THE ECONOMIC FEASIBILITY AND UTILIZATION OF COMPUTER APPLICATIONS IN A SMALL ELECTRONIC DESIGN AND MANUFACTURING COMPANY

by 680

DAVID J. UNRUH

B. S., Kansas State University, 1968

A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

College of Commerce

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1969

Approved by:

Major Professor

ACKNOWLEDGMENTS

I wish to express my sincere gratitude to Professor Rhae M. Swisher, my major professor, for his guidance in preparing this report. I wish to dedicate this to my wife, Carolyn, without whose understanding this report would not have been possible.

TABLE OF CONTENTS

CHAPTER PAGE

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

It appears that the majority of factors concerning feasibility studies of Electronic Data Processing may be broken down into two general propositions: First, that of arriving at a good decision as to whether or not to use Electronic Data Processing and, if so, to what extent; and second, that of implementing the decision. A successful installation needs both a good decision and a good implementation, and therefore, a major deficiency in either one will rarely permit overall success and most likely lead to serious difficulty.[1]

I. THE PROBLEM

Statement of the problem. It is the purpose of this report to aid the small business executive in dealing with the first of the two general propositions, that of arriving at a good decision as to whether or not to use Electronic Data Processing and, if so, to what extent. There are many questions which precipitate from this general proposition. (1) Should the company use Electronic Data Processing at all? (2) Should they use the services of an Electronic Data Processing service bureau? (3) Should they buy time on a time-sharing computer? (4) Should they

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[1] B. Conway , J. Gibbons, and D. E. Watts. Business Experience With Electronic Computers. New York: Controllers Institute Research Foundation, Inc., 1959, p. 14.

lease or buy a computer?[2] (5) What are the services going to cost? (6) Are they going to be able to save money and/or be able to do more than they are presently doing now? (7) What is going to be the return on their investment?

However, the above questions can be reduced to the following three basic questions: (1) What possible and/or probable utilization of computer applications exist? (2) What advantages, if any, may be gained from the use of a computer? (3) What is the economic feasibility of the use of a computer in the various applications which may be available?

Importance of the study. This report is intended to present and consider the three basic questions that a small business executive should seek to answer just prior to undertaking a so-called feasibility or justification study. This is important because a proper feasibility study is fairly expensive. "For a large firm it takes from six to nine months time of several people. For a medium size or smaller company the effort is shorter, but the cost is relatively as great."[3] Actually, a detailed "...study of a small business by a two-man team might be conducted in one week to a month..."[4]

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[2]Each one of these first four alternatives provide a different type or scope of service and expenses. For a specific volume, nature, and cost of service, one of the alternatives will best suit any company at a specific point in time.

[3]Ralph Weindling, H. W. Matthews, and P. T. Bridgeman. A Management Guide to Computer Feasibility. Detroit, Michigan: American Data Processing, Inc., 1962, p. 1.

[4]"IBM Study Organization Plan: The Approach," F20-8135-0. White Plains, New York: International Business Machines Corporation, 1963.

Why should a small business executive ponder these questions considered in this report? For the same reason that a large company should consider a feasibility study. In fact, Weindling says:

> Failure to act can be more expensive than even an abortive feasibility study, for it may mean that the company is being deprived of really significant benefits and perhaps exposing itself to competitive disadvantage. These dangers are accentuated because automatic data processing is a long-term project with a normal lapse of about three years between initial action and first application. A crash program to make up lost time is almost impossible.[5]

One should recognize that there are many other questions, such as technical programming problems, however, these types of questions have been considered extensively by many other authors and information may be obtained from electronic data processing vendors[6] or technical publications.[7] The author realizes that there are questions which have been, are, and will be recognized but not resolved which will be noted throughout this report.

II. DEFINITIONS OF TERMS USED

Electronic Data Processing. Electronic Data Processing is commonly referred to as EDP. EDP in this report will refer to the use of the electronic digital computer used to process data under consideration.

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[5]Weindling, loc. cit.

[6]"IBM Keyword-in-Context (KWIC) Indexing," E20-8091-0. White Plains, New York: International Business Machines, Corporation, 1968.

[7]Computer Abstracts. Vol. 1-12, Technical Information Company; Martins Bank Chambers; St. Helier Jersey, British Channel Islands, 1957-1968.

A Feasibility Study. A feasibility study is a thorough and detailed study, done by one or more employees of the firm, or by persons brought in to act as consultants, conducted to analyze and determine the feasibility of using electronic data processing in the firm.

III. ORGANIZATION OF REMAINDER OF REPORT

As stated in Chapter I, The Problem, this report will outline the basic questions that a small business executive should consider when making the decision whether or not to use data processing, and if so, to what extent.

So that one might better grasp the overall scope of this procedure, an actual small company will be analyzed. In order that this company may remain anonymous, it will subsequently be referred to as C.I.T.[8] The author realizes that C.I.T. is a very specific and specialized study and, therefore, this report is not intended to serve as a standard for all small electronics firms. It is the authors' belief, however, that the questions considered in this report will clearly demonstrate the type of study and analysis required in making the decisions considered herein.

In Chapter Two, the report will present the Review of the Literature which will be reviewed in four basic areas: (1) Literature on Decision Theory, (2) Literature on Feasibility Studies, (3) Literature on EDP Applications and Alternatives, and (4) Literature on the Small Company and Computer Usage.

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[8]This is a small midwestern company in the electronic industry with fewer than one hundred employees.

In Chapter Three, the report will present The Company studied and the characteristics of each EDP Alternative. The first part will describe C.I.T.'s organization and their general policies. Then the second will give a description of each EDP alternative and their respective characteristics.

In Chapter Four, the report will analyze C.I.T.'s operation as follows: (1) Sales and general office operation, (2) Engineering Department, (3) Production Department, and (4) Financial Analysis.

In Chapter Five, the report will analyze possible EDP applications in the first three areas mentioned above, from the standpoint of benefits and problems, and the economic feasibility.

In Chapter Six, the report will summarize which alternatives should be taken by C.I.T.

CHAPTER II

REVIEW OF THE LITERATURE

Much has been written about EDP installations, feasibility studies and implementation of EDP, and general decision theory of the firm. However, there are glaring inadequacies in some of the material when applied to the small company, and therefore, it is not easily adaptable to the limitations of a small company.

The author will present, in the first three sections, a brief summary of the work done in those areas which serve as a background to the related problems at hand. Then, in the last section, the review of material specifically related to smaller corporations with respect to the problem will be presented.

I. LITERATURE ON DECISION THEORY

Decision theory can be classified in two general areas: (1) Objective decision theory, such as mathematical optimazation, and (2) subjective decision theory, which the author is reviewing.

Subjective decision theory, as stated generally by both Weimer[9] and Scott[10], essentially involves the following steps or stages: (1) estimating the situation, identifying the problem and determining

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[9] Arthur M. Weimer, Business Administration: An Introductory Management Approach. Homewood, Illinois: Richard D. Irwin, Inc., 1962, p. 239.

[10] William G. Scott, Organization Theory: A Behavioral Analysis For Management. Homewood, Illinois: Richard D. Irwin, Inc., 1967, p. 219.

objectives and obstacles; (2) developing and analyzing alternatives; and (3) appraisal and selection. "These three steps may be thought of as the core of the decision process."[11]

Within step two, developing and analyzing alternatives, there is a need for information. Because, as Scott states, there is an "inverse relationship between information and uncertainty..." Therefore, the decision maker wishes to reduce uncertainty or, if possible, to convert it to a state of either certainty or risk."[12] However, there is a point at which additional information will not necessarily lead to reduced uncertainty.[13]

II. LITERATURE ON FEASIBILITY STUDIES

The basic approach to a feasibility study is stated by James Gibbons as:

> A computer feasibility study should be initiated solely for the purpose of investigating opportunities to improve specific operations.
>
> Once potential opportunities for improvement are defined, and a systems concept developed, it then becomes necessary to select the most suitable class of equipment for the job, taking growth into account. Also, the problems time, and cost of making the conversion must be anticipated, and the operating economies expected from the new system must be estimated.[14]

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[11]Weimer, loc. cit.

[12]Scott, op. cit., p. 224.

[13]Ibid.

[14]James Gibbons, "An EDP Consultant Discusses 'Your First Computer'," Administrative Management, 23:26-27, June, 1962.

However, Awad points out:

> A feasibility study involves the survey and evaluation of the advantages of using a computer to work out a set of given applications for a firm.
>
> In deciding whether a computer system should be installed, the character of a firm's operations, its present operational procedures, and its general objectives should be carefully reviewed in the light of the purposes that the processing machines are designed to serve. Management must formulate a sharply defined picture of its data-processing needs and of how a computer can fit into the organization to serve its various departments in this respect. It should be plainly understood that a computer is intended only as an aid to men. Without this understanding, the whole character of the system when installed is likely to be misconstrued and frustrations caused by its failure to live up to expectations.[15]

Although feasibility studies may be approached and planned differently in different types of organization, Ralph Weindling sets out a series of steps which he feels any company can use:

a) Select possible application areas.

b) Study selected areas in detail to determine: the information flowing in, the information referred to, and the information produced.

c) Ascertain management's needs and objectives in the areas.

d) Relate the areas to each other and examine possibilities of rationalizing and integrating.

e) Establish detailed costs for the present system, and estimates for providing the additional needs and objectives.

f) Design the broad data processing system.

g) Prepare a system specification on which manufacturers can prepare proposals for equipment requirements.

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[15] Elias M. Awad, Business Data Processing. New Jersey: Prentice-Hall, Inc., 1965, p. 271.

h) Compare manufacturers' proposals based on the specification and select the most suitable range of equipment.

i) Draw up a plan for conversion to the automatic data processing system.

j) Prepare a case for the most suitable computer based on economic and other factors.[16]

William Gill[17] identifies three situations in which computer utilization seems justified and then Dr. Sanders adapts them to present a simple feasibility appraoch for the small firm.

> The basic purpose of any feasibility study is to answer the question of whether or not the organization should use a computer. But in order to answer this query, many other factors must be investigated. First of all, is there any justification in using a computer? ...A computer appears to be justified only in three situations. The first is in the event that greater speed in processing is both desired and necessary. The second situation is where the complexities of processing data cannot be simplified without electronic help. The last situation is where the investment in computer use is offset by monetary or qualitative benefits--e.g., greater ability to make decisions through additional data, increased systems efficiency (lowered per-unit cost), or improvement in timeliness and accuracy of information.

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[16] Ralph Weindling, H. W. Matthews, and P. T. Bridgeman. A Management Guide to Computer Feasibility. Detroit, Michigan: American Data Processing, Inc., 1962, p. 8.

[17] William A. Gill, "Economic Considerations in the Use of Electronic Computers," Computers and Automation, 11:6-16, August, 1962, p. 6.

> Once a small firm has become convinced that it may possibly be justified in using a computer, an investigation of economic feasibility should be conducted. This does not mean that costs must be reduced, but it does mean that the greatest processing value will be sought for every dollar spent.[18]

III. LITERATURE ON EDP APPLICATIONS AND EDP ALTERNATIVES

EDP Applications. EDP applications run the full gamut from simple punched card-to-printer operations to highly sophisticated and complex real-time integrated systems. There are numerous publications where one can obtain an over-view of the many applications, such as; International Business Machines KWIC Indexes E20-8091-0[19] and C20-1673-0[20]. "Over 700 areas of application of computers" which appeared in Computers and Automation,[21] and then a book like Boore's, The Computer Sampler: Management Perspectives on the Computer,[22] puts some of the applications into the perspective of the organization.

Lyle L. Laws devides EDP business applications into the following general areas: (1) Management plans, such as operations research or

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[18]Donald H. Sanders, Introducing Computers to Small Business. Park Ridge, Illinois: Data Processing Management Association, 1966, p. 67.

[19]"IBM Keyword-in-Context (KWIC) Indexing," E20-8091-0. White Plains, New York: International Business Machines Corporation, 1968.

[20]"IBM Keyword-in-Context (KWIC) Indexing," C20-1673-0. White Plains, New York: International Business Machines Corporation, 1968.

