Changes in the Boundaries of Managerial Accounting Required by Modern Information Systems.

Chiou-hsiung Chang

Louisiana State University and Agricultural & Mechanical College

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CHANGES IN THE BOUNDARIES OF MANAGERIAL ACCOUNTING
REQUIRED BY MODERN INFORMATION SYSTEMS

A Dissertation

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in

The Department of Accounting

by

Chiou-hsiung Chang
B.S., Tam Kiang College of Arts & Sciences
M.B.A., California State University, Long Beach
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ABSTRACT

This investigation inquires into the present roles of the management accounting system and of accountants in large industrial firms, and suggests some changes needed in management accounting and accountants to accommodate their larger roles in modern information system environments.

The research is based mainly upon literature in this area of inquiry and the answers of 143 respondents, which represent 31.2% of the questionnaires mailed to the United States' 1000 largest industrial firms as listed in the May and June, 1972, issues of Fortune magazine.

Several findings and conclusions resulted from this investigation. This investigation revealed that:

1. There is an extensive formalization of the operating subsystems and the information systems among the 1000 largest industrial firms. An integration of the operating and the information subsystems has also taken place. The results of this integration are: (1) the establishment of a centralized data base, and (2) the automation of the routine structured decision making.

2. Except for inventory planning and control models and discounted cash flow model, other powerful mathematical decision models are not widely used in the 1000 largest industrial firms.

3. Advances in computer and information technology has
changed neither traditional responsibility center concepts such as the cost center and profit center, nor the computerized control techniques such as real-time performance monitoring.

4. In at least 50% of the 1000 largest industrial firms, the accounting department is no longer primarily responsible for the financial data and information processing duties.

5. Although there is no compelling empirical evidence which shows that mathematical decision models are widely used, the management accounting system is not the key information source and accountants do not participate in the implementation of the managerial decision models.

6. In at least 50% of the largest industrial firms, accountants influence the formalization of various information and operating subsystems, and have been given responsibilities in designing and preparing the non-computer oriented management control systems. However, the accountants are less involved in such computer based management control techniques. This is reflected in the finding that the person who directs the firm's information system normally is not an accountant by training and that accountants are unfamiliar with computer systems and operation research techniques.

The above findings are used as a basis to support the changes in the boundaries of managerial accounting systems as proposed by this study.

Since the routine financial data and information processes have been transferred out from the accounting department, a reorganization of the accounting department is proposed.

This study suggests changes in managerial accounting
concepts and thinking, and recommends that: (1) Managerial decision models should be the foundation of future managerial accounting system designs and research; (2) The filtering concept of a managerial accounting system should be redefined; and (3) Modern information sciences and technology should be applied in managerial accounting systems design.

Finally, this study proposes changes in current management accounting education. Recommendations include the establishment of a subspecialty in the managerial accounting program and the establishment of basic requirements for the future management accountant involved in computer systems and operations research techniques.
Nature of the Problem and Purpose of the Study

An accounting system produces information. Historically, the accounting system has been the major— and perhaps the only— formal information network for management. However, recent advances in information system technology and management science techniques have created a number of formalized information and operating subsystems to serve various operating departments or units of the firm. Accounting "... is not the whole of even the formal information system given (a) the diversity of data collected, processed, and distributed for the many different functions within the organization and (b) the expanded range of disciplines bearing on the information function."

A major objection to accounting— as emphasized in recent accounting literature— is that it does not serve as a primary information system for management planning and control functions and for the various managerial decision models used to implement these functions. The position of the accounting system in the emerging modern information system environment seems to be crucial: "It is however, difficult to conceive of accounting personnel not...

---

being a major force in information management.\(^2\)

The purpose of this study is to empirically investigate the present roles of accounting and accountants in industrial firms with particular attention on the following:

1. What are the major changes in the operating duties of the accounting department in performing routine financially oriented information processing functions?

2. Has the emergence of the other information subsystems diminished the importance of accounting as a primary source in providing information for managerial planning and control?

3. How does the implementation of the modern information systems in a firm effect the role of accountants in designing and maintaining the data base and the management control systems?

**Background and Present Status**

The nature of accounting was defined by the Council of the American Institute of Certified Public Accountants in 1966 as an official statement of policy. This statement reads: "Accounting is a discipline which provides financial and other information essential to the efficient conduct and evaluation of the activities of an organization."\(^3\)

In the same year, the American Accounting Association's (AAA) Committee to Prepare a Statement of Basic Accounting Theory defined accounting as "... the process of identifying, measuring and

\(^2\)Ibid., p. 344.

communicating economic information to permit informed judgment and decision by means of information."^4 The most recent pronouncement made by the AICPA describes accounting as "... a service activity. Its function is to provide quantitative information, primarily financial in nature, about economic entities that is intended to be useful in making economic decisions—in making reasoned choices among alternative courses of action."^5

Accounting is a service function, and its existence is justifiable only in terms of the usefulness of the services which it provides. While the accounting system of a business firm has traditionally provided much of the financial data and much of the analysis of that data applicable for decision making purposes, its services to management planning and control functions is the most important service. The 1966 Statement conceives that "... a future accounting system could include as accounting inputs all quantitative data gathered for whatever purposes and as accounting output all internal reports for planning, directing and controlling purposes, as well as the basic public statement."^6 Generally, the main emphasis of the basic concept of accounting has changed from historical financial reporting to management planning, decision


^6A Statement of Basic Accounting Theory, op. cit., p. 67.
making, and control. These changes are evidenced by the increased interest in responsibility accounting, profitability accounting, and contribution margin reporting, to name only a few.

While accounting has offered these applications and techniques for today's management planning and control functions, we see several developments in other disciplines that emphasize changes in the information handling environment in many firms. During the past two decades, these disciplines have been challenging the traditional role of accounting as a major information network in a firm. These developments are, basically, as follows:

1. The invention of high-speed and high-volume electronic devices, which are able to extract, assimilate and correlate all pertinent internal and external data.

2. The increasing complexity of business operations and improvements in managerial science techniques and mathematical decision model building have led to the development of sophisticated managerial planning and control systems.

3. The establishment of formal operating information subsystems and the perception of the organization as an integrated set of subsystems have resulted in integration among the information and operating subsystems. Consequently, there exists the possibility of a broader range of relevant information to be processed in a real-time mode for any particular decision maker's use.

Does each of these items have an impact on the role of the accounting information system functions? As early as 1960, Moonitz and Nelson expressed this concern:

As a matter of fact, the field of accounting systems may be displaced by information theory. Here again, accountants
have found the work done in other fields useful and stimulating. Norbert Wiener's *Cybernetics* comes in mind in this connection.

Just about the same time, two prominent accounting practitioners pointed out:

As a part of this development, accounting must divert itself from its preoccupation of the past with fiduciary and stewardship responsibilities. Responsibility for fiduciary decisions is a proper and major concern of the accountant. However, if the accountant is to comprehend and contribute the decision-making, information flow process within tomorrow's business organization, he must integrate stewardship responsibilities with a responsibility for broader management decisions.®

Projections for management accountants in the future appearing in the current professional literature cast a large shadow over the present and future roles of accounting within industrial firms. McRae predicts:

... unless the accountant prepares himself for the task of providing operational and market research data, instead of routine accounting returns he [will] inevitably find himself losing his place in the management team to the technologist, statistician, economist, or mathematician.®

A hole will be punched in the organization chart between those people performing the routine job of data collection and those performing the more sophisticated tasks of report interpretation and decision making.®

---


®Ibid., p. 91.
Consequently:

... the accounting department will be reduced in size and status. Data processing and data interpretation will be taken over by other departments.\textsuperscript{11}

The 1970-1971 AAA Committee on Accounting and Information Systems cites that the role of the accounting function is diminishing in the modern information environment:

... designing and managing information systems and providing decision data have been moved to new locations with different managers in charge. While frequently still in the financial organization these managers have broader responsibilities and interests. Line accounting duties have frequently been automated and merged with their respective operating systems or with their respective activities. Only control, the attest function, and third party reporting have escaped serious paring. Even these areas have felt the impacts of computer and computer-related technological developments.\textsuperscript{12}

**Hypotheses**

The hypotheses for this study are that whereas the accounting system has been the major formal information system in many firms, the extensive implementation of modern information systems has caused the following changes in information functions of management accounting in at least 50% of the 1000 largest

1. The traditional operating duties of the accounting department in performing routine financially oriented information processing functions have been transferred to another department(s) or another operating system(s) with a different manager(s) in charge.

