 before and $40,019.20 after mechanization.

The number of transactions, or document input, was 611,414 before and 551,325 after mechanization.

Conversion of this data to a cost per transaction figure yields the following results:

\[ \frac{\$48,526.40}{611,414} = \$0.07937 \]

\[ \frac{\$40,019.20}{551,325} = \$0.07258 \]

This amounts to a reduction in direct labor cost of

\[ \frac{\$0.07937 - \$0.07258}{\$0.07937} \times 100 = 8.55\% \]

required to process one document through the Material Requirements Function.

\[ \text{1 Interview with Philip Grant, Materiel Systems Planning Staff, California Division, Lockheed Aircraft Corporation, Burbank, California, June 1962.} \]
CHAPTER V

MATERIAL PROCUREMENT FUNCTION

Description of the Function

The Material Procurement Function also operates under authority granted to the Procurement Records and Services Department by the Director of Materiel.

The primary purpose of this function is to create documentation required to purchase parts as needed, in order to meet the requirements established in the Material Requirements Function. This is accomplished by examination of detail requirements with their corresponding procurement authority and the material position records. If this examination indicates that a shortage will exist for a specific part, a Request to Purchase document is forwarded to the Purchasing Department for further processing.

A secondary purpose of this function is to determine those parts that are no longer required to maintain current production or provide spare parts to customers.
When an inventory item is so declared, a Surplus Declaration is forwarded to the Material Sales Department in order to accomplish disposition of the subject parts.

Figure 3 depicts the system as it existed prior to mechanization.

Discussion of Conversion

Figure 4 depicts the system that existed after the initial mechanization. Even though the basic flow diagram remains practically the same, the efficiencies of electronic data processing allow processing of the detail requirements monthly instead of bi-monthly as was done previously. Under the old system, manual examination of the Kardex file was made on a sixty day "flip" cycle to determine those parts that required further action. Each and every Kardex had to be examined to ascertain if a debit or credit balance existed. Under the mechanized system, those items requiring attention are determined "by exception". This means that all zero and credit balances are sorted out by the computer prior to the Material Planners' examination of the Material Position Records.

These Material Position Record Reports are more convenient to use than the Kardex files were, and therefore
FIG. 3 - BEFORE - MATERIAL PROCUREMENT

TOTAL PERSONNEL = 61

MATERIAL RECORDS
AUDIT

KARDEX INFORMATION

WORK ORDER DEPT.

PROCUREMENT AUTHORITY

MATERIAL REQUIREMENTS

DETAIL REQUIREMENTS

KARDEX FILE

MATL. REQS.

PUNCH CARD

PROCESS.

PLANNER

SUPPORT

SHORT REQS.

AVAILABLE CHECK

TO: SHORT FILE

TO: CHANGE CONTROL

REQUEST TO PURCHASE

SURPLUS DECLARATION

TO: PURCHASING DEPT.

TO: MATL. SALES DEPT.

MATERIAL PLANNER

WORK ASSIGN.

SUPERVISION

1 INTERVIEW WITH PHILIP GRANT, CALIFORNIA DIVISION, LOCKHEED AIRCRAFT CORP., BURBANK, CALIF., JUNE 1982
FIG. 4 - AFTER - MATERIAL PROCUREMENT
TOTAL PERSONNEL = 41

DOCUMENTS FROM:

MATERIAL RECORDS AUDIT

LEDGERS

WORK ORDER DEPT.

PROCUREMENT AUTHORITY

MATERIAL REQUIREMENT

DETAIL REQUIREMENTS

MATERIAL RECORDS

TRANSACTIONS

DATA PROCESS. CENTER

LEDGER FILE

MATERIAL PLANNER

REQUISITION

MATERIAL POSITION RECORD

WORK ASSIGN.

SUPERVISION

PLANNER SUPPORT

AVAILABILITY CHECK

TO: CHANGE CONTROL

SHORT REQUISITIONS

TO: SHORT FILE

REQUEST TO PURCHASE

TO: PURCHASING DEPT.

SURPLUS DECLARATION

TO: MATL. SALES DEPT.

INTEGRATED DATA PROCESSING FOR MATERIAL AS OF JULY 1, 1958, CALIF. DIV., LOCKHEED AIRCRAFT CORP., BURBANK, CALIF.
provide more efficient utilization of the Planners' productive time.

**Summary of Labor Cost Data**

Study of the two flow charts presented on pages 32 and 33 shows that the total number of personnel in this function was reduced from sixty one to forty one in the two time periods under study. The direct labor cost was $280,373.60\(^1\) before and $200,782.40\(^1\) after mechanization.

Due to the fact that examination of material records was made monthly instead of bi-monthly, a large variation in transactions occurs in the two years under study. The number of transactions was 93,898\(^1\) before and 307,280\(^1\) after mechanization.