[21]_____. "Over 700 areas of application of computers," Computers and Automation, 13:82-4, June, 1964.

[22]William F. Boore, Jerry R. Murphy. The Computer Sampler: Management Perspectives on the Computer. New York: McGraw-Hill Book Company, 1968.

simulation techniques which could be used to help determine corporate policies that need implementation or formulation, (2) new business proposals, the first phase reports to management would be in the nature of future business where management would need to know the status of all requests for bids and the value of possible contracts, (3) schedules and budgets, which are the two most satisfactory guide posts for production, (4) production control, and (5) exception reports, where normal activities have been defined in the master plan and only deviations from the plan are reported.[23]

John Malloy describes a non-typical approach to application of a computer in a small firm:

> Top management in the firm decided to plunge toward the heart of the information system in this first installation in the belief that a larger and vital cost/profit improvement program could not be effected, unless 'clean' cost data were available from the Manufacturing Cost System. The computerization of the information system was part of a four-year program for improvement of profits, and was aimed at rejuvenating a small, well-established firm which was suffering from lack of vitality and the erosion of assets and net worth.
>
> An integral and key part of this effort involved the development of a new management information system. Study revealed that five major subsystems of the corporate information system were required: (1) A Financial Planning System; (2) A Marketing And Sales Information and Control System; (3) A production Planning System; (4) A Production Scheduling and Operation Control System; and (5) An Accounting Information Feedback System.[24]

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[23] T. Radamaker, Business Systems. Vol. II. 2 vols. Cleveland, Ohio: Systems and Procedures Association, 1963, pp. 22-6 to 22-14.

[24] John P. Malloy, "Computerizing The Manufacturing Cost System In A Small Production Shop," Computers and Automation, 16:18-21, July, 1967, p. 18.

Some of the more common applications are: (1) Payroll, (2) Inventory control, like IBM's IMPACT program system, (3) accounts receivable, aging accounts, (4) accounts payable, (5) order entry, (6) sales analysis, and (7) general engineering, such as IBM's ECAP program package.

EDP ALTERNATIVES. In the event that a company wishes to investigate the use of EDP, there are essentially three EDP alternatives which a company may consider: (1) A service bureau, (2) time-sharing, (3) leasing or buying their own computer.

An article written by Research Institute of America that appeared in Administrative Management describes the service bureau:

> Any company, regardless of size, can now enjoy the competitive advantages of rapid date handling without investing in expensive equipment. Small companies, especially, find that the outside EDP service center provides a practical way of speeding routine clerical jobs.
>
> Many companies have turned over such clerical jobs as payroll, inventory control or accounting to an outside center and are completely satisfied with results. Other companies look to the EDP center as an interim step before buying their own equipment. It provides an opportunity to test out applications and debug procedures before high cost facilities and staff are on their books.
>
> In either case, the line between a smoothly functioning, profitable relationship with a service bureau and a disappointing, high-cost headache can be very narrow. Choice of the wrong center, inadequate knowledge of what it can do, misconceptions about charges--all add up to some bitter experiences.
>
> Best safeguard is a clear understanding of the services available and the specific qualifications that are essential for your needs.[25]

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[25] _____. "Choosing and Using An Outside EDP Center," Administrative Management, 26:58-60, January, 1965, p. 58.

The second alternative, time-sharing, is "by far the most dynamic growth segment of the computer industry today... In a few years, time-sharing sales have gone from zero to well past $100 million/year and have been forecast as high as $1.6 billion/year by 1972."[26] Larry Meador states it"...has had its fantastic success for two very simple reasons. It is economically attractive and it works."[27]

Lewis Lachter, in his article entitled, "Time-Sharing: Low-Cost Link to Computer", describes how time-sharing basically works and some of its associated costs.

> Basically, time-sharing is a method of using any computing equipment with a large capacity in a way that the central computer services a number of low speed input-output terminals simultaneously. Since the central computer operates more or less parallel on many problems at once, it stays busy. And because the terminals have direct access to the central computer, there is a minimal delay in entering problems and receiving answers.
>
> To illustrate the economics of time-sharing, a center may install a $500,000 system at a monthly rental of $12,000. With a capability of servicing the needs of perhaps 50 printers, each user may obtain adequate computer access for several hundred dollars a month. Add to this several hundred more for telephone line service and the necessary low-speed peripherals for transmitting, receiving, etc., and a versatile data processing facility may become available for an amount less than $500 a month.
>
> To take a specific example, the IBM Data Center in New York offers 40 widely scattered firms the opportunity to use a single large scale 7040 particular computer. Installed in an individual company, this particular computer would rent for about $14,000 monthly. However, through a time-sharing arrangement, with input-output equipment in his own office, a user may contract for as few as 25 hours a month at a monthly charge of $325. It is useful to keep in mind that a tremendous amount of processing takes place in a computer hour.[28]

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[26]Meador, Larry. "Computer Time-Sharing," Chemical Engineering, 76:109-114, January 13, 1969, p. 109.

[27]Ibid.

[28]Lachter, Lewis E. "Time-Sharing: Low-Cost Link to Computer,"

The last alternative commits a firm to leasing or buying their own computer, to be installed in their facility:

> A computer housed in a desk? Or on a desk-top? Both these concepts are now realities and they have made EDP available to many small companies. Small computers, for the purpose of this article, range all the way from programmable desk-top units which sell for as little as $5,000, to full-scale systems which rent for $12,000 a month. Between these two extremes are small full-scale systems as well as a relatively recent innovation, the self-contained desk-size computer.[29]

IV. LITERATURE ON SMALL COMPANIES AND COMPUTER USAGE

Generally speaking, until recently, the new methods of data processing have been adopted by the larger firms. In the past, practically all the literature has described larger installations and the problems which larger firms experience. However, recent developments have changed the picture. "Thus, it is imperative that managers of smaller firms learn more about electronic methods of processing data in order to judge intelligently whether or not the use of a computer best fits the needs and goals of their organizations."[30]

> One might be tempted to tackle the largest or most economically important problems first. However, there are many factors to take into consideration, such as: Importance of the problem to the company, availability of literature on the subject, capability of the available computer equipment, size of the program that would be required to solve the problem and finally, how soon is an answer needed...

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[29]Daniel Peck, "Guide to the Small Computer," Administrative Management, 27:48-52, July, 1966, p. 48.

[30]Donald H. Sanders, Introducing Computers to Small Business. Park Ridge, Illinois: Data Processing Management Association, 1966, p. 2.

> Computer-oriented methods are considered inapplicable to their [engineering] small problems. It is thought that only the larger companies can afford the involvement in the use of complex fundamental analyses.
>
> In reality, however, the small company is confronted with problems that can best be solved by sophisticated analytical techniques. And these methods can often be applied without undue expenditure...
>
> If technical people expect quick answers from a computer-oriented approach to a problem, they will be disappointed... It has been our experience that at least a year is required before anything but trivial results are obtained...
>
> Computer-aided process design using time-shared equipment has been applied to several processes with a high degree of efficiency by a small chemical company. Engineering time savings up to 10%, and operating cost savings up to 50%, have been recorded.[31]

John Malloy, relates how a computerized manufacturing cost system was installed in a small manufacturing firm. Malloy states that "the manufacturing cost-performance system was part of accounting information feedback-simply the use of information from the data bank to compare actual results in dollars and cents with what had been planned or budgeted."[32] He concludes by saying:

> ...that the computer has proved a powerful, economically feasible tool at Modern Machine Works for analyzing costs and enabling management to upgrade quality.
>
> Certainly this experience should demonstrate that, with proper planning and execution, the small manufacturer can make the computer and its related systems a productive tool in the years ahead.[33]

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[31] William R. Ludwig, and Robert P. Peterson. "Computer Design Helps Small Chemical Company," Chemical Engineering, 76:98-105, March 10, 1969, pp. 99-105.

[32] John P. Malloy, "Computerized Cost System in a Small Plant," Harvard Business Review, 46:141-146, May-June, 1968, p. 142.

[33] Ibid, p. 146.

Rudolph Bergwerk feels that:

> Data Processing can revolutionize accounting for small business because it makes an almost unlimited number of general ledger accounts feasible. It is no longer necessary to compress all transactions affecting income into some twenty to thirty categories, or general ledger accounts, the economic limitation of a manual writeup. Three or four times the number of general ledger accounts will not merely yield more detailed information but can highlight data which might otherwise be overlooked.[34]

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[34] Rudolph J. Bergwerk, "Data Processing for Small Business," The Journal of Accountancy, 115:51-54, December, 1963, p. 51.

CHAPTER III

THE COMPANY STUDIED AND THE CHARACTERISTICS OF EACH EDP ALTERNATIVE

I. DESCRIPTION OF C.I.T.

Industry background. C.I.T. is part of the general electronics industry but more specifically, according to Dun and Bradstreet's Industry Studies Department[35], they are part of the electronic components and accessories industry.

According to Electronics: "Once again, the electronics industry anticipates a comparatively modest--by past standards, at any rate--year-to-year gain. Sales this year are expected to rise 6.5 percent from 1968, to $25.3 billion... Within the next three years, electronics will become an almost $30 billion industry."[36]

The company organization and general policy. C.I.T. used the classical approach since it is organized into three main departments: Sales, Engineering, and Production. However, their organization chart[37] does not readily reveal the fact that several men have responsibilities that extend to several positions within the company. For example, the

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[35]Dun and Bradstreet, Industry Studies Department. Key Business Ratios: In 125 Lines. New York: Dun and Bradstreet, Inc., 1964-1967.

[36]_____. "Electronics Magazine's 1969 Markets Report," Electronics, 42:110-142, January 6, 1969.

[37]See Appendix A.

same man has responsibilities for the following positions: President, Sales Manager, Salesman, Quality Control Manager, Industrial Engineering, and Buyer. The significance herein exemplifies the companies size--very small.

C.I.T.'s general policies are not clearly defined nor understood. Economic factors receive only sporadic consideration in company planning. Their interest in trade and business associations is limited; nevertheless, they are currently generally informed on federal, state, and local government regulations.[38]

The company's functions and their relative importance. C.I.T. is organized, as mentioned previously, into three departments: Sales, Engineering, and Production. The function of these departments and their relative importance largely stems from C.I.T.'s origin and their method of operation during their early years.

Their engineering department is considered their most important department. The specific product lines require engineering excellence which is demanded in order to maintain the quality of their products for which they are known.

Relative to the engineering department, the production department is considered their next most important department. Almost all of their products are required to meet extreme physical environmental tests which demand the product be well manufactured and assembled.

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[38]Howard Ellsworth Sommer, "How to Analyze your Own Business," Management Aids: for Small Manufacturers. United States Small Business Administration, No. 46. Washington, D.C.: Government Printing Office, 1966, p. 2.

The sales department, relative to the other two, is considered their least important department. The company is fairly dependent on its established business. C.I.T.'s marketing is particularly weak, since management depends on its acknowledged technical competence to bring in business.

How to analyze your own business. A questionnaire by this title was written by Howard Sommer[39] for the Small Business Administration. This was used by the author as an outline for obtaining additional information about C.I.T. and was incorporated in Chapter IV, The Analysis of C.I.T.'s Operation.

The questionnaire's basic divisions and subdivisions are as follows:[40]

I. GENERAL
   - Policy
   - Industrial Relations
   - Finance
   - Product Research

II. PRODUCTION
   - Procurement
   - Production Control and Scheduling
   - Plant Engineering
   - Tool Engineering
   - Methods Engineering
   - Manufacturing
   - Quality Control

III. DISTRIBUTION
   - Sales-Merchandising
   - Warehousing

IV. CONTROL
   - Standard Costs
   - Budget Control
   - Accounting

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[39] Ibid., p. 1 - 5.

[40] Ibid,, p. 1 - 5.

Financial information. Financial information is presented from three different sources: C.I.T.'s financial statements,[41] Electro-Networks, Inc.[42] (to be used as a comparison with C.I.T.), and industry financial information[43]. This information will be used mainly in financial ratio analysis.

In addition to the above information the author feels he has a general working knowledge of C.I.T., having been employeed during four summers, each a duration of three months, as a Student Engineer.