2. The management accounting system and the management accountants play no significant roles in the managerial planning

\textsuperscript{11}Ibid.

\textsuperscript{12}"Report of Committee on Accounting and Information Systems," \textit{op. cit.}, p. 348.
and control functions as the result of the integration of operating subsystems and information subsystems.

3. The influence and the responsibility of accountants in designing and managing the data base and the management control systems have been transferred to systems specialists.

Research Methodology

The methodology of this research involved four phases.

Phase 1: Literature research. A comprehensive survey was made of the literature in accounting and in information systems. This literature includes books, journals and publications of relevant professional associations. The research concentrated on conceptual developments in information sciences, information processing technology, and management science techniques that are believed to have contributed in developing modern management information systems and the accounting system that lies within them.

Phase 2: Empirical survey and questionnaire construction. The empirical approach used in this phase was done for both theoretical and practical reasons. The theoretical reason is that an empirical approach is one of the desirable qualities in any system study. The practical reason is that only a few of the currently operating management information systems have been recorded in the literature. At this point, the AAA 1966 Committee to prepare a Statement of Basic Accounting Theory recommended that one starting point would be an empirical study of all information flows within a firm.13 "Such a study would disclose the extensive amount of information

now transmitted outside the scope of the present accounting information system ...."^{14}

Based upon the knowledge and concepts obtained in Phase 1 of the literature research, the design and construction of the questionnaire attempted to determine: (1) the extent to which modern information system technology and management science techniques, such as decision models, computer systems as related to real-time and on-line techniques, have been implemented; (2) the roles of accounting and accountants in today's information system environments as related to the information processing function, information providing function, and systems directing and controlling function. (A sample of the questionnaire is included in the Appendix.)

Phase 3: Sample selection. The sample for the mailed questionnaire was selected from the United States' industrial firms listed in two issues (May and June, 1972) of Fortune magazine. The "big" firms were selected because in these firms there may exist more sophisticated information systems. Valid statistical techniques were used to determine sample size and sample selection. The formula used for determining the sample size was:^{15}

\[
N = \frac{t^2 \rho \alpha}{d^2} \frac{1}{1 + \frac{1}{N} \left( \frac{t^2 \rho \alpha}{d^2} - 1 \right)}
\]

^{14}Ibid., p. 71.

^{15}The formula was adapted from W. G. Cochran, Sampling Techniques (New York: John Wiley & Sons, Inc., 1953), p. 75.
n is the sample size.

N is the total population, that is, the 1000 industrial firms.

P is the estimated proportion, and is assumed to be .5.

Q = 1.0 - .5 = .5

t is the value of the normal deviate corresponding to the desired confidence probability, and is assumed to be 2.

d is the margin of error, and is assumed to be .1.

The expected response was estimated at 20 percent.

Based upon the above formula and estimation, 455 firms were selected to receive the questionnaire. Random number tables\textsuperscript{16} were used to select the firms within the 1000. One hundred and forty-three responses were received, or 31.2\% of the questionnaires mailed.

In addition to the mailed questionnaire, field interviews with various computer firms, corporate management, and CPA firms in the Baton Rouge (Louisiana) and Chicago Metropolitan areas were conducted. A pretest of the questionnaire was discussed with this level of local management before it was mailed for the general survey.

Phase 4: Analysis of the questionnaire returns. Statistical estimation was used to estimate population proportions.\textsuperscript{17} At 95\% statistical confidence interval, \( \hat{p} \) is:

\textsuperscript{16}Random Numbers III and IV of Table XXXIII of R. A. Fisher and F. Yates, Statistical Tables for Biological, Agricultural and Medical Research (Edenbury: Oliver and Boyd, Ltd., 1950), Appendix.

\[ \hat{\mu} = \hat{p} \pm Z_{0.025} \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \]

where

\( \hat{\mu} = \text{Estimated proportion for the 1000 largest industrial firms.} \)

\( \hat{p} = \text{The total numbers of the expected results} = \frac{n_1}{n} \text{ The total useful responses} \)

\( Z_{0.025} = 1.96 \)

The null hypothesis \( H_0 \) is set \( \geq 50\% \); that is, at least 50\% of the 1000 largest industrial firms would indicate that the information function of accounting has diminished. The alternative hypothesis \( H_a \) is set \( < 50\% \); that is, less than 50\% of the 1000 largest industrial firms would indicate that the information function of accounting has diminished. The statistical confidence interval was used to test the working hypotheses and sub-hypotheses, since the construction of a confidence interval is usually preferred to a hypothesis test.\(^{18}\)

**Limitation of the Scope of this Study**

The information function of accounting for managerial use varies among business organizations. The basic managerial accounting functions in a typical industrial firm may be identified in this study as (1) performing a number of routine financial data and information processes; (2) providing information for a variety of internal management decision making purposes; (3) designing and

\(^{18}\)ibid., p. 193.
maintaining a data base of data and potential information; and (4) providing an overall management control function.

Because the main conclusions of this study are derived from the responses from the mailed questionnaire, the following errors are possible: (1) errors in observation during the preliminary stage of this study; (2) unsophisticated questionnaire construction; (3) poor recall by the respondent; and (4) the formulas used to determine sample size, the confidence level and the standard of error are, at best, only statistical approximations.

Another limitation is that the firms chosen for this research are the top 1000 largest industrial firms in the United States. Service institutions, non-profit organizations, and thousands of smaller industrial companies have been excluded from this study. So the findings of this research do not necessarily apply to business organizations in general, but specifically only to those large industrial corporations under the survey. Finally, as one of the respondents, who is Director of Systems and Procedures in a large aircraft manufacturing firm, states in his reply letter: "As the Corporation consists of a number of components, each of which is organized somewhat differently, the answers do not describe any one component but are applicable in general to the operations as a whole."

Terminology Used in this Study

1. DATA is (are) an uninterpreted and unprocessed raw statement(s) of fact.

2. INFORMATION is purpose oriented organized data.

3. INFORMATION PROCESSING is the process of collecting,
manipulating, and distributing information from the source to the users.

4. OPERATING PROCESSING SUBSYSTEM is a system which receives information and resources to accomplish certain tasks.

5. INFORMATION PROCESSING SUBSYSTEM is a system which provides the input (in computer readable form), does a certain amount of processing, sends relevant activity information to a related operating department or subsystem, such as marketing, production, and procurement, and so on.

6. CENTRALIZED DATA BASE refers to common data files which contain information from all operating and information subsystems, or archival records. The INPUT/OUTPUT devices can be remote terminal stations, time-shared computer(s) with direct entering of data and user-initiated process and retrieval, or both. A unique firm-wide (or at least division-wide) coding scheme is a prerequisite for establishing a common data base.

7. INTEGRATION, as used in management information systems, describes multiple users of data based on the single entry into the system to eliminate the duplication common to many communication networks.

Preview of the Study

The advancement of information system sciences and technology, managerial science techniques, application of mathematical techniques, and integration of the management processes in planning, operating, and control are cited as the major factors that affect information systems for managerial use. Chapter 2 examines some details of these relationships and presents some of the characteristics of
modern information systems. The prerequisite of a modern information system is that it be computer-based. The establishment and the integration of information subsystems and operating subsystems, the data base design and retrieval techniques, the feedback mechanism within the systems, and allocations of tasks between man and computer are the major features of modern information systems. The boundaries of management accounting are also defined in Chapter 2. The surveyed results showing the degree to which the characteristics of modern information systems exist and the roles of accounting and accountants in modern information system environment are presented in Chapters 3, 4, and 5.

Chapter 3 concentrates on the role of the accounting department in performing routine data and information processing duties. The presumption is that most of, if not all, the routine and highly structured data processing and decision processes have been automated and merged with other operating and/or information subsystems. The accounting department in a company no longer monopolizes many areas, such as accounts receivable, accounts payable, and manufacturing cost analysis, among others. Consequently, the size of the accounting department has been reduced as the information processing functions have been transferred to the other departments or subsystems.

Chapter 4 discusses the role of the accounting system in providing information for management planning and control. As a consequence of management's establishing the operating and the information subsystems for each operating department, the hypothesis is that the operating managers no longer rely on accounting information for their planning and control purposes. The importance
of accounting information for the management planning and control functions via quantitative models and techniques is raised in the study. The question is whether the role of the accounting information function as a major information system diminishes as other information subsystems are established in a firm.

Chapter 5 examines the influences and responsibilities of accountants in designing and managing the data base and the management control system. The hypothesis is that these influences and responsibilities have been transferred to systems specialists who have heterogeneous backgrounds. They are interested in systems design, but have little accounting training and are less concerned about accounting records. Accounting records thus become by-products instead of the major reason for the system's existence.