Conversion of this data to a cost per transaction figure yields the following results:

Before: $280,373.60 \over 93,898 = \$2.98593$

After: $200,782.40 \over 307,280 = \$0.65341$

This amounts to a reduction in direct labor cost of

\(^1\)Interview with Philip Grant, Materiel Systems Planning Staff, California Division, Lockheed Aircraft Corporation, Burbank, California, June 1962.
\[
\frac{2.98593 - 0.65341}{2.98593} \times 100 = 78.1\%
\]

required to process one document through the Material Procurement Function.
CHAPTER VI

RECEIVING FUNCTION

Description of the Function

The Receiving Function is performed by authority granted to the Receiving Department by the Director of Materiel. The purposes for this function are contained in the Operations Functions and Responsibilities Statement presented as Appendix 2 on page 80.

This function is responsible for the receipt, count, and accuracy of all shipments received from vendors. They create a Receiving Memo that accompanies the parts to stores, notifies Purchasing of receipt of goods, informs Accounts Payable of payment due, and inputs data into the Material Records Audit Function. Shortages and damage in shipment are reconciled within the operation of this function.

Figure 5 depicts the system as it existed prior to mechanization.
Discussion of Conversion

The Receiving Function is the only one of the five functions under study that was not changed during the initial mechanization. All activities that existed prior to mechanization were continued after. The incoming packing slips still remain as the documentation required to perform this function.

Summary of Labor Cost Data

Study of the two flow charts presented on pages 37 and 39 shows that no reduction in personnel took place in the two time periods under study. The direct labor cost for the twelve personnel involved was $50,606.40 before and $52,832.00 after mechanization.

The number of transactions was 91,343 before and 102,663 after mechanization.

Conversion of this data to a cost per transaction figure yields the following results:

\[
\text{Before: } \frac{50,606.40}{91,343} = 0.55402$
\]

\[
\text{After: } \frac{52,832.00}{102,663} = 0.51461$
\]

\(^1\)Interview with Philip Grant, Materiel Systems Planning Staff, California Division, Lockheed Aircraft Corporation, Burbank, California, June, 1962.
FIG. 6 - AFTER RECEIVING FUNCTION

TOTAL PERSONNEL = 13 ½

DOCUMENTS FROM:

VENDOR

PARTS PACKING SLIP

RECEIVING DOCK

PARTS

STORAGE & COUNT AREA

PARTS RECEIVING MEMO

INSPECTION AREA

GOOD PARTS TO: STORES

RECEIVES TO: MATERIAL REVIEW BOOTH

RECEIVING MEMO BUYERS TO: PURCHASING

COPY

ASSEMBLER

RECEIVING MEMO ASSEMBLER

BUYERS TO: PURCHASING

PACKING SLIP

P.O. MASTER FILE

RECEIVING GRIEF DESK

PURCHASE ORDER MASTER

P.O. MASTER PACKING SLIP

RECEIVING PACKING SLIP

PACKING SLIP

TYPIST

DITTO OPERATOR

PACKING SLIP

RECEIVING MEMO

RECEIVING MEMO & PACK. SLIP

SHORT PARTS FILE

RECEIVING MEMO PACK. SLIP

TRANSMITTAL DESK

TO: AGENTS

COPR.1968, LOCKHEED AIRCRAFT CORP., BURBANK, CALIF.
This change in per transaction cost is directly attributable to the change in volume in the activity of the function. Because of this, the "before" cost will be assumed as an "after" cost in the final summation presented on page 58.
CHAPTER VII

MATERIAL RECORDS AUDIT FUNCTION

Description of the Function

The Material Records Audit Function also operates under authority granted to the Procurement Records and Services Department by the Director of Materiel.

The primary purpose of this function is to provide an accurate Material Position Record for utilization by the Material Procurement Function for determination of requirements necessary. Correct inventory balances and average price per part are determined by continuous updating of inventory and transaction records.

Figure 7 depicts the system as it existed prior to mechanization.

Discussion of Conversion

Figure 8 depicts the system that existed after the initial mechanization. This function benefited greatly from the conversion. A comptometer group that
FIG. 7 - BEFORE - MATERIAL RECORDS AUDIT
TOTAL PERSONNEL = 41

1 INTERVIEW WITH PHILIP GRANT, CALIFORNIA DIVISION, LOCKHEED AIRCRAFT CORP., BURBANK, CALIF., JUNE 1962
DOCUMENTS FROM:

STORES  PARTS REQUISITION

RECEIVING  RECEIVING MEMO

PURCHASING  PURCHASE ORDER

MATERIAL RECORDS ACCOUNT

RECONSTRUCTION OF LOST RECORDS

MATERIAL REQUIREMENT

LEDGERS

STOCK COUNT

FIG. 8 — AFTER - MATERIAL RECORDS AUDIT

TOTA L PERSONNEL = 24

(3) DOCUMENT SEQUENCING

(5) CODING

(8) N.C.R. OPERATORS COUPLED IN-LINE

(6) IBM 026 KEYPUNCH

(2) KEYPUNCH VERIFICATION

TO: D.P.C. RUN MATERIAL PROCUREMENT

TO: FILES

STOCK COUNT

STOCK COUNT

PRICE GRIEF

1 INTEGRATED DATA PROCESSING FOR MATERIEL AS OF JULY 1, 1958, CALIF. DIV., LOCKHEED AIRCRAFT CORP., BURBANK, CALIF.
was responsible for the arithmetic accuracy of the Material Position Records (Kardex balancing, inventory listing, etc.) was eliminated from the system. Their function, after mechanization of the system, was performed during the Material Procurement D.P.C. run by updating the "stored" Material Position Records with the data contained on the transaction tape output from this function.