II. DESCRIPTION OF EDP ALTERNATIVES AND THEIR CHARACTERISTICS

Following are brief descriptions of the three EDP alternatives and their basic characteristics, i.e., cost parameters, nature of respective service, convenience, and company control.

Service Bureau. A service bureau is an organization that will process any volume of data from its inception to presentation for ultimate utilization or any portion therein. The user should determine exactly what information, reports, and/or service is wanted, since the cost is thereby determined. The cost parameters are the number of man-hours used, the amount of computer time used, and/or a package of service bureau resources. This is the service bureau's main advantage--payment for only the resources used.

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[41]Financial statements of C.I.T. are confidential (see Appendix K).

[42]See Appendix E and L.

[43]See Appendix C and D.

Service bureaus are limited generally in four ways: (1) Application areas that may be used are those that are adaptable to batch-type processing, (2) service bureaus are usually found only in metropolitan areas, thereby limiting their services to users in these areas, unless a distant user wants to ship his information back and forth; however, if the user is in the area, the service bureau will usually provide a pick-up and delivery service, (3) the service bureau allows very little company control over processing by the very nature of the service itself, and (4) it is not convenient for the user's operator or programmer since they have to wait for the service bureau to process their program.

Time-sharing. Time-sharing is a method whereby a user has direct access to a large capacity electronic computer, via commercial telephone lines, by using a low-speed remote input-output terminal. A customer may use this service at "cost generally less than $200/mo. and $30/hr. for rent and online charges."[44] However, the "...cost of a parcel of time-shared computing power is relatively high when compared with the cost of an equivalent parcel of batch-processor computing power."[45]

It should therefore be apparent that the time-sharing alternative is more expensive than either the service bureau or leasing a computer, if measured on a per-unit of data processed.

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[44] Larry Meador, "Computer Time-Sharing," Chemical Engineering, 76:109-114, January 13, 1969, p. 109.

[45] Ibid., p. 113.

Time-sharing has many advantages because of its conversational, or immediate response, mode of operation. This direct communication with computer simplifies the debugging operations normally required in programming. For the engineer or scientist, the time-sharing terminal is a very powerful tool because they can process their programs when and as needed.

Lease or buy. When a company leases or buys a computer the end result is having the use of a computer on their premisses. The question of whether to lease or buy is mainly one of financing, and will be considered as one alternative since the end result is the same.

When a company leases a computer they have complete control of the operation and the utility of the application areas which are limited mainly by the quality of their EDP staff.

The cost of a leased computer may be divided in two ways: One time conversion cost and operating cost. The one time conversion cost includes: (1) Physical site preparation, i.e., the computer room itself, raised floor (if needed), and air conditioning equipment; (2) training of personnel, and (3) system design and initial programming. The operating costs are (1) additional EDP personnel, (2) monthly rental charges of equipment, and (3) new forms to be used.

CHAPTER IV

THE ANALYSIS OF C.I.T.'S OPERATION

This chapter consists of an analysis of C.I.T. using the material which was presented in Section I of Chapter III, as follows: (1) The company organization chart and general policies, (2) the Small Business Administration Management Aids, "How to Analyze Your Own Business", (3) the company functions and their relative importance, and finally, (4) analyzing their financial position.

The following Sections, concerning the various departments of C.I.T., are being presented in the natural sequence in which they are affected from the time of the receipt of an order to the shipment of the item ordered. At the close of each section a comment will be made as to the department's relative importance to C.I.T.

I. SALES DEPARTMENT

General Office Operation. The general office operation is the responsibility of the sales department, even though it also handles all the administrative paper work.

C.I.T. has a selective selling effort but it is not always directed toward the best profit possibilities. The President of C.I.T., who is also the Sales Manager, is the only directly employed salesman; however, their manufacturer's representatives are closely supervised.[46]

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[46] Howard Ellsworth Sommer, "How to Analyze Your Own Business," Management Aids: For Small Manufacturers. United States Small Business Administration, No. 46. Washington, D.C.: Government Printing Office, 1966, p. 4.

Their sales program is based on past customer experience and therefore their market potential is unknown with no selective advertising.

Their price structure is rigid and therefore accurate product costs are not used in setting sales prices. Competition partially governs pricing.[47]

Quotations. The orders come into the sales department, either through one of the company's manufacturer's representatives or directly from a customer. If it is a catalogue item, the sales manager will figure a price per quantity using a standard cost schedule which has been calculated and established by the company based on price cost data, and then the customer will be notified by phone, wire, or letter of the quotation price. If the item is not a standard catalogue item, the order and the customer specifications are routed to the Engineering Department. The Engineering Department produces a preliminary design which is used as the basis for the quotation price.

Accounting Procedures. C.I.T.'s accounting is fairly comprehensive, accurate, prompt, and well managed; but their accounting data is not adequate in comparison with most modern conceptions of control by standards.[48]

They use a general journal and ledger card accounting procedure for everything except payroll accounting. A multiple posting system utilizing the pegboard as a holding device is used for payroll preparation,

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[47] Ibid., p. 4.

[48] Ibid., p. 5.

which takes them an average of 24.75 hours to prepare.[49] The pegboard permits posting several related forms at the same time. This bookkeeping method provides the small firm with many of the advantages of bookkeeping machines, without the capital investment in them.[50]

Most of the accounting work and the general sales correspondence is handled by the two office secretaries. Their main functions are general secretarial duties, personnel records, payroll, billing, invoicing, and order entry. They spend approximately 25 percent of their time with order entry and the associated internal control documents.

Sales Analysis. C.I.T. has no sales budget, no real sales analysis, and no sales records beyond the orders booked and the sales billed.[51]

C.I.T. just this year started to use a simple breakdown of sales by customers who constitute approximately 75 percent of their sales. However, they do not have an analysis of their sales according to product or produce lines.

The only method that they use for sales forecasting is by considering the general economic conditions and their industries general outlook. They do not use a detailed product forecast, nor do they use a long-range sales forecast.

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[49] See Appendix M.

[50] R. W. Sheppard, "EDP Benefits for the Small Business," The Office, 67:196-197, January, 1968, p. 196.

[51] Sommer, op. cit., p. 4.

Their sales department is considered their least important department. The company is fairly dependent on its established business. C.I.T.'s marketing is particularly weak, since management depends on its acknowledged technical competence to bring in business.

II. ENGINEERING DEPARTMENT

Design Capabilities. C.I.T. has a good reputation for its engineering excellence, technical competence, and the quality of its final product.

If an order is not for a repeat or catalogue item, it is routed to the Engineering Department, as previously indicated, where a preliminary engineering design is prepared. This preliminary design is an approximate design, a general analysis of the customer's specifications, and also a consideration of the economic factors of design. Since this preliminary design is not a complete and detailed, there is the possibility that the final design will be different from the original or preliminary design.

The final network configuration or design will be prepared utilizing information contained in the preliminary design, even though the final design technique or procedure might be different. The quality of all C.I.T.'s products are dependent upon good designs. A design can be approached from either of two different general methods: (1) The classical network theory or (2) the modern network synthesis.

The first method, classical network theory, is utilized in designing networks whose design parameters of specifications are not very close or critical since the application of this technique is simpler, than those used in the modern network synthesis. The classical network theory is less exacting because the derivation of the equations are contingent upon

The second method, the modern network synthesis, is partially limited in its applications to certain designs. For when they employ modern network synthesis, C.I.T.'s engineers are limited to normalized design tables which are the solutions to equations that were computerized by someone else. Therefore, when the network specifications are outside the limits of the design tables, the engineer would use the classical network theory which can be used here since the design parameters are not limited as they are in the network synthesis method.

However, when design parameters are close and critical it would be advantageous to use the network synthesis method, since the element values of the network are approached simultaneously. Therefore, there is no accumulation of errors to decrease the accuracy of the computation.

It was estimated by C.I.T.'s chief engineer that the length of time it took to design a product comprised approximately 20 percent of the total engineering time spent on that project.

Valuation. The valuation of a design is the actual physical method of testing and analyzing the electrical characteristics and performance of the network that was designed.

So that this testing can be done, a working model, or breadboard (as it is called in the industry) of the design has to be made. This breadboard is not made as the final product will be, since it will just be used to test the electrical characteristics. If the electrical characteristics of the breadboard model do not meet the specifications of the customer, then the engineer must redesign the network, using the test results to guide his modifications.

C.I.T.'s chief engineer stated that this valuation stage accounts for approximately 60 percent of the total engineering time.

Paperwork. Engineering paperwork is comprised of the bill of material, assembly procedure and drawings, and the physical and electrical test specifications. This paperwork is drawn up once the design meets the customer's electrical specifications.

The bill of material is a document which has on it a list of all the parts that are needed to assemble the product. C.I.T.'s purchasing agent uses the bill of material to determine what parts and the quantity of each that needs to be purchased. The production department uses it to draw material out of the stock room or inventory.

The assembly procedures and drawings are also very important since they are the documents that the production department uses in the manufacturing and assembly of the product.

The test specifications include both physical and electrical requirements that must be met before the final product will be sent to the customer.

The engineer that designed the product is responsible for the quality of the three documents, since the quality of the final product is thereby determined.

C.I.T.'s chief engineer stated that producing the paperwork took approximately 20 percent of the total engineering time.

Research and Development. C.I.T.'s research effort is generally spasmodic, unorganized, and all the objectives are not definite, however, there is close cooperation with sales, manufacturing, and tool engineering to insure market acceptance and proper manufacturing.[52]

During the summer of 1968, C.I.T. started using a computer time-sharing service terminal to develop new design techniques and sophisticate their present techniques. They are presently using approximately forty hours a month on the terminal.

The area in which this will help the most is in the valuation since the engineer will not have to build a breadboard model to analyze his design.

C.I.T. hopes to engage in research and development in the future in production techniques and the development of new products.

Their engineering department is considered their most important department. Their specific product lines require engineering excellence which is demanded to maintain the quality of the products for which they are known.

III. PRODUCTION DEPARTMENT

Procurement. The purchasing decisions are the responsibility of the Production Manager. This function is generally well handled with fair expediting procedures, however, it lacks complete coordination with Engineering and Production Control.[53]

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[52] Ibid., p. 3.

[53] Ibid.

Manufacturing. Manufacturing is the main responsibility of the Production Manager. Production control and scheduling are completely planned in accordance with the Sales Department requirements and the manufacturing facilities. Their manufacturing facilities and machinery are up-to-date; on the other hand, their manufacturing costs are not low in the field and therefore their overall supervision needs to be improved.[54]

Material control encompasses both inventory and production material. This total material control and flow needs to be improved.[55]

C.I.T.'s products and production can be classified by (1) repeat items and (2) initial run items. Their repeat items account for approximately 60 - 70 per cent of the total production and usually only five per cent require any engineering revisions. Some of their initial products are still being manufactured; however, most products usually have a three year production life and then disappear from the market.

Industrial engineering. The industrial engineering at C.I.T. is mainly tool and methods engineering. The tools are developed, designed, and tested to yield the lowest feasible manufacturing cost for products which require them. The tools are also efficiently maintained and controlled. Methods and standards are worked out by various department heads; therefore, improvements are slow and full coordination between manufacturing, tool, and general engineering departments is not maintained.[56]

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[54] Ibid.

[55] Ibid.

[56] Ibid.

Quality control at C.I.T. is segregated as a separate function. They have an efficient inspection program tailored to each product and used as an aid to the sales and manufacturing departments.[57]

Personnel. C.I.T. does realize the value of good industrial relations and therefore has formulated sound policies, but the authority and the responsibility for carrying out the policies have not been clearly defined. The policies are planned to minimize labor turnover, build employee moral, and increase efficiency. Employee selection techniques have not been developed and there is no uniform procedure for applicant screening, placement and training, except that original interviewing is done by each department head.[58]

Salary and wages rates are equitable and fair for each job classification from the common labor to top management. This situation is limited by the fact that C.I.T. does not have sound job evaluation methods and incentive plans for all of their employees. They do keep individual history and progress records for each employee which are updated for use as an inventory of qualifications.[59]

IV. FINANCIAL ANALYSIS

Finance. C.I.T. does make forecasts of working capital and cash requirements for planned business volume and profits level, but on an unscheduled basis. Their depreciation reserves are conditioned only on

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[58] Ibid., p. 2.