The key element in successful application of management information systems, and the final achievement of management's goals, is the management control system. Does the accountant have the responsibility of designing these control systems? The management control systems consist of the following: cost center, profit center, discretionary expense center, investment center, real-time performance monitoring and on-line feedbacks. The rules that govern the interface operation of man and computer are the control features for management, since the reaction of management to the computer in a real-time mode environment may be essential to an effective management control system.

The last chapter concludes with the question of whether the extensive implementation of modern information systems has caused changes in the role of accounting as a major information subsystem.
in the 1000 largest industrial firms. The general summary of the previous chapters is used to evaluate the hypotheses. Implications for further study are recommended as an additional conclusion of this research.
Introduction

While there is no doubt that business information systems play an increasingly significant role in the process of achieving more effective managerial planning and control, definitions of information systems are not in agreement. For the purpose of this study, the definition described by the 1970-1971 American Accounting Association's Committee on Accounting and Information Systems is used. It reads:

The activities of the firm which involve collecting, processing, storing, and reporting of information can usefully be considered as a "system." While actually these activities may take place in separate parts of an organization as subsystems, to the extent that information function has common goals, resources, and resource management it can be viewed as one system.¹

The position of this study is that there are certain key operating processing subsystems, information processing subsystems, and sensor subsystems that make up the total business system, which is operating in a dynamic environment. These subsystems are identified as follows:

1. Operating processing subsystems--planning subsystem, executing subsystem, and controlling subsystem.

2. Information processing subsystems—routine data processing subsystem, information storage, and retrieval subsystem.


A simple model showing the relationship between an operating subsystem, an information subsystem, and a sensor subsystem in a total business system environment is illustrated in Exhibit 2-1.

Exhibit 2-1
Operating Subsystem, Information Subsystem, and Sensor Subsystem in A Total System Environment—A Simple Functional Model
As stated earlier, a total system in a business organization operates in a dynamic environment. The environment encompasses numerous variables or factors that contribute to rapid changes in the total business system. And a change in any area of these variables has a potential impact on and implication for the others and to the system as a whole.

The purpose of this chapter is to examine the characteristics of a total business system and the accounting subsystem that lies within it. The approach in this chapter is to examine the uses of information by operating subsystems for decision making, and the means of supplying information by information subsystems. Awareness of information value, the application of management science techniques, and the advent of computer technology are believed to change the managerial decision making processes, which in turn change the information requirements for that purpose. The new requirements for information, coping with the explosion of information sciences, change the information processing techniques—the means of supplying information.

Changes in Operating Subsystems (Decision Making Processes)

Awareness of information value and theory by decision makers. The value of information is to reduce the uncertainty in a decision making process. The role of information is to help decision makers (operating managers) in the following ways: to understand the strategy, to see the state of nature, to give probability in various states of nature, and to predict the outcome.

The large explosion of information theory, particularly in
the areas of decision theory and economic theory of information has contributed to the decision makers' awareness of information value and issues. Decision theory, for example, measures the value of information in decision processes; its assumption is that the action taken by a decision maker is the action which would maximize the expected payoff given by the information he received. The theory provides the foundation to consider information issues. The economic theory of information, on the other hand, explicitly deals with the decision maker's action taken and the information issues. The economic theory of information provides a formal procedure for evaluating information alternatives; that is, it evaluates the trade-off between cost of additional information and the value derived from it.

Awareness of value of information and information theory by decision makers (operating managers) has raised some information issues as to an information handling method in decision making processes. These information issues are information relevance, information timeliness, and information accuracy.

Information value is an incremental concept. The expected value of perfect information can be calculated by the difference between the expected payoff, assuming that a decision maker could obtain this perfect information and make the best decision given that information, and the expected payoff from making the best decision given the prior information. A basic decision theory explicitly states that a decision maker must specify the information process he is considering and the information message that might be generated by each of the information processes. Then, the
decision maker must specify the probabilistic relationship between
the information message and the environment, plus a prior distribution
over either the message or the environment. Although there are
a number of different ways to specify the required distributions, it
depends mainly on a decision maker's understanding of the processes
involved.

An information processing subsystem could be categorized
independently from its value to a particular decision. An information
processing subsystem is complete if a different signal is produced
for each state. An information processing subsystem is noiseless
if some signals are produced by more than one state. An information
processing subsystem is noisy if at least one state produces any
one of a number of signals and at least one of these signals is
produced by more than one state.

The information issues can be investigated according to the
category of the information processing subsystem to which it belongs.
Information inaccuracy results from erring in event observation,
information processing and communicating. Information time delays
in communicating the message show that the information processing
subsystem does not report on the most recent prior events.
Information relevance is denoted as the value of additional prior
events by determining whether to report them.

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2"Report of Committee on Accounting and Information Systems,"
op. cit., p. 302.
3Ibid., p. 302.
4Ibid., p. 305.
Application of management science techniques by operating managers (decision makers). In addition to awareness of information concepts and issues in decision making, application of management science techniques which were not recognized as such before 1950 provides management with analytical tools for problem solving. For the most part, these techniques include a number of mathematical procedures. Planning models, for instance, are currently capable of handling thousands of variables and constraints. The input variables or data for these models must be updated periodically; and, since management science techniques provide management with the problem's solution, the techniques suggest new requirements for information. This not only affects the decision making processes, but also has a retrieval relationship with an information processing subsystem.

Management science techniques affect the managerial decision making processes in several ways:

1. A computerized management science technique springs from computerization and is a logical part of the decision making process.

2. The techniques can feed back answers that they have analyzed, evaluated, or optimized to the decision makers.

3. Management science techniques are of the greatest significance in dealing with problems having a complex array of interacting variables, problems requiring much computation, and situations requiring complex mathematical manipulation of great masses of data. The application of modern information technology makes use of management science techniques feasible in managerial decision making processes.
The 1968-1969 American Accounting Association's Committee on Managerial Decision Models states that "... as the use of quantitative decision models becomes more widespread, the amount of quantified external information required by a particular organization will become larger." This implies that new types of data, collected, converted, and communicated, are required to meet the decision maker's needs that result from the use of these quantitative analytical models.

Changes in Decision Making Processes and Information Processing Methods Caused by Modern Computer Technology

The most important factor affecting an information processing subsystem has been the advent of modern information processing technology. Information technology includes solid state hardware, systems engineering, and numerical and systems analyses. The major components of a computer-based information processing system include: the central processor, random access storage devices, input-output devices, software, and communication networks. As the hardware has become more reliable, faster, and cheaper, the software developed for the hardware has become more sophisticated, compatible, and efficient. The impact of modern information technology is reflected in the following dimensions of information processing methods.

Developments in data input devices in various ways of capturing data and in data communicating systems have changed not only the means of data collecting but also the time dimension of

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information processing. Data communicating systems and multiplexors make it possible to transmit data from where it originates directly into a computer system, and to produce the information at the user's location. Thus, it significantly reduces the time lags in updating information and answering the user's inquiry at the starting point of decision analysis. Cathode ray tube displays and audio response units make it possible to output information quickly and directly to the user in a form that he can understand easily and absorb rapidly. These devices should help to speed up the information dissemination process and eliminate a lot of people and paper flow.

As any information user would prefer to have data that were collected at their points of origin, a change in the time dimension of information processing has produced two extremes. At one extreme, raw data can be captured directly in machine readable form, transmitted over the wires immediately to a data processing station, but handled upon arrival providing that the information user specifies the degree of tolerance he would bear. At the other extreme, the interfaces between data collecting and converting can be such that an event is captured and sent instantly to the point where the central processing unit is located.

In the most powerful mode, the information user is able not only to query but also to involve himself in a dialogue with the computer. In this computer and man interfacial situation, the user queries and is presented with information that answers his initial questions. He then interacts with the system by inserting data which has an input on what the system is processing and which, in turn, may alter the content of the responses to subsequent queries.
Under this real-time environment, quickness is not a prerequisite of data collecting and data transmitting. The basic criteria for a user oriented information processing system is the amount of delay the information user is willing to tolerate in getting information. Cost and benefit analysis is a crucial factor. This leads to change in another dimension of the information handling processes—establishment of data base both in data storage and information retrieval.