A coding group was added to assist the National Cash Register operators in their processing of the Receiving Memos, Purchase Orders, and Purchased Parts Requisitions utilized as input into this function.

Material Position Ledgers, updated by the N.C.R. operators, are used instead of the Kardex files used previously.

**Summary of Labor Cost Data**

Study of the two flow charts presented on pages 42 and 43 shows that the total number of personnel was reduced from forty one to twenty four in the two time periods under study. The direct labor cost was $157,456.00 before and $96,408.00 after mechanization.

\(^1\)Interview with Philip Grant, Materiel Systems Planning Staff, California Division, Lockheed Aircraft Corporation, Burbank, California, June, 1962.
The number of transactions was 883,987\textsuperscript{1} before and 999,767\textsuperscript{1} after mechanization.

Conversion of this data to a cost per transaction figure yields the following results:

\begin{align*}
\text{Before: } \frac{\$157,456.00}{883,987} &= \$0.17812 \\
\text{After: } \frac{\$96,408.00}{999,767} &= \$0.09643
\end{align*}

This amounts to a reduction in direct labor cost of
\[
\frac{\$0.17812 - \$0.09643}{\$0.17812} \times 100 = 45.86\%
\]
required to process one document through the Material Records Audit Function.

\textsuperscript{1}Interview with Philip Grant, Materiel Systems Planning Staff, California Division, Lockheed Aircraft Corporation, Burbank, California, June, 1962.
CHAPTER VIII
MATERIAL RECORDS ACCOUNTABILITY FUNCTION

Description of the Function

The Material Records Accountability Function also operates under authority granted to the Procurement Records and Services Department by the Director of Materiel.

The primary purpose of this function is to support the Material Procurement and Material Records Audit Functions by reconciling all variations in physical count on the production line and inventory balances on the Cost Accounting ledgers versus records as established through the material system. Adjustments are made to the Material Position Records to indicate the results of investigations performed within this function.

Figure 9 depicts the system as it existed prior to mechanization.

Discussion of Conversion

Figure 10 depicts the system that existed after the initial mechanization. This function maintains the
DOCUMENTS FROM:
ACCOUNTING
- REWORK SUSPENSE DISCREPANCIES
ACCOUNTS PAYABLE
- INVOICE DISCREPANCIES
MATERIALS RECORD AUDIT
- KARDEX INFORMATION

SUPERVISORS

MATERIALS RECORDS INVESTIGATORS
REQUEST FOR ADJUSTMENT
TO: PRODUCTION CONTROL

RECONSTRUCTION OF LOST RECORDS
TO: MATERIALS RECORD AUDIT

TOTAL PERSONNEL = 20

FIG. 9 - BEFORE - MATERIAL RECORDS ACCOUNTABILITY

1 INTERVIEW WITH PHILIP GRANT, CALIFORNIA DIVISION, LOCKHEED AIRCRAFT CORP., BURBANK, CALIF., JUNE 1962
DOCUMENTS FROM:

- TABULATING E.A.M.
- REWORK SUSPENSE DISCREPANCIES
- ACCOUNTS PAYABLE
  - INVOICE DISCREPANCIES
  - UNMATCHED INVOICES
- D.P.C. RUN MATERIAL PROCUREMENT
- MATERIAL POSITION RECORDS
- LEDGER FILE

FIG. 10 - AFTER - MATERIAL RECORDS ACCOUNTABILITY

TOTAL PERSONNEL = 18

- RECONSTRUCTION OF LOST RECORDS
- TO: MATERIALS RECORD AUDIT
- REQUEST FOR ADJUSTMENT
  - TO: PRODUCTION CONTROL

INTEGRATED DATA PROCESSING FOR MATERIAL AS OF JULY 1, 1958, CALIF. DIV., LOCKHEED AIRCRAFT CORP., BURBANK, CALIF.
same basic flow diagram that existed prior to mechanization. The main difference is the utilization of Material Position Records in report form instead of the Kardex files used previously. The Kardex files were originally produced in the Material Records Audit Function, while the Material Position Records are created as output from the D.P.C. run of Material Procurement.

Before mechanization, reconciliation of records established in Cost Accounting and Materiel was accomplished by comparison of an extended total cost resulting from the calculation of the value of the entire inventory stock. If the deviation in total value determined in the two systems was less than $\frac{1}{4}$ of 1%, no attempt was made to determine where the variations occurred. If this limit was exceeded, as was normally the case, physical examination of all Kardex ledgers had to be made until the resulting deviation was less than the specified limit. At this point, investigation was stopped. Under the mechanized system, the computer produces item inventory balances along with their corresponding average unit prices that yields an extended value for each item in inventory. The summation of extended values equals the total inventory valuation. The computer also
points out those cost extensions whose value does not agree between the Cost Accounting and Materiel Systems.

These more up-to-date and accurate records assist the Material Records Investigators in their creation of documentation to act as input into the Material Records Audit and Production Control Functions.