[59] Ibid.

allowable deductions for tax purposes (they use the double declining balance method) but C.I.T.'s are not properly planned from a capital asset replacement point of view.[60]

Job costs. C.I.T. uses a job cost accounting procedure which is fairly accurate but it is not organized to provide information promptly and therefore their cost estimates are not usually checked against actual costs. Their profit or loss is estimated monthly and then verified and adjusted annually to the inventory. They do not breakdown their profit or loss figures by product. The effect of additional volume on cost and profit is estimated because it is not easily determined. The value of break-even analysis is underestimated and therefore not determined.[61]

Budgetary control. C.I.T. makes no attempt to budget or forecast their performance, prepare sales budgets or quotas, centralize control of selling prices within limits of predetermined profit requirements, or establish long-term planning. What budget policies they have vacillate because they are not founded on complete comparative information and thorough analysis.[62]

Comparison of financial position. This is a comparison of C.I.T.'s financial position relative to the Electronic Components and Accessories

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[60] Ibid.

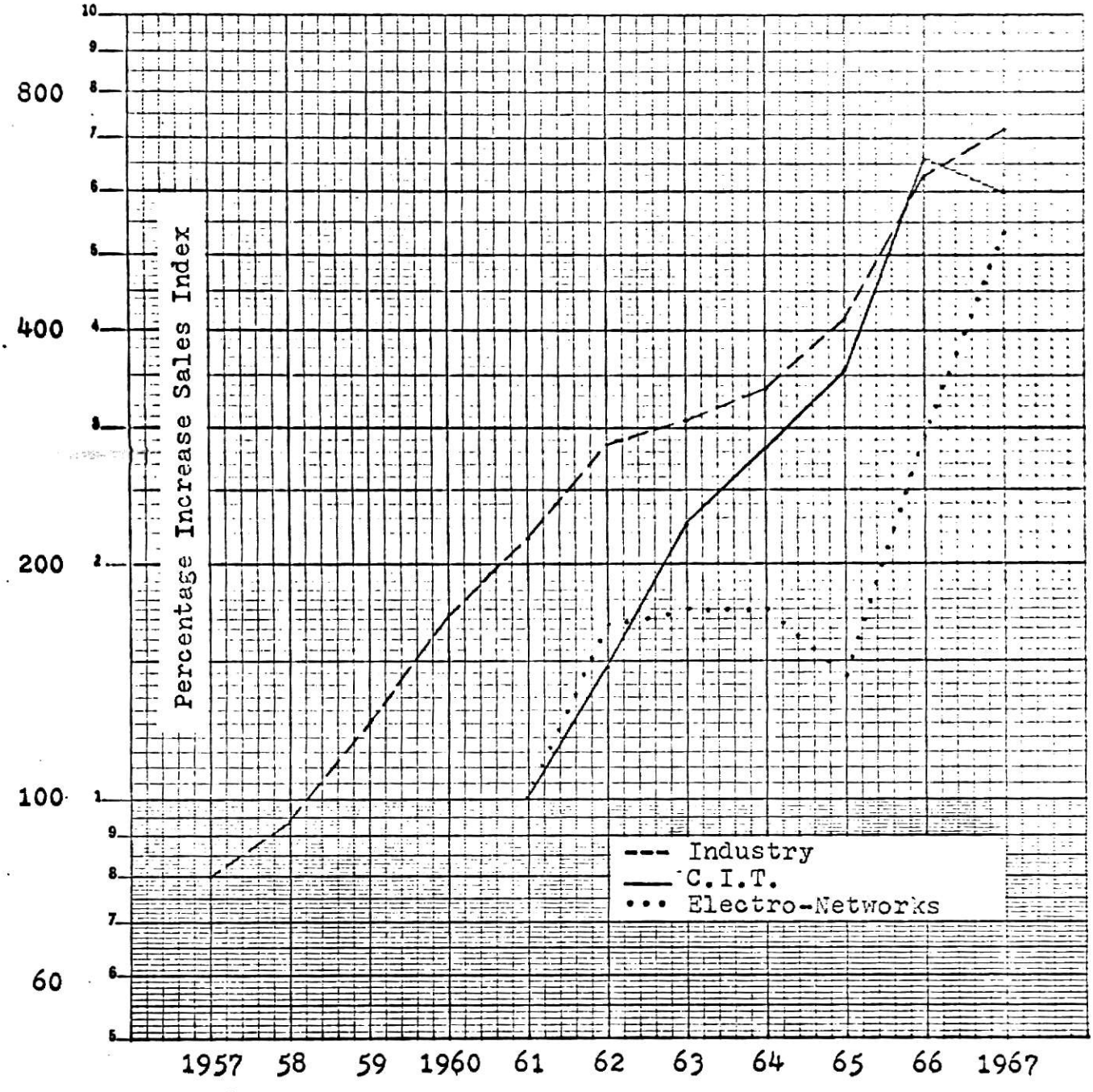
[61] Ibid., pp. 4-5.

[62] Ibid., p. 5.

Industry and Electro-Networks, Inc., another company in the same industry. The importance of this will be to establish that C.I.T. is financially a relatively healthy company, thereby lending credibility to the analysis of the economic feasibility of EDP for C.I.T.

This brief sales history presentation will show that C.I.T.'s sales growth trend is fairly representative of the industry. The industry sales (using 1957-1959 = 100) has increased over 700 percent, as can be seen from Figure 1, page 34. Electro-Networks' percentage increase in sales (using 1961 = 100) from 1961 to 1962 was better than the industry or C.I.T.. In 1963 and 1964 their rate of increase was actually zero and then in 1965 the rate went negative, decreasing from 175 to 144 percent. However, in the two following years, 1966 and 1967, Electro-Networks' rate of percentage increase was better than the industry by reaching 536 percent in sales growth in 1967.

C.I.T.'s rate of percentage increase in sales (using 1961 = 100) was somewhat better than the industry, when in 1966 they exceeded the industry sales growth by reaching the 660 percent increase sales mark. Then in 1967 their sales decreased to 600 percent.



[a]See Appendix E

FIGURE 1

SALES COMPARISON[a]

TABLE I

LIQUIDITY

Year	Current Ratio		Accounts Rec. Turnover		Inventory Turnover	
	C.I.T.[1]	Indus[2]	C.I.T.[1]	Indus.[3]	C.I.T.[1]	Indus.[2]
1967	1.91	2.75	9.49	7.16	14.72	5.3
1966	2.22	2.14	8.20	7.0	15.45	5.4
1965	4.29	2.42	6.04	6.3	6.74	5.4
1964	3.66	2.20	8.27	6.9	12.20	6.4

[1] See Appendix K; [2] See Appendix D; [3] This is collection period (see Appendix D) divided into 365.

This liquidity analysis will show that C.I.T. is a good short-term credit risk. The current ratio is the basic indicator in a financial analysis of a firm's liquidity. However, to complete a liquidity position appraisal, a complete cash analysis utilizing a cash budget is necessary. C.I.T.'s current ratio, which is one measure of liquidity level, was above the industry except for 1967, as seen from Table I, page 35. C.I.T.'s liquidity flow, consisting of the accounts receivable and inventory turnovers, was considerably better than the industry as a whole in all four years, even though there was a fairly large variance in the inventory turnover. The reason their inventory turnover is high is because they are an engineering firm,and they actually obtain a sale commitment before all the material is purchased. Since their liquidity

flow for 1967 was well above the industry, the low current ratio should not cause a great deal of concern.

This analysis of earning power will show that it is important, if growth is a goal, that percentage increases in operating expenses and the operating assets be held below the percentage increase in sales. The earning power of C.I.T., Electro-Networks, and the industry are presented in graphic form in Figure 2, page 37. The earning power is the product of the profit margin and the capital turnover.

The industry's capital turnover leveled off in 1965 and 1966, and actually decreased in 1967 for two reasons: (1) The industry was becoming more sophisticated and thereby requiring a somewhat higher level of operating assets relative to the sales, and (2) the percentage of capacity utilization decreased in 1967. It is evident that the industry's profit margin decreased in 1966 because the operating expenses increased more than the sales. This decrease in profit margin was the main factor in decreasing the earning power in 1966. Since the profit margin and thereby the earning power improved, this shows the industry was able to raise their sales more than their expenses.

The calculation of Electro-Networks' earning power was only possible by making the assumption that their profit margin was typical for the industry; therefore the industry profit margin could be used since their net operating income was not given.[63] Electro-Networks' capital turnover is almost a mirror image of the profit margin, and therefore, their earning power was fairly constant. The decreasing trend in the capital turnover

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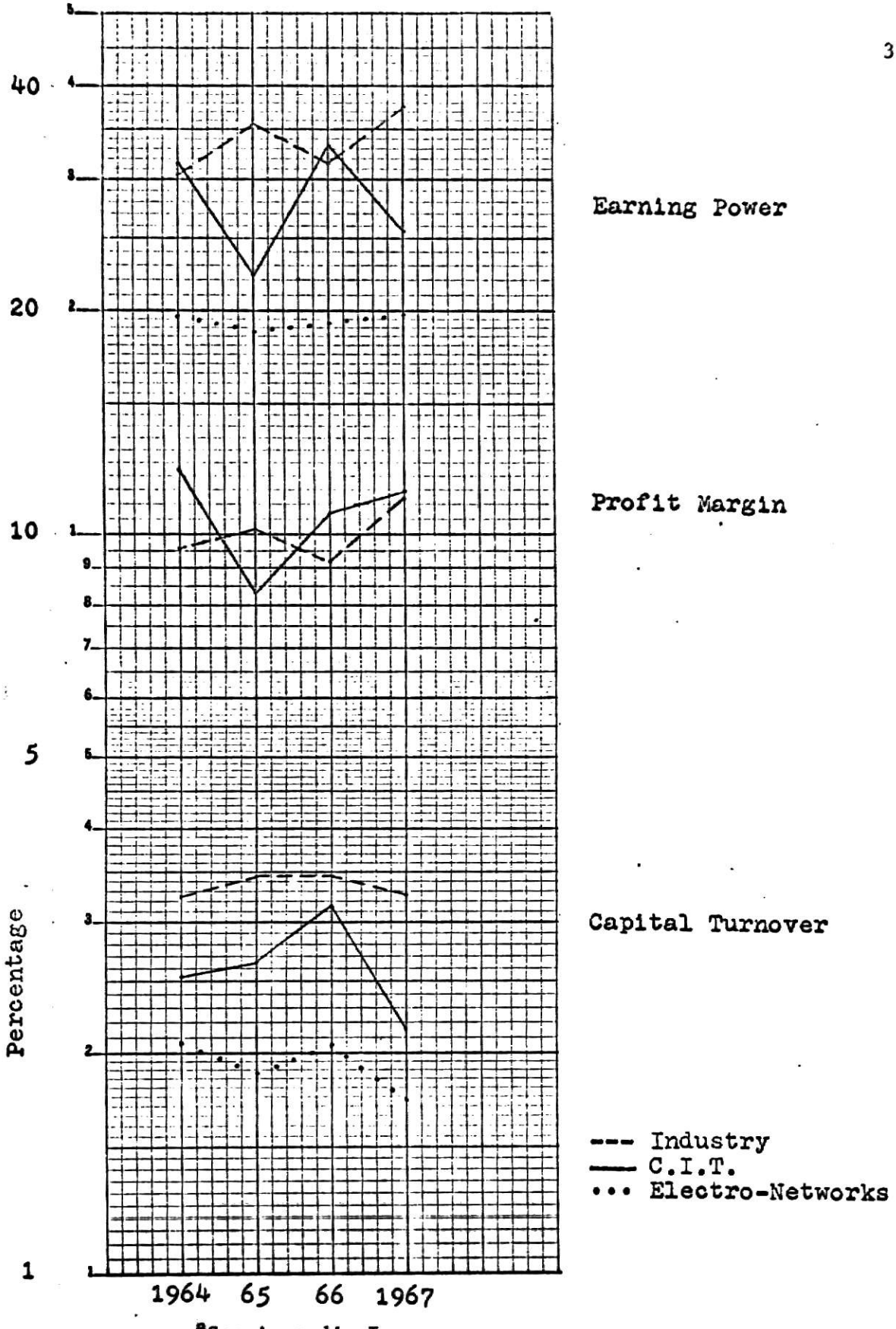
[63]See Appendix L.