Before more advance information technology was introduced, a sequential file was often used. Under this sequence oriented file management, observed events were collected and processed in batches, and information was only adaptable to a sequential file. However, developments in file management technology have made storage of large quantities of data in nonsequential organization possible. Direct access bulk storage devices, such as disk file, data cell drive, and file organization and retrieval techniques permit the storage of literally billions of characters of information "on-line" for direct access by the central processing unit after a short set up time.

Another development is the single-entry concept to data base management—a transaction enters into memory files once and affected records are updated. It is a vital function of information handling, and thereby overcomes some age-old problems concerned with keeping multiple sets of the same data or information.

The impact of these changes on time and data base of information processing methods on decision making processes (operating subsystems), as depicted in Exhibit 2-2, is obvious.
Exhibit 2-2
The Impact of Modern Information Technology
on Operating Processing Subsystems

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinds of information received</td>
<td>Slight</td>
<td>Moderate</td>
<td>Substantial</td>
</tr>
<tr>
<td>Volume of information received</td>
<td>Slight</td>
<td>Slight</td>
<td>Substantial</td>
</tr>
<tr>
<td>Accuracy of information received</td>
<td>Slight</td>
<td>Moderate</td>
<td>Great</td>
</tr>
<tr>
<td>Timing of decision to be made</td>
<td>Substantial</td>
<td>Great</td>
<td>Very great</td>
</tr>
<tr>
<td>Kinds of decisions to be made</td>
<td>None</td>
<td>Slight</td>
<td>Substantial</td>
</tr>
<tr>
<td>Decision process</td>
<td>Slight</td>
<td>Moderate</td>
<td>Great</td>
</tr>
<tr>
<td>Overall impact</td>
<td>Slight</td>
<td>Moderate</td>
<td>Great</td>
</tr>
</tbody>
</table>

Changes in Information Processing Subsystems

Development of information science. Information processing methods involve data collecting, data converting, data measuring, data transmission, and information communicating. While modern information hardware technology, namely, the computer, has much to do with information handling techniques, several theoretical aspects of information sciences concepts also have an impact on and implication for information handling methods. These information concepts are information measurement theory and information communicating theory.

A relatively modern concept is that an information processing system must or should be a measurement system. A measurement system analyzes the nature of numerical descriptions that may be applied to relevant events observed. A measurement system consists of fundamental and derived measurement processes. Consequently,
the measurement problems, in terms of monetary terms, quantitative units and recording the measuring results, are the basic ingredients of data filtering, collecting, and converting processes of an information processing system. Exhibit 2-3 depicts the measurement processes in an information system.

Exhibit 2-3

The Elements of Information Processes

in a Measurement System
The difference between the fundamental measurement process and the derived measurement process, as shown in Exhibit 2-3, is that the fundamental one measures raw data for storage or communication in some cases, and the derived one measures the information already in the system, or the outputs of the fundamental measuring process for communication and prediction.

Converting and classifying at the technical computerized processes are coding and sorting. These are very important in the design and potential uses of a computerized information processing system. The data classification structure must be sound, or data will lose its identity and cannot be converted into meaningful information. The main manifestation of this function is in the preparation of code structures governing the classification of accounts. The coding scheme must be flexible in order to meet the broad and complete needs of a firm-wide data base.

While measurement theory analyzes the nature of numerical descriptions that may be applied to various observed relevant events, communication theory concentrates on the technical problem of transferring data—the conversion of data (encoding), transmitting channel, and the conversion of the signals (decoding).

The role of the communication processes in an information processing system is displayed in Exhibit 2-4. Note that the output signal receivers are not only the information users, but also are information transferred back to the data base (information retrieval) or to processing.
Exhibit 2-4

The Role of Communicating Processes (Activities) in an Information Processing System

__Storage & Retrieval (Data Base)___

Communication Processes

Encoding → Transmitting Channel → Decoding

Output Signal

To User

One of the crucial issues in designing information processing systems for output signals to the users is whether descriptions of detailed items should be aggregated for reporting purposes. Baruch Lev states that there is "the information loss caused by aggregation." If data are kept separate by event, the resultant mass precludes

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interpretation. On the other hand, over-summarization by aggregating data makes it impossible to see characteristics. Where a centralized data base is used, data will flow into the system from many points: finance, personnel, production, and so on. Communication of meaningful management information makes it essential that data from these sources are brought together in a meaningful manner.

Changes in information processing subsystems caused by modification of the organization setting. The appearances of computer and related information processing technology not only have changed information processing methods, but also have changed or modified the traditional organizational setting; the latter, in turn, changes the information processing subsystems in that organization. Modern information technology should permit skills to be used more effectively, and it could very well provide a mechanism for helping identify and more fully utilize a man's talent. If this is the case, then the organization under the shadow of the modern information technology environment would not have traditional lines, or at least there would be differences in the conduct of activities as now operating. Each authority has its own view of where the organization is heading. Leavitt and Whisler predicted in late 1958:

... One important reason for expecting fast changes in current practices is that information technology will make control much easier. ... by qualifying more information it will extend top management's control over the decision processes of subordinates. Information technology should make recentralization possible. It may also obviate other major reasons for decentralization. For example, speed and flexibility will be possible despite large size, and top executives will be less dependent on subordinates because there will be fewer "experience" and "judgment" areas in which the junior men have more working knowledge. In addition, more efficient information processing techniques
can be expected to shorten radically the feedback loop that tests the accuracy of original observation and decisions.\textsuperscript{7}

Simon believes that a new organization will emerge with an integrated information system:

... Organizations will still be constructed in three layers—an underlying system of physical products and distribution processes, a layer of programmed (and probably largely automated) decision processes for governing the routine day operation of the physical system, and a layer of non-programmed decision processes (carried out in a man-machine system) for monitoring the first level processes, reversing them, and clearing parameter values. Organizations will still be hierarchical in form. The organization will be divided into major sub-parts, each of these into parts, and soon, in familiar forms of departmentalization.\textsuperscript{8}

Professor Carroll states:

... In the type of management systems described here, the centralized data base and decision programs certainly imply the feasibility of centralized decision making; but the important points are (1) they do not require it, and (2) they may alleviate one major reason for it. The first follows directly from the fact that the human decision maker may be located "out in the field." The second is a more complex argument. One of the major pressures to centralize decision making stems from locally suboptimal decisions. That is, one organizational sub-unit cannot consider the status of other remote but interdependent decisions inconsistent with overall corporate welfare. But, if the sub-unit can be given access to the corporate data base, then its decisions can be reconciled with full corporate status and, to them be made consistent with corporate status and objectives.\textsuperscript{9}

In summary, it seems clear that the changes in management decision making processes and advancement of modern information processing


technology have made an organization structure designed around projects and decision systems rather than around separate functional areas. Traditional organizational theory, emphasizing the separation of activities into functional areas such as line and staff functions, does not give sufficient recognition to the interrelationship and interdependencies of the various activities.

On the other hand, Churchill, Kempster, and Uretsky find that the activities designed to achieve the goal or objectives of the organization have been organized on a functional basis:

It would be possible to focus on a structure for a total, general purpose, management information system. Such a system imposes the triple requirements of task definition and consequent information needs; identification of the requisite resources attributes; and the collection, maintenance, and retrieval systems necessary to handle these demands. No such system was observed. Instead, the existing systems were oriented around functional activities, such as manufacturing operations, sales, accounting, engineering, etc.10

However, centralized data and information processing and control could be the case more than not over file structures, data entry, specifications and coding, program design policies and so on. The reasons for this centralization are two-fold: (1) the need for compatibility and common file use; and (2) the technical and organizational complexity of many information processing decisions that require skilled, specialized people not found in every data processing center.

There is another modification of the organizational setting resulting from the emergence of information technology, the

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information handling function to report directly to the top management level, frequently with a separation made between financial or controller function and information systems director.

Changes in information processing subsystems resulting from the integration of managerial processes in planning, executing, and control. The classical view of Henri Fayol, a French industrialist, maintains that regardless of their levels in the organization, management performs essentially the same tasks or elements of administration. These elements or tasks are: planning, organizing, commanding, coordinating, and controlling.¹¹ These elements of administration generally refer to what are later called managerial processes. Current practice in management universally recognized planning, executing, and controlling as descriptive of management processes.

The planning process recognizes a problem, searches for alternative solutions, evaluates the alternatives discovered, and selects the best alternative evaluated.

The executing process carries out the plan.

The controlling process sees that the plan selected is implemented in the emerging problem areas—the feedback to planning process. Perhaps the first important impact of managerial science techniques and information science concepts on managerial processes is the integration among the managerial processes, as shown in Exhibit 2-5.