**Summary of Labor Cost Data**

Study of the two flow charts presented on pages 47 and 48 shows that the total number of personnel in this function was reduced from twenty to eighteen in the two time periods under study. The direct labor cost was $88,306.40\(^1\) before and $84,084.00\(^1\) after mechanization.

The number of transactions was 34,359\(^1\) before and 51,410\(^1\) after mechanization.

Conversion of this data to a cost per transaction figure yields the following results:

\[
\text{Before: } \frac{88,306.40}{34,359} = 2.57010 \\
\text{After: } \frac{84,084.00}{51,410} = 1.63555 
\]

\(^1\)Interview with Philip Grant, Materiel Systems Planning Staff, California Division, Lockheed Aircraft Corporation, Burbank, California, June, 1962.
This amounts to a reduction in direct labor cost of

\[
\frac{\$2.57010 - \$1.63555}{\$2.57010} \times 100 = 36.4\%
\]

required to process one document through the Material Records Accountability Function.
CHAPTER IX

MACHINE COSTS

General

The machine cost figures available for the two years under study are in terms of total dollars per year cost for the Materiel Procurement and Storage Operations. Under both systems, before and after, the various functions utilize reports and records processed and prepared on E.A.M. or mechanized equipment. These equipment costs, to be made compatible with the cost figures developed in Chapters IV through VIII, must be converted to a dollar per transaction amount. Since the functions do utilize the end product of machine use, a reasonable method of apportionment is amortization of machine costs by the sum total of document inflow, or transactions, of these various functions.

Summary of Transactions

Table 1 presents a summary of the various transaction data presented in the detailed analyses of the five functions.
### TABLE 1

**TRANSACTIONS BY FUNCTION**

<table>
<thead>
<tr>
<th>Function</th>
<th>Number of Transactions Before</th>
<th>Number of Transactions After</th>
<th>Page Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Requirements</td>
<td>611,414</td>
<td>551,325</td>
<td>29</td>
</tr>
<tr>
<td>Material Procurement</td>
<td>93,898</td>
<td>307,280</td>
<td>34</td>
</tr>
<tr>
<td>Receiving</td>
<td>91,343</td>
<td>102,663</td>
<td>38</td>
</tr>
<tr>
<td>Material Records Audit</td>
<td>883,987</td>
<td>999,767</td>
<td>45</td>
</tr>
<tr>
<td>Material Records Accountability</td>
<td>34,359</td>
<td>51,410</td>
<td>50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,715,001</strong></td>
<td><strong>2,012,445</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Machine Costs**

The machine costs were $30,389.00\(^1\) before, and $83,748.00\(^1\) after mechanization. Utilizing the transaction data from Table 1 and the total machine costs, the machine costs per transaction are:

\[
\text{Before: } \frac{30,389.00}{1,715,001} = .01771
\]

\[
\text{After: } \frac{83,748.00}{2,012,445} = .04161
\]

\(^1\)Interview with Philip Grant, Materiel Systems Planning Staff, California Division, Lockheed Aircraft Corporation, Burbank, California, June, 1962.
This results in an increase of

$$\frac{.04161 - .01771}{.01771} \times 100 = 135\%$$

in machine cost per transaction.
Chapter X

Summary and Conclusions

Summary of Developed Costs

The hypothesis posed as a basis for this thesis, as presented on page 4, required the development of savings in operating costs for the Procurement and Storage Operations. Chapters IV through IX contain the pertinent operating costs for the functions under study. For the purposes of this paper, these operating costs were limited to those direct labor and machine costs that apply to the manual (before) and mechanized (after) systems. Since all the cost data contained in these chapters has been reduced to a common denominator, i.e., per transaction, direct addition of these various contributions to total cost can be performed. Table 2 presents a summary of the data assembled in the aforementioned chapters.

-55-
Direct Labor Costs

The direct labor costs developed in Chapters IV through VIII include only the direct cost of the personnel involved in the operation of the five functions. No overhead costs, such as that of systems analysis, programming, machine installation, floor space, and document storage to name just a few, have been "folded in" or included as operating costs for the functions, under either the manual or mechanized systems.

Machine Costs

The machine costs presented in Table 2 below, include only that portion of Lockheed's machine costs that apply to the controlled purchased parts section of the Materiel System. These costs, compiled in Chapter IX, consider two separate and distinctive types of equipment.

One type is that equipment utilized directly in the functions described in Chapters IV through VIII. Reference to the flow charts contained in these chapters indicates the exact usage of this equipment along with the number of personnel involved with its operation. The direct cost of these personnel is therefore included in
the summary presented in each chapter. The other type of equipment is comprised of those components assembled together to form the electronic computer system. The cost of the computer system, in this instance, is considered as variable since the machine was utilized for more hours than the basic rental cost covered. The machine cost of the computer system includes the labor cost of computer operators and operating personnel. Since these labor costs cannot be applied directly to any of the five functions listed in Table 2, the method of apportionment utilized to amortize the machine costs, as described in Chapter IX, is also applied to these costs. The two types of equipment under discussion are rented by Lockheed from various concerns. Therefore, since it is the intention of this thesis to only consider operating costs, the machine costs utilized contain only rental and pertinent labor costs. A Data Processing Report shows that other areas absorb a greater percentage of the available computer time.¹ In 1959 the distribution was as follows:

<table>
<thead>
<tr>
<th>Function</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materiel</td>
<td>12.5%</td>
</tr>
<tr>
<td>Manufacturing Planning</td>
<td>15.2%</td>
</tr>
</tbody>
</table>

¹Data Processing Report as of January 1, 1961, California Division, Lockheed Aircraft Corporation, Burbank, California. p. 2.2.
Production 20.8%
Finance 38.6%
Marketing 5.5%
Engineering 5.8%
Others 1.6%

In general then, it can be said that the operation under study should absorb only its "fair share" of the total computer cost depending upon its level of activity compared to the total usage of all areas.

**TABLE 2**

**SUMMARY OF COST DATA**

<table>
<thead>
<tr>
<th>Function</th>
<th>Cost per Transaction Before</th>
<th>Cost per Transaction After</th>
<th>Page Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Requirements</td>
<td>$0.07937</td>
<td>$0.07258</td>
<td>29</td>
</tr>
<tr>
<td>Material Procurement</td>
<td>2.98593</td>
<td>0.65341</td>
<td>34</td>
</tr>
<tr>
<td>Receiving</td>
<td>0.55402</td>
<td>0.55402</td>
<td>38</td>
</tr>
<tr>
<td>Material Records Audit</td>
<td>0.17812</td>
<td>0.09643</td>
<td>45</td>
</tr>
<tr>
<td>Material Records Accountability</td>
<td>2.57010</td>
<td>1.63555</td>
<td>50</td>
</tr>
<tr>
<td>Machine Costs</td>
<td>0.01771</td>
<td>0.04161</td>
<td>53</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$6.38525</strong></td>
<td><strong>$3.05360</strong></td>
<td></td>
</tr>
</tbody>
</table>

Analysis of this cost per transaction data yields a reduction of

\[
\frac{\$6,38525 - \$3,05360}{\$6,38525} \times 100 = 52.18\%
\]
in total cost to process a transaction through the Material Procurement and Storage Operations.

Additional figures of importance for the support of the hypothesis are obtained by summing the various costs presented in Chapters IV through IX. The labor costs amount to $625,268.80 before and $474,125.60 after mechanization to perform the Procurement and Storage Operations. This is an absolute saving, neglecting variation in volume during the periods under study, of $151,143.20 in labor cost alone. This amounts to a

\[
\frac{151,143.20}{625,268.80} \times 100 = 24.17\%
\]

reduction when based on the "before" cost.

As is shown in Chapter IX, the conversion had to absorb an increase in machine cost amounting to $53,359.00 ($83,748.00 - $30,389.00). This additional cost reduces the savings obtained from direct labor to $97,748.20 ($151,143.20 - $53,359.00) which is the net savings realized from the conversion. Again, this figure neglects the increase in volume from 1,722,797 to 2,022,839 transactions for the two time periods.

Discussion of Other Factors

The possibility that factors, other than those
incident to conversion to mechanized means, may affect the final results of the study are inherent in this type of analysis. If factors, beside those accruing from computer usage, did affect the results, it is obvious that the conclusions reached must have limitations or restrictions placed upon their validity. In light of this possibility, how valid are the results of the case study and must any limitations be placed on the interpretations of the results? To determine this, it is best to examine some of these factors and show their effect upon the case study.

Improvement of a basic business system can result in a drastic change either in efficiency of the system or the volume of paperwork. Examination of the document flow charts contained in Chapters IV through VIII reveals that the basic Procurement and Storage System remained relatively unchanged during the initial phase of mechanization. The computers are used to process and output documentation that was previously manipulated by hand. This type of work is extremely repetitive and time consuming. The documents utilized in the system are basically the same, both in type and number, except that in some cases they are recorded on tape where under the manual system
they were either in printed form as Kardex files, or as punched cards, etc. It should be mentioned at this point that Lockheed Aircraft Corporation did modify their system after the initial mechanization. As is to be expected, it can be said in general that further efficiencies of operation as well as reduction in personnel and volume of paperwork was accomplished.

Inaccuracy of results can also be obtained if the manpower of a system is not used efficiently. When a system is overstaffed, additional volume can be absorbed without addition of personnel. Examination of the five functions under study indicates only one where this may be true. The number of personnel engaged in the Receiving Function did not change after the conversion, even though the volume of transactions rose by approximately 10%. This is explained by the fact that there are certain operations to be performed within the Receiving Function that require the attendance of a person. These "slots" of the organization chart could not be combined to "share" a man and still maintain efficient operation. In this situation then, it is not a case of the personnel putting out more under a mechanized system, but rather that the
organization itself contains inherent inefficiencies when operating at a volume less than optimum.