[a]See Appendix I

FIGURE 2

EARNING POWER[a]

coupled with their skyrocketing sales from 1965 to 1967 as shown in Figure 1, page 34, indicates that their operating asset base was greatly expanded.

C.I.T.'s sales volume as shown in Figure 1, page 34, from 1964 to 1966 increased at a faster rate than their operating assets, thereby showing an increase in their capital turnover as shown in Figure 2, page 37. However, in 1967 their sales decreased considerably while their operating asset base continued to expand which means that their capacity utilization decreased as indicated by the decrease in the capital turnover. C.I.T.'s operating expenses increased almost twice as much as their sales from 1964 to 1965 which caused their profit margin to decrease, also affecting their earning power directly. In 1966, their profit margin recovered because their sales increase was greater than their operating expense increase, and since their capital turnover also improved, their earning power completely regained what it had lost in 1965. Their sales decreased in 1967 as shown in Figure 1, page 34, but their operating expense decreased a greater percentage; therefore, their profit margin actually improved. However, they continued to expand the operating asset base, as mentioned previously, even though their sales decreased. This caused their capital turnover to fall, thereby pulling down their earning power as well.

CHAPTER V

ANALYSIS OF EDP IN C.I.T.

This chapter will answer the three basic questions in the statement of the problem: (1) What possible and/or probable utilization of computer applications exist? (2) What advantages, if any, may be gained from the use of a computer? (3) What is the economic feasibility of the use of a computer in the probable applications?

The first question will be satisfied by an analysis of the possible and/or probable EDP applications which are applicable to C.I.T.'s operations at this time. The second question will be answered by analyzing the benefits and problems of EDP, both in the selected application areas and, in general, within C.I.T. The last question will be dealt with by an analysis of the economic feasibility and the possibility of the subsequent justification of EDP within C.I.T.

I. THE POSSIBLE AND/OR PROBABLE EDP APPLICATIONS

In this section the immediately apparent, possible, and/or probable EDP applications will be examined from the point of view first, of the sales and general office operation, then the engineering department, the production department, and finally the company as an integrated system.

Sales department. The sales department's possible EDP applications are: (1) Payroll, (2) personnel records, (3) general accounting, i.e., accounts receivables and payables, (4) quotations or product pricing

to customers, (5) sales analysis, and (6) order entry, which includes invoicing and billing.

The probable applications in the list above are the payroll, quotations, sales analysis, and order entry; they will be analyzed further in the next section.

The personnel records were not considered for a probable EDP application because C.I.T. does not have extensive personnel files and very little time is spent in this area. Likewise, the accounts receivables application, part of the general accounting, was not considered because there are relatively few accounts and there is very little trouble collecting them; which is shown by their high receivables turnover (see Table I). Further, there is almost no bad debt write-off.

Engineering department. The engineering department's possible EDP applications are (1) network design, (2) network valuation, (3) bill of material, and (4) research and development.

The two areas which were earlier estimated to comprise approximately 80 percent of the engineer's total time spent on a project were network design, 20 percent, and network valuation, 60 percent; therefore, the first two EDP applications listed above will be analyzed further in the next section.

Production department. The production department's possible EDP applications are (1) production planning and scheduling, and (2) manufacturing cost performance system.[64]

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[64]See Appendix O.

Since C.I.T.'s production planning is usually set by the customers requirements and since their manufacturing is a job shop operation, their need for a sophisticated system in this area is limited. Therefore, only the manufacturing cost performance system will be analyzed further in the next section.

Integrated analysis. At this time C.I.T. should consider further the intergration of the following applications into an EDP system: (1) Payroll, (2) sales analysis, (3) manufacturing cost performance system, (4) order entry, (5) quotations, (6) network design, and (7) network valuation.

II. BENEFITS AND PROBLEMS

This section will first consider the benefits and problems related to the use of EDP by C.I.T. in the seven selected application areas and then consider the benefits and problems generally related to the use of EDP.

Selected application areas. The payroll application would initially seem unfeasible because of the small work force. However, most small businessmen do not know how much it actually costs them to prepare their payroll. C.I.T.'s industrial engineer did a time-study analysis and determined that it took C.I.T. an average of 24.75 hours to prepare their payroll.[65] The EDP alternatives which are open to them, if just considering only the payroll application, are the service bureau and the time-sharing. The service bureau would not allow the amount of control which

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[65]See Appendix M.

they are accustomed to, although this should not produce a negative decision initially. It should be carefully considered. The service bureau would handle the complete payroll system, which includes the preparation of the checks, K-2 forms, W-2 forms, and the quarterly reports. The main benefit with using the service bureau for this application is that it would free the secretaries to do other work. The time-sharing allows approximately the same amount of control which their present system does; however, what are the cost comparisons--this will be analyzed in the next section. One problem with the time-sharing, which the service bureau would not involve, is that someone would have to write a program for the terminal.

The sales analysis application cannot be compared directly with C.I.T.'s present procedure because they use a pseudo-sales analysis. During the summer of 1968, C.I.T. started keeping track of their larger orders to their major customers, but not by product. However, a product/customer-sales analysis would be very beneficial to them since they presently rely on their reputation to bring in orders. They need to seek new and profitable markets. The EDP alternatives which are open to them, if just considering this application, are the service bureau and the time-sharing. The service bureau alternative appears the most promising since C.I.T. would not have to program the application.

The evaluation of a manufacturing cost performance system, even as an application for EDP would be difficult to determine. C.I.T. presently does not monitor their manufacturing cost performance. Another small manufacturing company which set up this type of system stated two of their reasons for initializing their system:

> It was particularly important to obtain a better reading of labor costs, since they made up a big part of the sales dollar and since changes in these costs affect profits so profoundly.
>
> The unreliable cost system put a great deal of guesswork into product pricing.[66]

By virtue of the system, it also monitors the amount of material used and the related scrap. It was evident that this particular system would require a large volume of data and therefore to make it economically feasible, the company computerized the system. Further, C.I.T. does not have a good cost control procedure and therefore should consider a similar system. This type of application should be run on an in-house computer or done by a service bureau since this application uses a large volume of card input which is hard to adapt to a time-sharing terminal.

The order-entry application should only be considered if a computer is leased or purchased to be used in C.I.T.'s facilities. This is because of the numerous input/output functions which this system performs. Since the order entry function is such a complex system it would take a very detailed study of the information flow in their present system. Such an analysis was not considered to be within the feasible scope of this report.

Producing a complete quotation or bidding system would be very time consuming and difficult. However, the biggest part of a quotation at C.I.T. is the initial network design and then the valuation. Therefore, if a faster method could be found to design and valuate the networks, this

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[66]John P. Malloy, "Computerized Cost System in a Small Plant," Harvard Business Review, 46:141-146, May-June, 1968, p. 142.

would not only aid the engineer, but would also aid the sales department in reducing the turn-around time now required to get a bid back to the customer.

This leads to the analysis of the network design and valuation application. The present network design and valuation methods were previously described very thoroughly.[67] Further, compared to a non-technical person, it is relatively easy for an engineer to write a computer program. C.I.T.'s engineers have already written several programs to use with their time-sharing terminal. The implication herein is that their engineers could write a program that would enable them to use the modern network-synthesis method of designing networks. By using this method, the engineer would be able to valuate the design in a much shorter time span. This would also allow the designing time of a network to decrease. This total process of design and valuation, as mentioned previously, comprised approximately 80 percent of an engineer's time at C.I.T.[68] This type of application requires that the programmer be able to insert appropriate data at different points in the program; therefore, this application has to be run on either a time-sharing terminal or on a leased/purchased computer in-house.

General. C.I.T. is a technically oriented firm with a good engineering staff and, therefore, their total overall programming effort

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[67] cf. pp. 26-28.

[68] cf. p. 40.

and training would probably be less, as compared to a non-technical firm. Nevertheless, if the alternative to lease/purchase a computer is chosen, then C.I.T. should consider hiring someone or giving one of their people very extensive EDP systems training; so that they might be able to make the most efficient use of the EDP system.

Also within the area of personnel, C.I.T. could train one of their secretaries who is proficient in typing to be a keypunch operator as well. Not only should C.I.T. consider EDP personnel but they must also consider the transition time that it takes to implement any EDP system. The probem of implementation, even though not within the scope of this report, should be considered if the alternative to lease/purchase a computer is chosen.

Another benefit that must be mentioned is that the computer gives personnel the freedom to experiment creatively. To the engineer, this could be most beneficial.

III. THE ECONOMIC FEASIBILITY

This will be an analysis of applications to determine the economic feasibility and the possibility of subsequent justification in the areas of payroll, sales analysis, manufacturing cost performance system, and network design and valuation.

Payroll. The analysis of the economic feasibility of the payroll application will examine C.I.T.'s present cost, the service bureau cost, and the cost of the time-sharing alternative. C.I.T.'s present cost of preparing their payroll is $0.90 per check.[69] The applicable cost which a service bureau would charge is $0.35 per check.[70] The cost of using a time-sharing terminal in preparing C.I.T.'s payroll is $0.62 per check.[71] Therefore, if just considering the payroll application, it is apparent that C.I.T. should have their payroll processed by a service bureau.

Sales analysis. The economic feasibility of the sales analysis application has to be examined from the standpoint of the cost versus the benefits gained from the application. A program run-time would have to be determined to analyze the time-sharing terminal and since this was not within the scope of this report nor could any published cost be obtained, just the service bureau cost will be presented. A simple breakdown of

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[69] See Appendix M, Sect. III.

[70] See Appendix M, Sec. I.

[71] See Appendix M, Sec. II.

sales into product and/or customer done by a service bureau would cost $50.00 for each run.[72] If this application was done quarterly, it would cost C.I.T. $16.67 on a per-month basis.

Manufacturing cost performance system. The economic feasibility of the application of a manufacturing cost performance system has to be approached from the standpoint of the cost versus the reduction of labor cost and other benefits gained from the application. The operating cost of this system installed by another company was $850.00 per month for 16 hours of time on an IBM 1401 computer in a service bureau.[73] This application uses a large volume of card input which is hard to adapt to a time-sharing terminal and therfore, will not be considered as an alternative for this application. In 1967 C.I.T.'s labor cost made up 41.9 per cent of their cost of goods sold. This cost affects their net operating income and thereby their profit margin. If they could lower their labor cost 6.76 per cent by using a similar manufacturing cost performance system, the application could pay for itself. However, this is not considering the cost or time it would take to initialize this complex system.

Network design and valuation. The economic feasibility of the network design and valuation application will be analyzed by showing the possibility of reducing the amount of time it takes to design and valuate a network.

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[72] _____. "The Computer - Is Your Company Ready for It?," The Management Letter. College of Commerce, Kansas State University, Vol. III, No. 7, March 1966, p. 2.

[73] John P. Malloy, "Computerized Cost System in a Small Plant," Harvard Business Review, 46:141-146, May-June, 1968, p. 144.

C.I.T.'s engineering salaries in 1967 were $4,400 per month, which will be considered as the cost of 100 per cent of their total engineering time. Assuming a five per cent shrinkage (or effective time loss) in both valuation and design times, their valuation time (60 per cent of total) cost them $2,510 per month and their design time (20 per cent of total) cost them $836 per month.

If C.I.T.'s engineers could lower their valuation time from 60 per cent to 30 per cent, by employing the above EDP application, they could achieve a possible savings in time cost of $1,190 per month. Therefore, if the cost of computer time is equal-to or less-than $1,190 per month, it would be economically feasible. This would have to be, as mentioned previously, on a time-sharing terminal or a leased or purchased computer.