Exhibit 2-5

Integrated Managerial Processes

in Planning, Executing, and Controlling

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Professor Ross terms Exhibit 2-5 as information flow in the management processes—planning system, operating (executing) system, and control system. The information user receives information from the information processing subsystem for his planning process along with his goals or objectives. The output of the planning process serves as input to the operating (executing) process, which utilizes it as a premise for achieving the plan. A basic output of the operating (executing) process is performance against the plan, and information concerning this process is in turn provided as input to the control process. Feedback on performance is obtained through the control process, which monitors the executing (operating) process and furnishes feedback information to it as well as to the planning process. Decisions are made within each process based upon information, and within each system there is a flow of information to implement changes and correct deviations based upon feedback from other processes.\textsuperscript{13}

**Integration of information processing subsystems with managerial processing subsystems.** Since the key to success in performing the managerial processes lies in information, it follows that success in achieving the goals and objectives of the organization lies in performing these managerial processes through the vehicle of a properly specified information processing subsystem for each of the managerial process use, as shown in Exhibit 2-6.

The current developments in information processing begin with the formalization and automation of essentially separate...

\textsuperscript{13}Ibid., p. 116.
Exhibit 2-6

The Integration of Information Processing Subsystems with Managerial Processes
operating processes and relatively independent information subsystems. Experience in the process of systemization and the advent of modern information technology provide the basis for combining the previously separated information and operating subsystems, and finally the automation of the routine and structured decision making tasks. These, then, become so closely linked with the information system that it is impractical to determine where decisions (managerial processes) begin and information ends.

Cybernetics concepts and sensor subsystems. Sensor subsystems are used to measure changes within the total system, and the operating and information subsystems with the external environment.

A sensor is a device that responds to a physical stimulus and transmits a resulting impulse as for operating control. Beer describes cybernetics as the science of control and communication—whenever these occur in whatever kinds of systems. The core of cybernetics is that there is unity of natural law in the way controls must operate, whether the system controlled is animate or inanimate, physical or biological, social or economic.

Cybernetics is the science of control, and since control is one of the important managerial processes, an examination of the impact of cybernetics concept on a sensor subsystem in the total

15 Ibid., p. 339.
17 Ibid., p. 11.
system is necessary.

Since a business total system is operating in a dynamic, complex uncertain environment, cybernetics provides a guideline to get information from observing how the system reacts to the changes in the environment and how a decision maker responds to the change. The role of cybernetics as a sensor element in integrated managerial processes and information processes is depicted in Exhibit 2-6.

The sensor subsystems have two roles: (1) sensor and feedback the changes which occur outside the system, such as a possible state in the real world; and (2) sensor and feedback the changes which occur within each integrated operating information processing subsystem.

Though the use of cybernetics feedback concept as a control technique has been reflected on the standard cost accounting system, the implication can go further; that is, to monitoring changes continuously in the dynamic environment so that corrective action can be taken. The implementation of this concept can be workable as real-time, on-line information processing technology is utilized.

**Characteristics of Total Business System**

As stated in the previous section, a modern information system consists of a certain number of operating processing subsystems (i.e., production, marketing), and information processing subsystems (i.e., accounting), and sensor subsystems.

Developments in information sciences and management science techniques along with modern information processing technology, have improved managerial decision making processes (operating
processing subsystems), which consequently have raised several information issues—relevance, timeliness, and accuracy for the information processing subsystems which serve them. Furthermore, a sensor subsystem is facilitated to monitor and to feed back the results of decision making processes as well as external environmental states to the information processing subsystems. This section puts these subsystems together in a total system model as shown in Exhibit 2-7. Note that the total system model is started at the information user—the operating subsystem (decision making). A general explanation is discussed as following.

**Formalization and integration of operating and information subsystems.** As shown in Exhibit 2-6 (p. 35), information is needed at every level of the managerial process and for almost every action taken. This demand produces a number of information processing subsystems, both formal and informal in nature. An information processing subsystem is built around the operating subsystem (decision making process) that it serves. Each level of operating subsystem has its own characteristics that are relevant to its description and management. For each such relevant managerial process, an information processing subsystem can be structured. This subsystem would contain the information pertinent to the operating subsystem, maintain it in up-to-date form, and be capable of producing information on both the process and relationships among the processes.

Experience in this systemization and the advent of modern information technology provide the basis for the next step of combining previously separate processes. Data sources may be
Exhibit 2-7
A Total System Model---
Computer Approach

Information Processing Phase

Real World Data Source

Raw Data Filtering

Enter Data into Computer System

Enter the Selected Data

Coding of Raw Data

Processing of data by closed set of computer programs

Planning data files

Central database

Output signals

Decision-making Phase

Decision-maker

Critical information for use

On-line storage of selected information

Yes (high)

Weight the selected data and reassign current assignment

On-line set of computer program (Decision rules)

Internal Data Sources

Cybernetics Sensor Phase

Stop

No

Change in parameters and variables

Closed set of computer programs

Revised procedures and standards

Action taken

Result

Feedback

Feedback
merged, output may be blended, and a common data base then can be constructed. Exhibit 2-8 illustrates the integrated operating information subsystems in a typical industrial firm.

Integration takes place in the operation's next step. That is, there is further integration between the information processing subsystems and operating processing subsystems; finally the automation of the routine and structured decision-making tasks takes place. In this case, the proper extent of authority in the information specialist or system analyst not only provides data and interprets the prediction, but also makes decisions that connect to the goals.

Integration among these subsystems is essential, since in practice it gives the following merits:

1. System outputs (reports) could be used for various purposes.
2. The need for reports is well established by their use in higher order subsystems.
3. The timing, frequency, and contents have been especially designed to emerge in the next higher order subsystems.
4. The volume of data is closely related to the minimum requirement to transmit all information essential for higher order subsystem decisions, but not in excess of this amount. Simultaneous updating affected by one input becomes possible.

Computer-based information storage and communicating networks. The computer technology engenders extensive efforts toward formalization and further integration of information and operating subsystems. However, it should be noted that information processing systems existed long before computers were used or even before punched-card equipment became available. Furthermore, neither computers alone
Integration of the Information Processing Subsystems

**Production Operating Subsystem**
- Production order
- Inventory EOQ decisions
- Purchase order & data
- Labor distributions
- Overhead allocations
- Other data

**Marketing Operating Subsystem**
- Consumer order data
- Invoice data
- Salesmen's reports
- Special orders
- Other activities

**Managerial Planning Subsystem**
- Raw materials received
- Cash receipts
- Short-run sales forecast
- Long-term profit forecast
- Economic trend

Central processing unit

Outputs of the Operating Subsystems
- Reports*
  - *Payroll distribution
  - Sales trend analyses
  - Sales
  - Inventory status
  - Capital projects
  - Variance analyses
  - Order and customer profiles
  - Shares of markets
  - Profit-center performance
  - Raw materials forecast
  - Accounts receivable ages
  - Work-in-process summary
  - Overhead analyses
  - Factory capacity analyses
  - Financial position
  - Cash position
  - Net income determination
  - Other reports

*Economic trend
- Ledger balances
- Standard rates
- Accounts payable
- Employee payroll
- Work-in-process
- Raw materials inventory
- Accounts receivable
- Sales data
- Others
can make a good information processing system nor will the company with up-to-date information processing equipment necessarily have a good information processing system.

In the past, computer systems have been used for routine and structural clerical operations. As the pace of computer technology and related devices have expanded the capabilities of collecting, processing, storing, analyzing and reporting data and information, computer systems are not merely data processors for accomplishing the functions recognized in the past as the basis of business. The result of the use of computer technology and integration among the subsystems is that operating departments in a company are information service centers whose highly automated structures are producing products as well as information. All levels of management (strategic planning management, middle management control and supervising operation control) are involved in one or another information processing activities.

**A centralized data base.** In expressing the need for an entirely new approach to designing an information system, Professor Anthony focuses sharply on the concept of a data library, emphasizing the need for a data base from which a user may rapidly obtain facts and relationships of interest to time without knowing in advance what information is available.\(^\text{18}\)

The term "data base" includes both on-line and off-line situations in which a total set of data elements are stored in

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\(^{18}\) *Computer and Management* (The 1967 Leatherbee Lectures, Boston: Harvard University Graduate School of Business Administration, 1967), p. 117.
computer readable media and are accessible to various users. However, where there is more than one department or where the depository of information is independent from the departments, an on-line use of the same data base is preferable. This kind of depository is labelled a "centralized data base." So that in a total system environment when a centralized data base is established, one expects only on-line use of the data base. Exhibit 2-9 displays a centralized data base structure for a typical industrial firm's financial and logistic system.