Additional efficiencies of labor and machine can usually be obtained when an organization of decentralized groups is combined to form a centralized operation. The duplication of facilities, both personnel and equipment, present under a decentralized system can be reduced when it is consolidated into the more efficient centralized form. These statements are not to be generalized in such a manner as to apply to all phases of business operations, but rather to the subjects of this study, procurement and storage of controlled purchased parts. The economics of larger purchases, tighter control of inventory, prevention of duplication of requisition, and reduction in manpower, machines, and used floor space are just a few benefits possible with a centralized system. In many cases, a decentralized system will be centralized when mechanized in order to take advantage of the resulting benefits.

Another factor to be considered is when the use of mechanized equipment allows a more detailed or frequent examination of the records utilized to control the function under study. This factor can affect the results to a great
degree as is the case in the Material Procurement Function where the number of transactions rose from 93,898 to 307,280. The ability to perform detailed and tedious examinations more often and rapidly than by manual means should be reflected as prime advantages of a mechanized system. More frequent examination obviously leads to better control over procurement and inventory.

Another factor is the accuracy of the records created under both systems. A computer's accuracy is quoted in the order of one error per million operations. A record created and maintained manually cannot hope to be as concise. It follows then, that records created electronically for use in a mechanized system provide a relatively "error free" tool with which to audit and control a function. An example of the increased accuracy possible is described on page 49 under the Material Records Accountability Function. Labor cost is reduced by machine indication of cost extension values that require additional investigation. This is also a benefit derived from utilization of a mechanized system and is reflected in the final results.

The factors described above are, most certainly,
important ones that could affect the final results of any study. Since those that are not characteristic of a mechanized system, such as change to the basic business system and the implied levels of manpower productivity, do not enter into the results of this study to any great degree, it is felt that no limitation or restriction should be placed on the results obtained from the case study of Lockheed Aircraft Corporation.

**Validity of Lockheed’s Experience Applied to Other Firms**

The Discussion of Other Factors lends credence to the results obtained from the case study of Lockheed Aircraft Corporation. Certain operating conditions were present at Lockheed during the time periods of the case study. The Materiel System for the purchase and storage of controlled purchased parts was:

a. Geographically centralized

b. Functionally centralized at the same facilities
c. Of large size
d. Dealing with production for a limited market
e. An electrically assisted IBM system

It follows then, that analysis of these conditions could
expand the case study's scope to encompass other firms of different type or size.

Geographically Centralized

The Materiel System for the subject area processes documentation required for all of the Burbank production facilities. Ready access to the raw data by the computer group and speedy transmission of the processed reports to the using departments are the main advantages of this centralization. An alternate form of organization is geographic decentralization of production facilities. The results obtained in the case study can be expected from this alternate method of organization due to the efficiencies possible from computer processing.

Functionally Centralized at the Same Facilities

The facilities for purchase and storage of controlled purchased parts are located centrally at Burbank, California. The advantages to this condition are basically the same as those cited for a geographically centralized organization in the preceding paragraph.

Centralized processing for decentralized facilities, where the preparation of raw data and the utilization
of the completed reports are the responsibility of the decentralized facility, is an example of partial functional decentralization. The results obtained in the case study can be expected because of the efficiencies possible from computer processing. The only reduction in expected efficiency results from limitations imposed by the present "state of the art" in data acquisition and transmission. At the present time, these areas are receiving extensive investigation by computer manufacturers.

Total functional decentralization involves complete processing at decentralized facilities. This alternative, since it is actually in-plant processing, is identical in function to that existing in the case study. Therefore, the advantages gained are also the same.

Of Large Size

Since Lockheed is a corporation of large size, the capacity of the Materiel System for the subject area is also large due to the volume of operations. Correct machine usage is an important factor that affects the results of the case study to a great extent. A complete program of integrated data processing must be inaugurated,
regardless of the firm's size, to obtain the results desired from mechanization. Total utilization of computer time yields the smallest unit machine cost per transaction. To accomplish this, the total volume of operation must be considered in the selection of the computer used. Small, medium, and large size equipment is available from many manufacturers. The selection of the computer size should consider the present and future size of the firm, the expected volume of activity for all mechanized systems, and the ability of these systems to maintain efficient utilization of the equipment. Therefore, the size of the firm influences the size of the computer required to obtain a minimum unit cost, but does not preclude the efficiencies expected from mechanization.

Dealing With Production for a Limited Market

The main customer for Lockheed products is the United States Government. Because of this, there is not a competitive market present for the aircraft and related items produced. The mechanized system allows Lockheed to purchase and store, at a low unit processing
cost, those parts that are required contractually. Firms of other type dealing in competitive markets are also able to derive benefits from mechanization. Some firms are described in Chapter III and include airlines, wholesale mail order houses, retail stores, produce companies, and record manufacturers. The variety of different products and services generated by these firms supports the contention that the type of firm would not affect the benefits of mechanization exhibited in the case study.

An Electrically Assisted IBM System

A portion of the documentation utilized as input for the Materiel System at Lockheed Aircraft Corporation was in a form acceptable to the computer as an input media. If a firm does not possess this capability, the introduction of equipment to prepare this documentation will mainly involve the retraining of personnel to use the new equipment. This training cost will rapidly be overcome by savings realized from the efficiencies of the mechanized system. The machine rental and direct labor costs will be amortized over the volume of documentation
processed and will result in comparable unit costs to those obtained in the case study. It is noted again that the personnel and equipment costs applicable are only that portion associated with the system under study.