This time savings would not necessarily appear as money saved directly but would rather enable the same engineers to accomplish that much more work.

C.I.T. is presently using a time-sharing terminal, the average cost per month for the last six months of 1968 was $698.20. This includes a leased phone line cost of $102.60 per month. They have derived very little actual operating benefit, since they are in the developmental stage of network design and valuation programs.

This developmental stage, for an engineering firm, takes approximately a year.[74] Therefore, the cost they are presently incurring could

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[74]William R. Ludwig, and Robert P. Peterson. "Computer Design Helps Small Chemical Company," Chemical Engineering, 76:98:105, March 10, 1969, p. 104

be treated as research and development cost or a one-time initial cost, either of which could be amortized over a five year period. The total development cost amortized over a five year period would be $505 per month.[75] Then add the cost of development, $505, to the cost of operating the terminal, $698.20, and then the total cost of this application would be $1,203.20 per month on a time-sharing terminal. Now compare the application cost of $1,203.20 with the possible savings of $1,190; this shows that this application is only $13.20 per month away from justifying itself economically. Therefore, on a time-sharing terminal, is this application worth $13.20 per month to C.I. T.? Considering that this application would enable the engineers to produce a more accurate network design in a shorter time span, this application would be well worth the $13.20 per month that it would cost.

C.I.T. should also compare the typical monthly rental of a small computer to the possible savings of the network design and valuation application. C.I.T. could use the time-sharing terminal to develop their programs while their computer was on order, thereby, being ready when it arrives. Therefore, the developmental stage cost would be the same as mentioned previously, $505 per month. One of the smallest computers that would handle this application is an IBM 1130, which has a typical monthly rental[76] of $695. Then the total cost would be $505 plus $695, or $1,200; if used for just this application.

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[75]See Appendix N.

[76]Daniel Peck, "Guide to the Small Computer," Administrative Management, 27:48-52, July, 1966, p. 51.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Summary. The purpose of this report is to aid the small business executive, specifically C.I.T.'s management, in arriving at a good decision as to whether or not to use EDP and, if so, to what extent.

In the decision process, the first step is to identify the objectives and purpose, which are again stated above. The second step in the decision process is to develop and analyze the alternatives, therein to gain information about C.I.T. and the EDP alternatives, which is the core of this report.

The analysis of C.I.T. not only brought out areas of possible application to EDP but also revealed areas where problems now exist as well as areas where problems may occur in the future and therefore, necessitating the need for further examination by C.I.T.'s management.

Through an operational analysis of the uses of EDP in C.I.T., the selection of four applications was made so that they could be further examined to test their economic feasibility. This appraisal and selection of alternatives is considered the final step in the decision process.

From an overall economic standpoint the use of EDP in three of the application areas needs to be considered in order to arrive at the probable cummulative economic benefits which may be obtained from such EDP use. Assuming C.I.T. were to use a service bureau, instead of their secretaries, to prepare their payroll they would experience a net savings of $102 per month, which economically justifies the payroll application. This savings thus makes funds available, a portion of which, should be used for an EDP

sales analysis, since such a sales analysis can be obtained from a service bureau for approximately $17 per month. The remainder of the $102 savings would be available to defray C.I.T.'s cost of using the time-sharing terminal, even without any operational benefits for up to one year; if, at the end of this period their engineers could achieve the 30 percent cut in network valuation time. Furthermore, if C.I.T.'s management felt, assuming continual analysis of their engineers' progress, that the engineering staff would achieve the 30 percent cut in network valuation time, then they should consider the leasing or purchasing alternative.

If C.I.T. could develop and subsequently economically justify the network valuation application on the time-sharing terminal, then they could also economically justify the use of an IBM 1130 or similar small computer which would replace the terminal, because there would be very little additional initialization cost associated with a computer of this size.

Conclusion. This report demonstrates that a company's management may determine certain EDP applications and alternatives that can be used by their company as a direct result of the use of an analysis such as the one used in this report, that is, one that seeks its' own answers to the economic feasibility and utilization of computer applications.

Further, if their analysis warrants the conclusion that the alternative to lease or buy a computer should be chosen; the company can gain some interim benefits by using the economically feasible applications and alternatives to gain experience and develop their programs prior to installation of the leased or purchased computer. Also, if this alternative is chosen and full utilization of the leased computer is desired, then consideration should be given to conducting a more detailed feasibility systems

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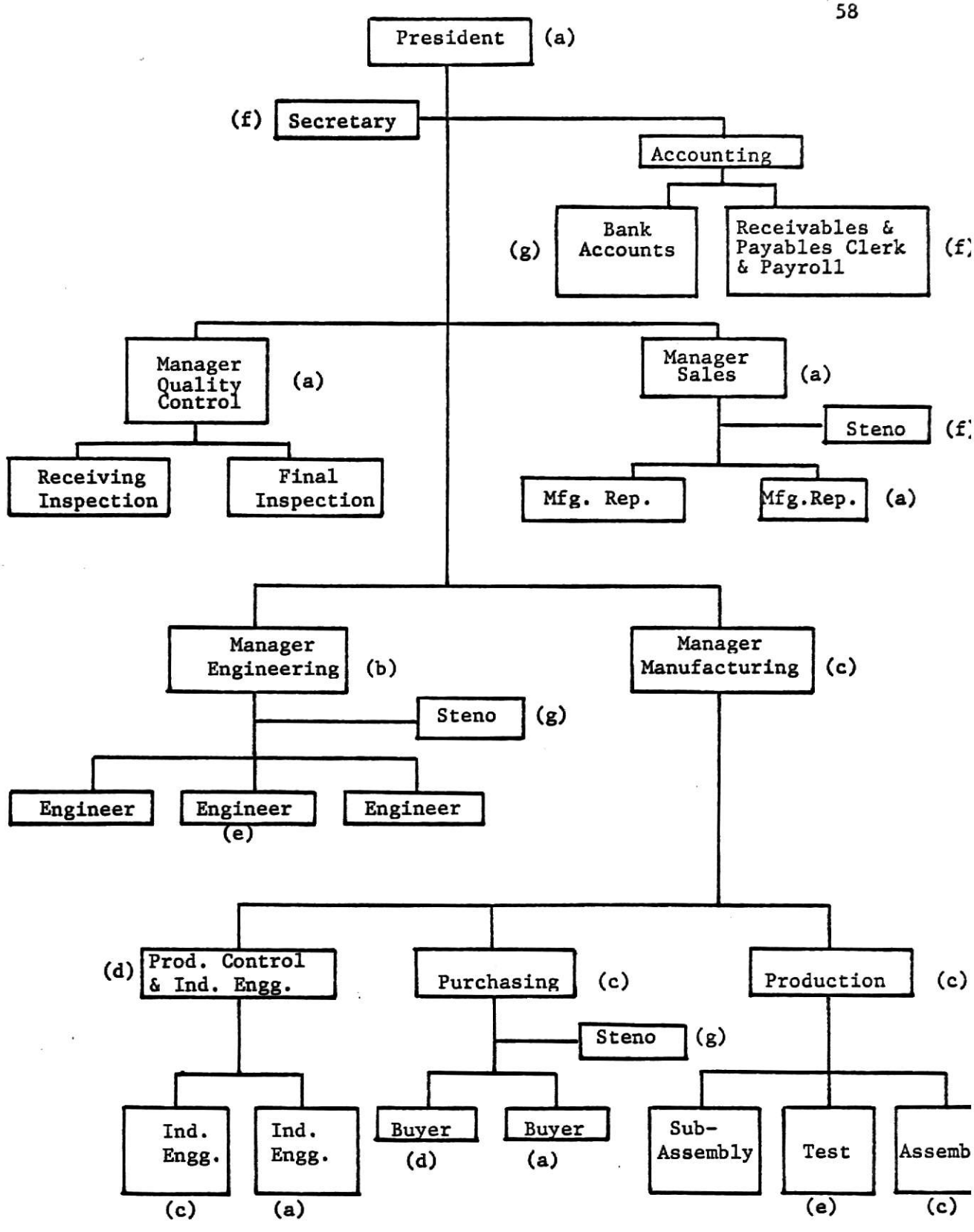
APPENDIX

APPENDIX A

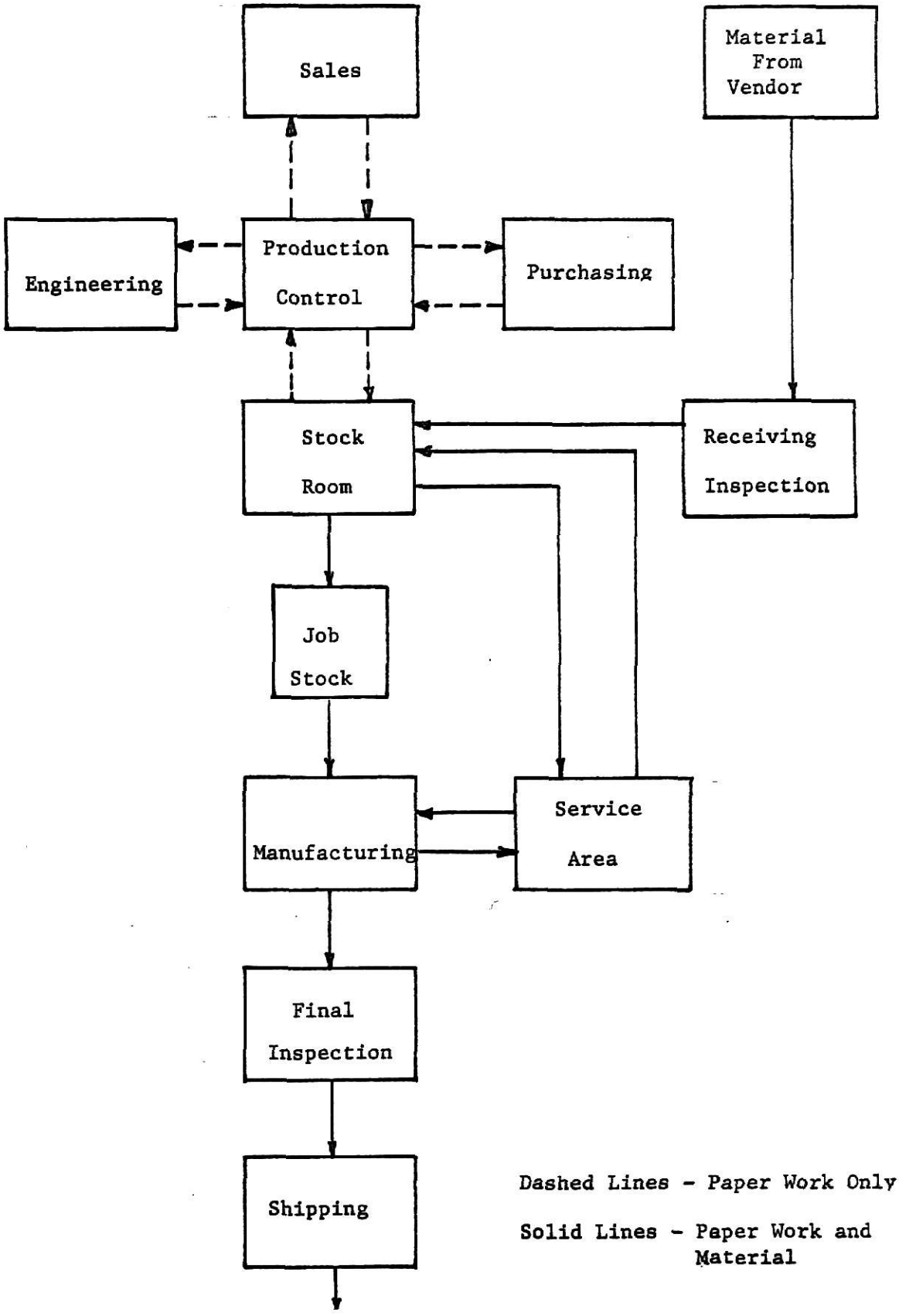
C.I.T.'s ORGANIZATION CHART



There is one person that has responsibility for positions that have the same letter designation, i.e., (a) President, Sales Manager, Salesman, Quality Control Manager, Industrial Engineering, and Buyer.