A data base can be designed to do no summarization of the raw data unless a particular summary is requested. Taking an accounting system as an example, rather than posting the transactions to accounts and summarizing them, a computer system can be created to direct the computer with the information it needs to find the appropriate data and to construct any kind of summary that might be requested. Such a system would have the potential to construct any information based upon the data, but would actually construct only requested information at the time of the request.

There are numerous advantages to a centralized data base. One is the minimization, if not elimination, of duplication that must be present when different managerial groups use separate aspects of the same resource and each maintains its own information style. Another advantage is the ready availability and the ability to pull together and integrate related data from various applications as the need arises.

The major disadvantage in this data base stems from the difficulty of knowing all the uses to which that information on
Exhibit 2-9

A General Model of a Centralized Data Base

ORDER ENTRY SUBSYSTEM

Salesman order

Order online processing
1. editing
2. pricing
3. credit check
4. mark sel.
5. ship date

Sales office

Mail copy to customer

Warehouse

Customer file

Freight routing and rates

Product file

Finished goods inventory

Open invoice file

Standard price list

Open order file

Hold order file

Marketing Analysis and Financial mgmt.

Systems

Sales Forecasting and Production schdl.

Subsystems

Inventory Planning and Control Sub-

Systems

Processing

Processing and Storing

Invoices to customers

Marketing & Accounts Receivable

Reports

a process will be put and specifying the characteristics of the attributes that are to be put in the file.

On-line real-time systems. The developments in information processing technology and data communicating system equipment have permitted many companies to begin the use of the on-line real-time system (OLRT).

The aims of OLRT systems are two-fold: (1) to establish a complete network of information flow mechanically which would perform in the accumulating, recording, updating, summarizing and reporting without continued physical surveillance (on-line); (2) organization of data in the storage files, for instance, and specific retrievals (real-time).

The major purpose of using a real-time system in a firm is for its management control functions—measurement, situation analysis, and corrective action. Though the critical time cycle for management control varies greatly depending upon what is to be accomplished, shortening the management control cycle permits substantial economic benefits and other benefits to be realized. Morton and McCosh propose a terminal cost system in taking real-time advantages.  

The objective of a cost information system, as the authors suggest, is to combine the manipulating power of modern information technology and managerial techniques to arm management with the most up-to-date, accurate, and appropriate cost information.  

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21Ibid., p. 44.
As the benefits of the on-line real-time are obvious, the costs to acquire the system could outweigh the benefits. In a large industrial firm, for instance, where several operating departments (or subsystems) have access to on-line equipment, there is a need for alternative equipment. Since data is to be maintained on-line and is to be updated as a relevant event occurs in a real-time system, the need for alternative equipment is obvious. This makes the implementation of OLRT systems expensive.

**Interfacial operations between man and the computer.** The success of an information system using computer technology is not only determined by how fast and how broad the data and the information base is, but also by how managers react to the computer operations. That is the interaction between man and computer operation. A simple interfacial relationship between man and the computer is like this: an operating manager inserts data into a computer, gets a response based upon the processing of the information that he has provided, examines the results occasioned by his action, determines whether he should continue his dialogue with the system. It is an approach that combines the strength of the human mind and the strength of modern computer technology.22

David Li classifies this man and computer interfacial relationship into these three categories:

1. Machine initiated, man and machine interfaces; that is, the computer system is unable to provide its own direction and asks for a human being to make the necessary decision for it.

---

2. Man initiated, man and machine interfaces; that is, the management initiates a request for information that can be supplied instantaneously by the computer.

3. Man conditioned, man and machine interfaces; that is, the provision by the computer to flash information that may be valuable in initial remedial action.23

Consider inventory control, for example. If material A inventory minimum level is to be maintained at 100 units at all times, this 100 units is the constraining information and is stored in the data base. In the course of processing material A information that involves issuing material A, the inventory balance is 95 units. The computer immediately transmits the following message to the inventory control manager: "MATL A. NO 03213 95 UNITS 3PM AT 2-13-73, UNIT COST $10."

Crucial to the effective use of this interactive capability is the manager's prompt response to the computer (as in the computer-initiated situation). Since the computer cannot continue the process until it receives further instruction from human beings, the time differential between information provided under on-line processing and under batch processing will disappear, as happened in this case, if there is a time delay.

An Overview of the Total System Model--Summary

As Exhibit 2-7 (p. 39) illustrates, a total system model consists of three major parts: decision making (operating subsystem),

---

information subsystem, and sensor subsystem. A total system becomes a decision oriented system as the operating subsystem (decision maker) is capable of determining the type of information to be provided by the information subsystem.

However, the decision making subsystem encompasses a wide spectrum. At one extreme, the decision making rules are neither incorporated into the system nor implemented by the computer. The computer only provides information considered relevant for the decision making done by human beings. At the other extreme, the decision making rules are formalized and incorporated into the system. Under these situations, the decision is an output of the system, such as placing purchasing orders when reorder points and materials sources have been predetermined by the operating manager. Even where the decision situation is such that the computer system provides only a part of the data needed, the breadth of the information available permits better instructed decisions and increased use of decision models and the scientific methods. This, in turn, influences the information supplying subsystem in two ways:

1. When decision models are developed and used, and the information requirement becomes more explicit, more precise, and more formalized.

2. The sensor control system monitors the performance of decision models against the plan and feeds back the results to the information processing subsystem.

The Boundaries of Accounting as a Managerial Information System—A Normative Model

Accounting has traditionally been defined as the art of
recording, classifying, summarizing, evaluating, and communicating financial data. These various information processing functions are not independent, but rather built one upon the other, culminating in the communication of financial information. The recording, classifying, and summarizing of data are techniques which the accountant uses to accomplish his primary objective as a provider of financial information. Thus, the accounting department in a company is established for the major purpose of information and the accounting department is born far before the information systems. Exhibit 2-10 illustrates this traditional role of the accounting system.

Exhibit 2-10

The Traditional Role of the Accounting System
Although there is general agreement that accounting essentially is an information system, opinions concerning the boundaries of accounting and its relationship to the total system in general and to other information subsystems in particular vary. A review of the current accounting literature reveals the different philosophies.

The first view is that accounting covers an entire information system and the external financial reporting functions. Thus, the information system is a subset of accounting. Some accounting educators believe that accounting should and can not only perform the external financial reporting function, but also cover the entire scope of managerial information for internal use.

The second approach is that accounting is a subset of the many information subsystems in a business organization, and the accounting system receives much of its input data directly from the other subsystems.

The third view holds that accounting and information for managerial use are two distinct sets, and each set contains certain elements not contained in the other set. Information requirements for management planning and control systems are independent from conventional notions of accounting.

This study uses the second approach. That is, the accounting function is one of the major information subsystems in a business firm. This view corresponds closely to that of the American Accounting Association 1970-1971 Committee on Accounting and Information Systems which considers the function of accounting one
of the most important systems in an organization.\textsuperscript{24}

Exhibit 2-11 shows the relationship of the accounting system with the other information subsystems and the information system as a whole. Accounting, in this role, is supplementary to the many information subsystems, and in fact, receives much of its input data directly from them. As the many information subsystems are formalized and directly connected with the operating managers, the management accountants have ceased to be the information brokers standing between the sources of information and the operating managers and decision makers.

Exhibit 2-11

The Role of the Accounting System

with the Other Formal Information Subsystems\textsuperscript{25}

\footnotesize
\begin{itemize}
\item \textsuperscript{24}"Report of Committee on Accounting and Information Systems," \textit{op. cit.}, p. 344.
\item \textsuperscript{25}\textit{Ibid.}, p. 292.
\end{itemize}
Chapter 3

THE OPERATING DUTIES OF THE ACCOUNTING DEPARTMENT IN PERFORMING ROUTINE FINANCIAL ORIENTED INFORMATION PROCESSES

Introduction

The information processing subsystems in an industrial firm are staffing elements, which provide services—data and information processing, and advice—providing planning and control information to these line operating subsystems and/or to other staffing subsystems to operate effectively and efficiently for attaining the firm's goals.

While accounting has been one of the most important information processing subsystems in a business firm, the literature research reported in Chapter 2 describing the current state of a total system and various subsystems that lie within it cast a large shadow over the importance of accounting as an information processing subsystem. However, whether the role of accounting is diminishing in its information functions involves empirical tests. The question is so pragmatic that it cannot be settled solely on the basis of theoretical arguments or on the basis of individual opinions and experience as some authors cite.