The basic business system remained relatively unchanged during the time periods of the case study. Certain efficiencies of operation and reduction in personnel and volume of paperwork was accomplished. If the system is revised, either by the firm's personnel or by consultants, a thorough feasibility study can only improve the efficiencies obtained over an existing system that is left unchanged and then mechanized. These improvements generally result from the extensive examination given the system during the feasibility study and would yield, at least, those efficiencies obtained in the case study.

From the conditions discussed above, it follows that a firm's type or size are not important factors in deciding the results obtained from mechanization. Careful studies must be made considering the firm's needs, organizational structure, and volume of operation in order
to determine if mechanization is feasible. If the feasibility study indicates this, then the study will select equipment that is most efficient for the firm's level of activity. When this is done, there is no reason to believe that the results obtained by them will be other than those realized by Lockheed Aircraft Corporation.

**Conclusion**

The conclusion reached in this thesis is that conversion of an existing procurement and storage system from electrically assisted to mechanized means results in cost savings when considering those operating costs of direct labor and machine. The data contained in Chapters II and III, from computer manufacturers and users, infers that these savings can be realized. Results of the case study indicate not only savings based on an adjusted per transaction figure, but also in terms of absolute dollars even though an increase in volume be neglected. By analyzing the operating factors and conditions present at Lockheed Aircraft Corporation during the time periods of the case study, the results of the case study were expanded to indicate that the same results
might be expected at other firms regardless of size or type. Corollation of these inferences with the expanded results of the case study can only result in support of the hypothesis posed as a basis for this thesis.

For information purposes, it is felt that an additional benefit accruing to Lockheed Aircraft Corporation from the mechanization of their system should be discussed at this time. Since this benefit did not affect the operating costs of the operation, it was not introduced previously. By use of better control and more rapid dissemination of information to the procurement and audit functions, a desired objective of reducing the investment in purchased parts inventory was accomplished. Determination of this reduction is beyond the scope of this paper. In 1957 there were 26,000 items in inventory with a value of $9,876,000. $76,585,000 in controlled purchased parts was disbursed during that same year. Any reduction in inventory balance for a corporation of this size results in savings when considering the cost of capital investment. In some instances this saving may be

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1Integrated Data Processing for Materiel as of July 1, 1958, California Division, Lockheed Aircraft Corporation, Burbank, California.
more significant than any other factor.

Other Considerations

While engaged in research for a thesis of this type, there are always questions raised that must remain unanswered as being outside the scope of the subject. Itemization of some of these may provide additional paths for those interested in providing more knowledge in the area of computer application.

1. What is the capital investment required for a computer installation compared to a prior method?

2. What changes are required in personnel job descriptions and content when a system is mechanized?

3. Are different skills and intelligence levels required on the part of personnel before and after mechanization?

4. What savings can be obtained in floor space used after mechanization?

5. How adequate are the feasibility studies obtained prior to the adoption of mechanized systems?

6. Do users provide potential for future growth into their systems?
7. What benefits accrue other than those directly obtained from operations?

8. When the decision has been made to mechanize, is it better to buy, rent, or contract computer service?

9. Can methods be devised to compare the relative worth of mechanizing one business system versus another?

10. What further savings can be realized from subsequent modifications to the procurement and storage system?
APPENDIX I

PROCUREMENT RECORDS AND SERVICES

DEPARTMENT

Reports to: Director of Materiel

Areas and Models Covered: All areas, all models

Summary: Analyze released engineering data; estimate raw material requirements; summarize and report requirements for productive experimental materials and parts; establish, maintain, and analyze the Material Position Records for all productive and nonproductive materials in inventory; reconcile inventory records with subsidiary ledgers; settle all vendor claims against Lockheed; dispose of Corporate and Government-owned surplus and scrap items; maintain accountability records of all Lockheed-owned tooling in outside vendors' possession; receive, store, and disburse vendor-fabricated tools; process all

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1Operations Functions & Responsibilities Statement, Lockheed Aircraft Corporation, California Division, Organization No. 52-01, Effective date January 8, 1962.
inventory resulting from terminated prime contracts; perform clerical operations for the Procurement Division; provide stenographic and other clerical services for the buying departments of the Procurement Division.

1. Analyze released engineering requirements, operation sheets, and fabrication records; estimate raw material requirements, summarize, and report to Procurement Planning; establish and maintain official nomenclature and numerical codes for all raw materials and purchased part items; prepare special bills of material; identify Engineering Change Proposal (ECP) control numbers to specific parts numbers and quantities.

2. Process, record, and audit data pertinent to materials held in productive and nonproductive inventories in respect to requirements, orders, receipts, disbursements, and adjustments of quantity, price, or referenced information.

3. Establish and maintain an average price for each item of productive material, and provide material cost distribution data to Cost Accounting.

4. Maintain perpetual inventory records on productive and nonproductive materials.
5. Provide for timely analysis of the position of each item of productive material relative to Lockheed Work Orders, and take corrective action to accomplish necessary adjustments.

6. Provide basic data for computation of the quantity to be ordered by contract for each item of productive material, in order to provide a basis for procurement action by Procurement Planning.