APPENDIX B

C.I.T.'s ORDER ENTRY - PRODUCTION CONTROL



APPENDIX C

COMPOSITE INDUSTRY DATA[d]
ELECTRONICS

Year	Sales[a]	Profit Margins[b] Percent	Earnings as Percent[c] as Sales
1967	714	11.44	4.18
1966	621	9.20	3.36
1965	416	10.18	4.15
1964	338	9.58	3.74
1963	309	8.53	3.17
1962	286	7.62	3.05
1961	217	8.09	3.07
1960	173	8.28	3.39
1959	126	NA	NA
1958	94	NA	NA
1957	80	NA	NA

[a]This is an index number arrived at by averaging the percentage increase in sales of thirteen electronic companies (1957 - 1959 = 100).

[b]This is N.O.I. (Net. operating income) divided by sales.

[c]This is N.I. (Net income or earnings) divided by sales.

[d]Standard & Poors, ("Industry Surveys: Basic Analysis,") December 5, 1968 (Sec. 2), p. E 28 - E 30.

APPENDIX D

KEY BUSINESS RATIOS[a]

1967

Line of Business (and number of concerns reporting)	Current assets to current debt	Net profits on net sales	Net profits on tangible net worth	Net profits on net working capital	Net sales to tangible net worth	Net sales to net working capital	Collection period	Net sales to inventory	Fixed assets to tangible net worth	Current debt to tangible net worth	Total debt to tangible net worth	Inventory to net working capital	Current debt to inventory	Funded debts to net working capital
	Times	Per cent	Per cent	Per cent	Times	Times	Days	Times	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
3671-72-73-74-79	3.42	7.59	21.75	30.49	4.40	5.62	38	7.8	24.9	29.0	53.0	54.9	63.8	28.1
Electronic Components	2.75	4.23	14.83	18.57	3.27	4.09	51	5.3	39.0	48.1	100.2	81.3	84.2	53.2
& Accessories (95)	1.94	1.86	6.40	6.57	2.34	3.27	70	4.0	63.2	71.6	166.5	99.2	110.6	84.2

1966

Line of Business (and number of concerns reporting)	Current assets to current debt	Net profits on net sales	Net profits on tangible net worth	Net profits on net working capital	Net sales to tangible net worth	Net sales to net working capital	Collection period	Net sales to inventory	Fixed assets to tangible net worth	Current debt to tangible net worth	Total debt to tangible net worth	Inventory to net working capital	Current debt to inventory	Funded debts to net working capital
	Times	Per cent	Per cent	Per cent	Times	Times	Days	Times	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
367	2.98	6.98	24.97	35.14	4.82	7.46	44	7.2	23.1	39.1	76.9	62.3	75.2	23.6
Electronic Components	2.14	4.69	16.46	18.76	3.43	4.86	52	5.4	45.0	61.5	104.6	83.9	96.9	48.4
& Accessories (98)	1.64	2.06	7.49	9.74	2.46	3.17	66	3.9	60.4	100.8	177.5	137.6	134.7	74.5

1965

Line of Business (and number of concerns reporting)	Current assets to current debt	Net profits on net sales	Net profits on tangible net worth	Net profits on net working capital	Net sales to tangible net worth	Net sales to net working capital	Collection period	Net sales to inventory	Fixed assets to tangible net worth	Current debt to tangible net worth	Total debt to tangible net worth	Inventory to net working capital	Current debt to inventory	Funded debts to net working capital
	Times	Per cent	Per cent	Per cent	Times	Times	Days	Times	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
367	3.01	5.76	19.85	25.45	4.22	6.46	44	7.6	25.3	38.7	62.4	59 4	68.9	26.9
Electronic Components	2.42	4.13	12.80	15.95	3.46	4.22	58	5.4	47.1	55.9	102.9	80.3	95.2	44.4
& Accessories (80)	1.78	2.12	8.98	10.68	2.31	2.88	71	3.5	65.3	88.0	148.2	112.8	141.6	77.2

1964

Line of Business (and number of concerns reporting)	Current assets to current debt	Net profits on net sales	Net profits on tangible net worth	Net profits on net working capital	Net sales to tangible net worth	Net sales to net working capital	Collection period	Net sales to inventory	Fixed assets to tangible net worth	Current debt to tangible net worth	Total debt to tangible net worth	Inventory to net working capital	Current debt to inventory	Funded debts to net working capital
	Times	Per cent	Per cent	Per cent	Times	Times	Days	Times	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
367	3.35	5.65	21.16	31.39	4.55	6.50	39	8.7	25.6	31.2	55.5	47.7	68.3	13.6
Electronic Components	2.20	3.94	10.35	16.10	3.22	4.51	53	6.4	42.7	51.5	91.9	76.1	102.8	42.5
& Accessories (83)	1.58	0.64	1.75	2.30	2.38	3.30	66	3.9	65.1	88.9	159.0	106.7	152.5	80.3

[a]Dun and Bradstreet, Industry Studies Department. Key Business Ratios: In 125 Lines. New York: Dun and Brandstreet, Inc., 1964 - 1967.

APPENDIX E

SALES COMPARISON[a]

Year	Industry[b]	C.I.T.[c]	Electro-Networks[d]
1967	714	600	536
1966	621	663	291
1965	416	358	144
1964	338	282	175
1963	309	226	175
1962	286	147	166
1961	217	100	100
1960	173	NA	NA
1959	126	NA	NA
1958	94	NA	NA
1957	80	NA	NA

[a]This is a percentage increase sales index.

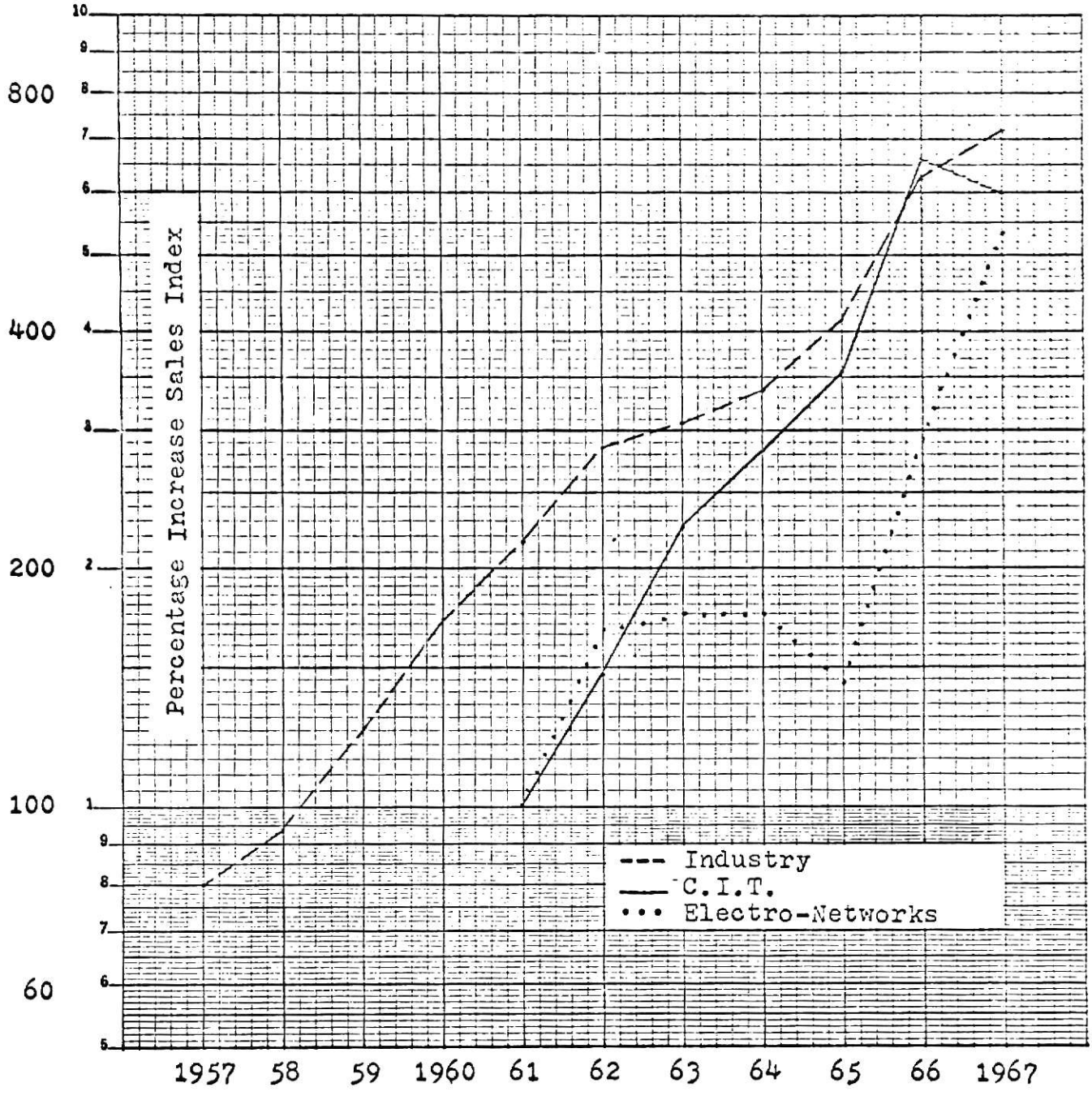
[b]See Appendix C.

[c]Confidential (base year 1961) percentage increase.

[d]Moody's Industrial Manual; Electro-Networks, Inc.. 1962 - 1968. (Base year 1961), percentage increase. (See Appendix L).

APPENDIX F

SALES COMPARISON[a]



[a]See Appendix E.

APPENDIX G

EARNINGS AS PERCENTAGE OF SALES

Year	Industry[a]	C.I.T.[b]	Electro-Networks[c]
1967	4.18	7.15	8.44
1966	3.36	6.45	12.86
1965	4.15	6.62	6.65
1964	3.74	8.8	4.01
1963	3.17	9.07	8.79
1962	3.05	4.06	8.79
1961	3.07	3.06	5.22
1960	3.39	NA	NA

[a]See Appendix C.

[b]This was calculated from confidential financial statements.

[c]See Appendix J.

APPENDIX H

LIQUIDITY

Year	Current Ratio		Acct. Rec. Turnover		Inventory Turnover	
	C.I.T.[a]	Indus.[b]	C.I.T.[a]	Indus.[c]	C.I.T.[a]	Indus.[b]
1967	1.91	2.75	9.49	7.16	14.72	5.3
1966	2.22	2.14	8.20	7.0	15.45	5.4
1965	4.29	2.42	6.04	6.3	6.74	5.4
1964	3.66	2.20	8.27	6.9	12.20	6.4

[a]See Appendix K.

[b]See Appendix D.

[c]This is 365 divided by collection period (See Appendix D).

APPENDIX I

EARNING POWER

Year	Profit Margin			Capital Turnover			Earning Power		
	Ind.[a]	C.I.T.[c]	E.-N.[e]	Ind.[b]	C.I.T.[c]	E.-N.[d]	Ind.	C.I.T.	N.E.
1967	11.44	11.8	11.4	3.27	2.15	1.71	37.4	25.3	19.6
1966	9.20	10.6	9.20	3.43	3.16	2.04	31.6	33.4	18.8
1965	10.18	8.3	10.18	3.46	2.68	1.88	35.2	22.3	19.1
1964	9.58	12.3	9.58	3.22	2.57	2.08	30.9	31.6	19.9

(1) Profit Margin = $\frac{\text{Net Operating Income}}{\text{Sales}}$ % = Net Operating Margin

(2) Capital Turnover = $\frac{\text{Sales}}{\text{Total Assets}}$ %

(3) Earning Power (Before Taxes) = $\frac{\text{Net Operating Income}}{\text{Total Assets}}$ %

(3) Earning Power = (1) x (2) %

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[a]See Appendix C.