Modern computer systems are characterized by the integration of information processing activities. The aims of this integration are the preparation of all desired managerial reports from a single recording of each business transaction and the integration of financial and accounting data with operating data. Such integrated
systems have been made possible by recent developments in data collecting equipment, communicating facilities, random access storage devices, advanced software techniques, and time sharing hardware.

Moreover, a merging of information processing and operating subsystems might eliminate information processing duties from the accounting department. At plant level, the cost accumulating duty might become part of the production operating processing subsystems.

These developments in integration of operating and information processing subsystems and computerization lead to the following hypothesis that at least 50% of the 1000 largest industrial firms would indicate that:

1. The accounting department's primary duties in performing financial data and information processes have been transferred to the other departments or subsystems with the different managers in charge.

2. The size of the accounting department has been reduced.

3. The information processing functions and the controller's functions of reporting to the top corporate level have been separated.

This chapter presents the surveyed results of the current role of the accounting department in performing financially oriented information processing functions. The role of accounting as an information provider for planning and control purposes is presented in the subsequent chapters.

The Accounting Department's Operating Duties in Financial Data and Information Processing Functions

Traditionally, the accounting department has been responsible for a number of routine financial data and information processing
activities, as shown in Exhibit 3-1, which depicts a traditional accounting department structure. This structure has been organizationally divided into the following major sections related to financial information processes: (1) the cashier's section; (2) the billing and accounts receivable section; (3) the accounts payable section; (4) the inventory control section; (5) the cost accounting section; and (6) the capital assets section.

Exhibit 3-1
Functional Organization of the Accounting Department---

A Traditional Model
Each of these accounting units performed a part of the traditional accounting functions of recording, classifying, summarizing, and reporting business transactions within a financial information processing framework. Because people were the major processing vehicle in this traditional accounting information processing system, the separation of accounting units provided adequate internal control to safeguard the company’s assets and check the accuracy and reliability of the financial data.

However, as business data processes evolved from manual through punched card equipment to computerized data processing systems, these financial information processes were logical candidates for automation, due to the routine and highly structured nature of these activities.

In light of this hypothesis, the first question in Section 1 of the questionnaire asks:

Of the following financial information processing functions, please indicate (✓) the department(s) which is (are) primarily responsible for the process. (Process is intended to include preparing data input, manipulating, and information output.)

The financial information processing functions were identified in the question as sales-order billing, accounts receivable, accounts payable, inventory updating, payroll, cost accumulating process, production cost routine analysis, and sales margin analysis. The departments were divided into two major categories: information processing departments (subsystems)—accounting, EDP; and operating departments (subsystems)—production and sales. A space was provided for listing other departments, if any.

Since the statistical confidence interval was used to test these subhypotheses, the null hypothesis (H₀) was set that there is
at least 50% of the 1000 largest industrial firms in which the accounting department is not primarily responsible for the financial data and information processes, that is $H_o \geq 50\%$; or the alternative hypothesis ($H_a$) was set that there is less than 50% of the 1000 largest industrial firms in which the accounting department is not primarily responsible for the financially oriented data and information processes, that is $H_a < 50\%$.

The accounting department is not primarily responsible for sales-order billing process. Although sales are a firm's line operating activities, the process of sales-orders from customers and billing to the customers have traditionally been the staff's (information processing)—the accounting department's—responsibility.

Because of the voluminousness and yet routine and highly structured process, the process was one of the few earliest candidates for automation. Has the sales-order and billing process been transferred out of the accounting department as a result of the application of information processing technology and emergence and integration of information and operating processing subsystems?

More than 73% of the total useful responses indicate that the accounting department is not solely responsible for the sales-order billing process. Based upon this sample result, the 95% statistical confidence interval for the proportion of the 1000 industrial firms in which the accounting department is not primarily responsible for the process ranges from not less that 65.8% to 80.8%.  

\[1\] Detailed computations of the statistical confidence level and the test of the hypothesis for this section and the sections that follow are attached in the Appendix B.
Since the smallest percent of the confidence interval is larger than 50%, the null hypothesis ($H_0$) that there is at least 50% of the 1000 large industrial firms in which the accounting department is not primarily responsible for the sales-order billing process must be accepted.

The accounts receivable process is not primarily done by the accounting department. Although accounts receivable result from sale activities, it has traditionally been the responsibility of accounting departments to keep the customers' records, collect the credits, and prepare accounts receivable aging schedules. Has the emergence and integration of marketing operating and information subsystems removed this responsibility from the accounting department?

More than 47.1% indicate that the accounting department is not primarily responsible for the accounts receivable process. Based upon the sample result, the estimated proportion for the 1000 largest industrial firms in which the accounting department is not primarily responsible for the process ranges from 38.7% to 55.5% at 95% statistical confidence level. Since $H_0$ falls within the confidence interval, the null hypothesis must be accepted. That is to say, there is at least 50% of the 1000 industrial firms in which accounting is not primarily responsible for the accounts receivable process. The acceptance of the null hypothesis is also valid when the following testing hypothesis technique is used.

$$Z = \frac{n_1 - n_p}{\sqrt{n_p q}} = \frac{64 - 136 (.5)}{\sqrt{136 (.5)(.5)}} = -1.686 > -1.64$$
where,

\[ n_1 = \text{the number of the firms indicating the accounting department is not solely responsible for accounts receivable process is 64.} \]

\[ n = \text{the total useful responses is 136.} \]

\[ p = \text{the hypothetical probability is .5.} \]

Since \( H_0 \geq 50\%, \) it is the left-side one tail test, \( Z_{0.05} = -1.64. \)

So that the null hypothesis must be accepted.

**The accounting department is still primarily responsible for the accounts payable process.** The process for accounts payable involves not only making payment to the vendors at any possible cash advantage condition, but more importantly making an appropriate allocation of the expenses and costs paid into proper accounts. Traditionally, the accountant has this expertise in classifying the accounts as well as maintaining the charts of accounts.

Through the use of the computer system, a purchase may be recorded into the system, such as the computerized voucher system, and the system would make the routine decisions by displaying some sort of signals for making payment prior to the cash discount privilege date. In this sense, the accounts payable process would not be necessary within the accounting department but in the data processing department, or even in the purchasing department.

However, the sample results show that less than 37% of the total useful responses indicate that the accounting department is not primarily responsible for the accounts payable process. The estimated proportion for the 1000 industrial firms' accounting department not primarily responsible for the process ranges from 28.4% to 44.6% at 95% statistical confidence interval. Because the
largest percent is not greater than 50%, the hypothesis that there is at least 50% of the 1000 industrial firms in which the accounting department is not primarily responsible for accounts payable process must be rejected.

Inventory updating is not processed primarily by the accounting department. The major purpose of inventory control is to maintain an optimal level of inventory investment. Inventory records are only a means to the goal of inventory control. While a production department might be in charge of the inventory quantity updating, the accounting department has traditionally been responsible for the monetary aspect of inventory record keeping. Did the computer application and integration of information and operating processing subsystems change this situation?

More than 72% of the total useful responses indicate that the accounting department is not primarily responsible for the inventory updating process. The estimated proportion for the 1000 industrial firms in which the accounting department is not primarily responsible for the process ranges from 65.4% to 80.2% at 95% statistical confidence interval. Since the lowest range of the confidence interval is larger than 50%, the hypothesis that there is at least 50% of the 1000 large industrial firms in which the accounting department is not responsible for inventory updating process must be accepted.

Payroll is not processed primarily by the accounting department. In an industrial firm, the major payroll data processing function involves distributing labor costs to each department or product, in addition to accurately computing and promptly paying employees.
The tasks of the payroll process have been somewhat complicated by the necessity for withholding specified amounts from workers' earnings, measuring costs of employees' workman's compensation and other fringe benefits, and meeting various governmental regulations.

The withholdings, employees' fringe benefits, corporate employees' plans, and so on require an intricate network of accounts and supporting documents. Thus, the payroll process plays a large role in a firm's data processing time. Payroll records, files, and handling techniques have also played a substantial role in the information processing system design.

Since the accounting department traditionally has been related to payroll, what is the change in this relationship after automation? More than 55% of the total useful responses indicate that the accounting department is not primarily responsible for the payroll process. The estimated proportion for the 1000 firms in which the accounting department is not primarily responsible for the payroll process ranges from 47.2% to 63.8% at 95% statistical confidence interval. Since the null hypothesis, $H_0 \geq 50\%$, falls within this confidence interval, the null hypothesis could not be rejected. That is, the hypothesis that there is at least 50% of the 1000 industrial firms in which the accounting department is not primarily responsible for the payroll process must be accepted.