7. Perform analysis and prepare reports of items of material affected by price redetermination, contract closure, or terminations; schedule and coordinate price redetermination and contract closure programs in Operations.

8. Initiate follow-up action on rejected items of material, to ensure proper disposition.

9. Reconcile, with Stores, the physical status of items of productive and nonproductive material in inventory with the recorded position, and make appropriate adjustments; perform re-counts and special counts as required for reconciling nonproductive inventories.

10. Negotiate Cost Accounting schedule for semiannual reconciliation of inventory records with the subsidiary ledgers; receive report of variances from the Finance
Branch, and make detailed analyses and required adjustments to balance records within the Finance Branch limit.

11. Summarize and report requirements for Government-controlled materials; ensure compliance with Government regulations; maintain records and prepare reports as required.

12. Negotiate and settle all vendor claims against Lockheed (such as those resulting from cancellations, design changes, contract terminations, or defective material furnished by Lockheed).

13. Sell all Corporate-owned surplus inventory items, capital assets, noninventory expense items, salvage material, and Corporate-generated scrap; maintain records and issue reports reflecting action taken; dispose of all surplus and obsolete Government-owned materials, tooling, and manufacturing aids upon proper authorization; maintain accountability records of all transactions.

14. Arrange and maintain accountability for shipments of tooling and materials consigned to vendors;
operate a vendor-fabricated tool crib and maintain necessary records covering their receipt, storage, and disbursement.

15. Handle the receipt, storage, accountability, and disposition of all in-plant inventory resulting from engineering changes and/or prime contract terminations.

16. Audit all documents authorizing procurement; type and distribute Purchase Orders and change requests; receive and distribute all incoming mail, telegrams, specifications, test reports, and similar documents for the Procurement Division; establish and maintain price, source, and financial files; provide stenographic and other clerical services for the buying departments of the Procurement Division.

17. Negotiate Purchase Order discrepancies and the clearance of consignment accounts; investigate, and prepare for approval, all policy write-offs involving Lockheed Purchase Orders.
18. Arrange the sale of materials to subcontractors as required by contractual agreements; make accommodation sales of inventory items.

19. Coordinate Operations Branch activities pertaining to Lockheed product warranties; analyze and negotiate satisfactory warranty provisions covering purchased items.
APPENDIX II

RECEIVING DEPARTMENT

Reports to: Director of Operations
Director of Materiel
Material Handling General
Department

Areas and Models Covered: All areas; all models

Summary: Receive all productive and nonproductive items; route to appropriate departments and prepare receiving documents; make recommendations for the settlement of claims.

1. Receive all productive and nonproductive items (except IBM equipment, correspondence, periodicals, and advertising) by:
   a. Unloading inbound shipments.
   b. Verifying that containers received and carrier's documents are in agreement.
   c. Opening containers, verifying quantity of items received, and preparing the items for storage by applying protective coatings, wrappings, and

1Operations Functions & Responsibilities Statement, Lockheed Aircraft Corporation, California Division, Organization No. 55-22, Effective date January 8, 1962.
repackaging in accordance with applicable specifications.

d. On all materials necessitating inspection upon receipt, obtain blueprint folder and laying out material for inspection according to the requirements.

e. Noting discrepancies and informing affected organizations (and, upon request, taking appropriate action).

f. Identifying purchased items which were not properly identified by vendors.

g. Marking the expiration dates and category numbers on storage-limited items and their containers.

2. Route items to the appropriate department (and prepare receiving documents) by:

a. Sending to Quality Control:

(1) All productive items.

(2) All nonproductive items covered by specifications.

(3) All nonproductive items (not covered by specifications) which do not seem to meet Purchase Order requirements.

b. Sending to Tool Inspection:

(1) Project tools, standard tools, and fixed
asset tools.

(2) Items covered by RM's specifying Tool Inspection.

c. Sending all other items to Stores or to using departments.

d. Preparing Shop Orders for those purchased parts requiring rework or completion, as authorized by Quality Control.

e. Originating documents reflecting receipt, acceptability, and routing of items received.

f. Transmitting receiving and/or disbursement documents affecting inventory items.

3. Make recommendations to the Procurement Division for the settlement of claims against vendors for rework, loss, or damage.

4. Match RM's (Freight Audit Copies) with corresponding freight bills, and prepare daily statements recording all bills received from each carrier.

5. Maintain a file of nonnegotiable disbursements requisitions for productive raw materials and purchased parts and equipment.

6. Establish and maintain complete follow-up on all material being processed through the Receiving
Function; initiate remedial action as necessary to ensure availability of the material to using organizations on schedule.
BIBLIOGRAPHY

Books


Reports


Articles and Periodicals


Ammer, D. S. "Automated Order Writing; How to Save a Dollar an Order," Purchasing, January 6, 1958.


"Instant Inventory Control (Use of Data Collection Equipment)," *Purchasing*, March 14, 1960.


Other Sources

Lockheed Aircraft Corporation, California Division, Burbank, California. Personal interviews with Mr. Norval Johnson, Data Processing Planning Staff. 1961 and 1962.