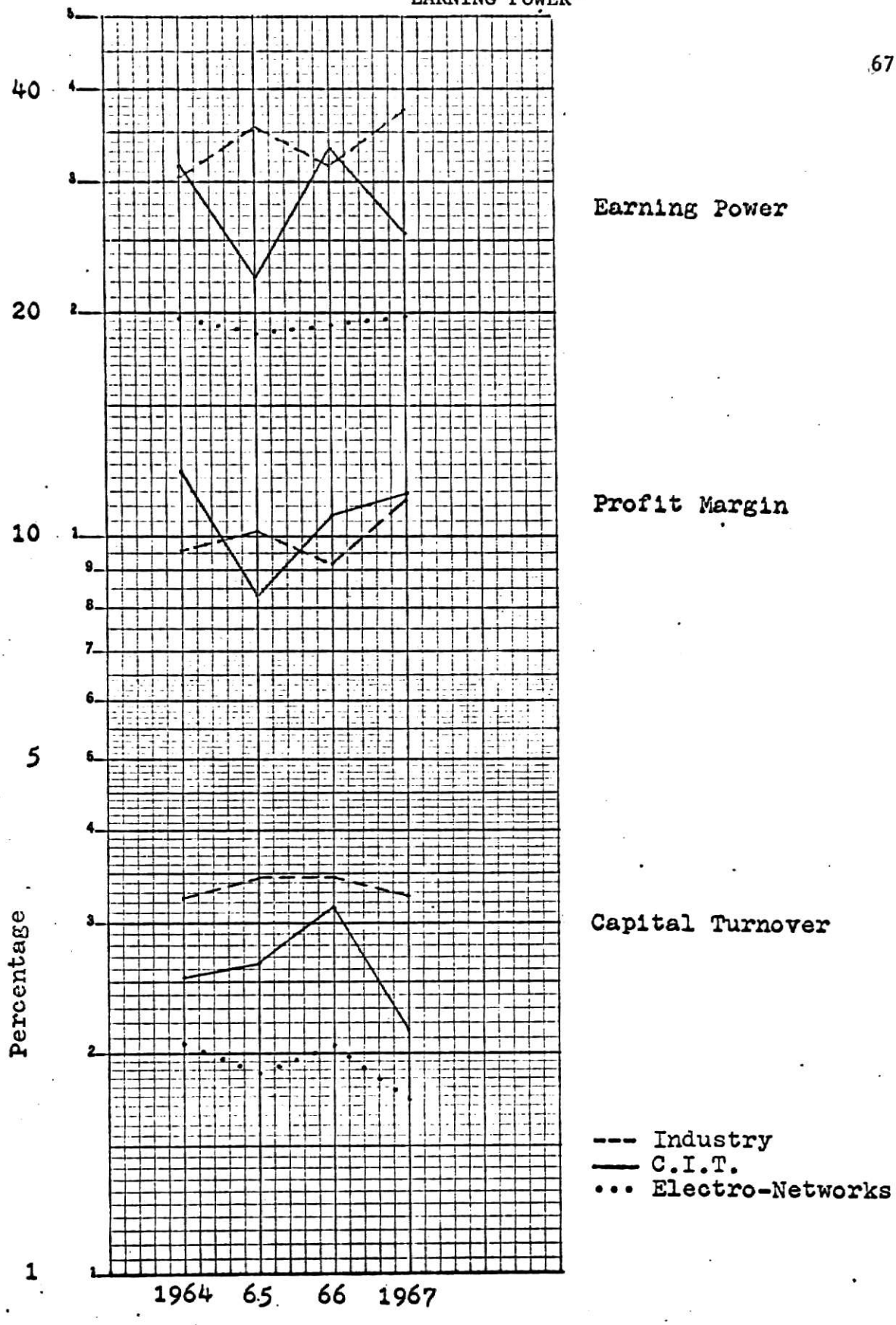
[b]See Appendix D.

[c]See Appendix K.

[d]See Appendix L.

[e]The Net Operating Income was not given, therefore the Industry Average was used so that a relative comparison figure could be calculated.

EARNING POWER[a]



[a]See Appendix I.

APPENDIX K

C.I.T.[a]

Years	1967	1966	1965	1964
Liquidity Level:				
Current Ratio	1.911	2.223	4.291	3.662
Acid-test Ratio	1.389	1.521	2.391	2.763
Current Asset Composition:				
Cash Asset Ratio	0.322	0.090	0.063	0.396
Receivables Ratio	0.405	0.594	0.495	0.358
Inventories Ratio	0.261	0.315	0.443	0.243
Liquidity Flow:				
Accounts Receivable Turnover	9.491	8.198	6.035	8.265
Inventory Turnover	14.721	15.454	6.741	12.201
Earning Power:				
Net Operating Margin	0.118	0.106	0.083	0.123
Capital Turnover	2.145	3.161	2.676	2.571
Earning Power (Before Taxes)	0.253	0.334	0.223	0.316

[a]Calculated from confidential financial statements.

APPENDIX L

ELECTRO-NETWORKS, INC.[a]

Years	1967	1966	1965	1964
Total Assets	2,426,278	1,105,483	595,754	654,961
Current Assets	1,760,782	888,436	449,627	508,748
Current Liabilities	1,081,587	364,246	108,454	182,904
Sales	4,143,003	2,249,696	1,117,362	1,356,947
Net Income	348,425	289,426	74,323	54,434
Dollars per share:				
Earnings	0.69	0.78	0.20	0.16
Dividends	0.14	0.10	Nil.	Nil.
Common Shares	505,959	370,889	368,469	334,972
Employees	450	210	220	N.A.
Stock Holders	1,250	915	710	N.A.
Dollars of Debt	289,616	None	4,400	64,616

[a]Moody's Industrial Manual, Electro-Networks, Inc., 1964 - 1968.

APPENDIX M

COST ANALYSIS OF PAYROLL APPLICATION

I.	Service Bureau (in the midwest)	
	Base cost includes preparation of checks, W-2 forms, state withholding forms, quarterly reports, and the yearly tax forms	$0.35/check
II.	Time-Sharing (in the midwest)	
	Data storage per employee per month.... $0.28	
	This cost per employee per paycheck.....	$0.07
	Payroll calculation per employee per paycheck	0.09
	Terminal rental cost (no line cost) ... $85/mo.	
	Cost per check $\frac{\$85.00/mo.}{185\ checks/mo}$ = ...	0.46
	Total Cost per check.....	$0.62
III.	C.I.T. present payroll preparation cost[a]	
	Time preparing taxes, W-2, state form, and quarterly records..... 4.42 hr./mo.	
	Time spent writing checks and deposits.....17.33 hr./mo.	
	Time spent balancing statement, allocating labor, etc..... 3 hr./mo.	
	Time distributing checks[b]..... 4.25 hr./mo.	
	Cost: wage = $2.70/hr.; overhead = 150% x $2.70 =	$4.05
	(4.42 + 17.33 + 3) hr./mo. x $ (2.70 + 4.05)/mo.	
	= $\frac{\$167.06/mo.}{185\ checks/mo}$[c] = ...	$0.90/check

[a]Time study done by C.I.T.'s Industrial Engineer.

[b]This time would be used no matter what system, omit.

[c]September 1968 taken as average month when 185 checks were prepared.

APPENDIX N

NETWORK DESIGN AND VALUATION EDP APPLICATION

These are development costs associated with a one year period.

Time-sharing terminal[a] ..... (approximate $9.00 per hour)	$595.60/mo.
Leased phone line cost	102.60/mo.
Total Terminal Cost	$698.20/mo = $8,378.40/yr.

Engineering time costs:

The number of hours the terminal was used.

$$\frac{(\$698.20 - 102.60)/\text{mo.}}{\$9.00/\text{hr.}} = 66.4 \text{ hr/mo.}$$

Engineering time cost per hour.

$$\frac{\$4{,}400/\text{mo.}}{160 \text{ hr/mo.}} = \$27.50/\text{hr.}$$

Engineering time cost per month

$27.50/hr x 66.4 hr/mo. = $1,825/mo.

Total engineering time cost	$21,900/yr.
Total development cost for one year	$30,278
Total cost amortized over five years on a per month basis	$ 505/mo.

[a]This is the average cost per month for the last six months of 1968.

APPENDIX O

MANUFACTURING COST PERFORMANCE SYSTEM[a]

1. Individual Earnings Register: This report itemizes all jobs which each productive operator works on during the pay period.
2. Departmental Labor Control Report: This report summarizes the performance of each operator in each department.
3. Factory Labor Control Report: This report provides a department-by-department cost summary of the entire factory including the indirect departments (tool room, inspection, maintenance, etc.).
4. Manufacturing Engineering Profit Report: This report summarizes productivity according to those parts which are assigned as the profit responsibility of each manufacturing engineer.
5. Actual Cost Performance by Part and by Customer: When a production lot is closed, a summary of the cost performance by part is available to management (including the sales engineer). Periodically, these data can be summarized by customer to examine cost performance for a particular part by lot or by manufacturing process.
6. Machine Utilization Report. Quarterly time cards can be processed and the actual time utilization and productivity results on each machine tool can be determined.
7. Individual Performance Record: Once each quarter a summary of the performance of each operator can be made.

[a]Malloy, John P. "Computerizing The Manufacturing Cost System In A Small Production Shop," Computers and Automation, 16:18-21, July, 1967. p. 19.

THE ECONOMIC FEASIBILITY AND UTILIZATION OF COMPUTER APPLICATIONS IN A SMALL ELECTRONIC DESIGN AND MANUFACTURING COMPANY

by

DAVID J. UNRUH

B. S., Kansas State University, 1968

AN ABSTRACT OF A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

College of Commerce

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1969

It appears that the majority of factors concerning feasibility studies of Electronic Data Processing may be broken down into two general propositions: First, that of arriving at a good decision as to whether or not to use Electronic Data Processing and, if so, to what extent; and second, that of implementing the decision. A successful installation needs both a good decision and a good implementation, and therefore, a major deficiency in either one will rarely permit overall success and most likely lead to serious difficulty.

It is the purpose of this report to aid the small business executive in dealing with the first of the two general propositions, that of arriving at a good decision as to whether or not to use Electronic Data Processing and, if so, to what extent.

This general proposition percipitates many questions; however, the following three basic questions are those that a small business executive should seek to answer just prior to undertaking a so-called feasibility or justification study: (1) What possible and/or probable utilization of computer applications exist? (2) What advantages, if any, may be gained from the use of a computer? (3) What is the economic feasibility of the use of a computer in the various applications which may be available?

So that one might better grasp the overall scope of the procedure which should be used to answer the above questions, an actual small company was analyzed. This company ananymously referred to as C.I.T. is a small midwestern company in the electronic industry with fewer than one hundred employees. It is the authors belief that the questions considered in this report will clearly demonstrate the type of study and analysis required in making the decisions considered herein.

Information was obtained to analyze C.I.T. through personal interviews, a questionnaire, and the author's general working knowledge of C.I.T.; having been employed during four summers, each a duration of three months, as a Student Engineer.

In the event a company wishes to consider the use of EDP, there are essentially three different EDP alternatives from which a company can choose; service bureau, time-sharing, and/or lease or buy. Each of these alternatives provides a different type or scope of service and expenses. For a specific volume, nature, and cost of service, one of the alternatives will best suit any company at a specific point in time.

Through an operational analysis of the use of EDP in C.I.T., a selection of four applications was made so that they could be further examined to test their economic feasibility. Each one of the four applications were analyzed separately with respect to the three different EDP alternatives, with the one most economically feasible being so identified. Following this is a complete appraisal of the three applications, along with their respective EDP alternative, which were examined from the standpoint of the cummulative economic benefits.

This report demonstrates that a company's management may determine certain EDP applications and alternatives that can be used by their company as a direct result of the use of an analysis such as the one used in this report, that is, one that seeks its' own answers to the economic feasibility and utilization of computer applications.

Further, if their analysis warrants the conclusion that the alternative to lease or buy a computer should be chosen; the company can gain some interim benefits by using the economically feasible applications and alternatives to gain experience and develop their programs prior to installation of the leased or purchased computer. Also, if this alternative is chosen and full utilization of the leased computer is desired, then consideration should be given to conducting a more detailed feasibility systems analysis.