Product cost accumulating process is not done by the accounting department. Because traditionally the production process has been a firm's operating activity, the production cost accumulating process has been the "staff" function. The cost accumulating process involves two major activities: product cost determination and routine cost
The duties of product cost accumulating traditionally has been within the cost accounting section of the accounting department. The integration of the operating and the information subsystems may cause the cost accumulating activities to be integrated as part of manufacturing management system, and the accounting department might no longer serve as a staff function for processing cost information. This is confirmed by 52% of the total useful responses. The estimated proportion for the 1000 industrial firms in which the accounting department is not primarily responsible for the product costing function ranges from 43.0% to 60.0% at 95% statistical confidence interval. The null hypothesis, \( H_0 \geq 50\% \), falls within the confidence interval; the hypothesis that there is at least 50% of the 1000 industrial firms in which the accounting department is no longer primarily responsible for the product costing activity must be accepted.

The accounting department is not primarily responsible for the routine production cost analysis. As stated earlier, one of the major functions of cost accounting is cost analysis—variance analysis. The scope of these analyses consists of three major cost components, materials, labor, and overhead variance analyses.

Traditionally, the cost variance analysis has been done in the cost accounting section. However, integration of the operating subsystem (production operation) with the information subsystem (production cost accumulating activities) has made it possible for the manufacturing manager to analyze the deviations that result from his department's operations. The question is, has the production
cost variance analysis duty been transferred out of the accounting department?

Based on the sample results, 45% of the total useful responses indicate that the accounting department is not primarily responsible for the production cost variance analysis. The estimated proportion for the 1000 industrial firms in which the accounting department is not primarily responsible for the production cost variance analysis ranges from 36.8% to 53.6% at 95% statistical confidence interval. Since the null hypothesis is set equal to or greater than 50%, which falls within this confidence interval, the hypothesis that there is at least 50% of the 1000 large industrial firms in which the accounting department is not primarily responsible for production cost variance analysis must be accepted. The acceptance of the null hypothesis may also be confirmed by the following testing technique.

\[
Z = \frac{n_1 - np}{\sqrt{npq}} = \frac{61 - 135(.5)}{\sqrt{135(.5)(.5)}} = -1.12 > -1.64
\]

where,

\(n_1\) = the total number of the firms indicating the accounting department is not solely responsible for routine production cost variance analysis is 61.

\(n\) = the total useful responses is 135.

\(p\) = the hypothetical probability is .5.

Since \(H_0 \geq 50\%\), it is the left-side one-tail test, \(Z_{.05} = -1.64\).

The accounting department is not primarily responsible for sales margin analysis. Contribution margin analysis is often used to select the product line and marketing distribution channel. The
general rule is that the larger the sales margin, the more profitable the product or the channel is. Traditionally, this analysis responsibility has fallen upon the accounting department. However, what is the impact of integration of marketing operating subsystem and the marketing information processing subsystem on the role of the accounting department doing this analysis? Forty-four and four-tenths percent of the total useful responses indicate that the accounting department is not primarily responsible for the analysis. The estimated proportion for the 1000 industrial firms in which the accounting department is not primarily responsible for the sales margin analysis ranges from 36.0% to 52.8% at 95% statistical confidence level. Since the null hypothesis is stated at equal to or greater than 50%, which falls within the confidence interval, the hypothesis that the accounting department is no longer primarily responsible for the sales margin analysis in at least 50% of the 1000 large industrial firms must be accepted. The acceptance of the null hypothesis may also be confirmed by the other hypothesis testing technique as follows:

\[ Z = \frac{n_1 - n \cdot p}{\sqrt{n \cdot p \cdot (1-p)}} = \frac{60 - 135 \cdot (0.5)}{\sqrt{135 \cdot (0.5) \cdot (0.5)}} = -1.29 > -1.64 \]

where,

- \( n_1 \) = the total number of the firms indicating the accounting department is not primarily responsible for sales margin analysis is 60.
- \( n \) = the total useful responses is 135.
- \( p \) = the hypothetical probability is .5.

Since \( H_0 \geq 50\% \), it is the left-side one-tail test, \( Z_{0.05} = -1.64 \).
There Has Been No Reduction in the Size of the Accounting Department

The findings of the previous section confirm that all of the routine financially oriented information processes, except accounts payable, have been transferred out of the accounting department in at least 50% of the 1000 largest industrial firms in the United States. The findings agree with the observation made by the American Accounting Association 1970-1971 Committee on Accounting and Information Systems.\(^2\)

The ad hoc committee also states that the overall impact of the information technology had been a reduction in the size of the accounting staff, a curtailment of financial processing operations.\(^3\)

The questionnaire, in this section, asks if there had been any change in the number of the accounting department's personnel, and approximately what percentage of the change was attributed to the implementation of modern information systems. Twenty-six and two-tenths percent of the total 130 useful responses indicate that there has been a decrease in the accounting department's personnel. The estimated proportion for the 1000 largest industrial firms in which the accounting department's personnel has been curtailed ranges from 18.6% to 33.8% at 95% statistical confidence interval. The null hypothesis that there is at least 50% of the 1000 industrial firms in which the size of the accounting department has been reduced must be rejected.

Based upon the confidence interval, obviously there has been no decrease in the accounting department's personnel despite the


implementation of modern information systems. This conclusion is in contradiction to the findings of the previous section, which concludes that the information processing functions of the accounting department have been largely reduced. This writer observes that this inconsistency could be caused by two possibilities:

1. Holding the firm's internal growth and expansion constant, only implementing modern information systems did not cause any change in the numbers of the accounting department's personnel.

2. Any possible need for more accountants resulting from the firm's internal growth and plant expansion were offset by the implementation of modern information systems.

The firm's internal growth and plant expansion imply a long term concept. The questionnaire failed to take the time span into consideration and this may have contributed to the greater percentage of responses indicating no change.

However, by comparing the ratio of increase and decrease, it is consistent with the findings of the previous section. As shown in Exhibit 3-2, 26.2% (or 34 firms) indicate that the accounting department's personnel has decreased, while only 10% (or 13 firms) indicate that there has been an increase in accounting personnel. Furthermore, as there is one firm which indicates no more than a 20% increase, there are 6 firms which indicate that their accounting personnel has decreased from no less than 40% to 100%.

The Organization Structure as to the Information Processing Functions

Most of the professional literature has cited or predicted that the information processing functions reporting directly to the top
Exhibit 3-2

Comparison of Decrease and Increase of the Accounting Department Personnel

<table>
<thead>
<tr>
<th>Range</th>
<th>Decrease</th>
<th></th>
<th>Increase</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Firms</td>
<td>Percentage of Total Decreases</td>
<td>Firms</td>
<td>Percentage of Total Increases</td>
</tr>
<tr>
<td>1% - 10%</td>
<td>24</td>
<td>70.6%</td>
<td>12</td>
<td>92.3%</td>
</tr>
<tr>
<td>11% - 20%</td>
<td>4</td>
<td>11.8%</td>
<td>1</td>
<td>7.7%</td>
</tr>
<tr>
<td>21% - 30%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31% - 40%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41% - 50%</td>
<td>2</td>
<td>5.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>51% - 60%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>61% - 70%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>71% - 80%</td>
<td>1</td>
<td>2.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>81% - 90%</td>
<td>2</td>
<td>5.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>91% - 100%</td>
<td>1</td>
<td>2.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
<td>100.0%</td>
<td>13</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Percentage of the 130 useful responses 26.2% 10.0%

corporate officer levels are divided between the controller and the information manager. Aimed at this assertion, Section I, question 2 asks:

Please indicate the following immediate supervisor, at the division or plant level of each manager listed below. You may check more than one, if there are different organization charts among divisions or plants.
EDP manager reports to the director of management information systems. Of the 145 useful replies,\textsuperscript{4} 42.8\% indicate that the director of management information systems is the immediate supervisor of the EDP manager, while 26.9\% indicate the controller, followed by the vice-president in finance, 18.6\%. There are 3 firms reporting that there is no EDP manager in their companies.

The controller is the immediate supervisor of the director of management information systems. Of the total 103 useful responses, 42.7\% indicate that the director of management information systems is under the controller's supervision, with 33.0\% under the vice-president in finance, 4.9\% go to the president.

A surprising finding is that 9\% (13 firms) indicate that there is no director of management information systems in their firms.

The accounting manager is under the controller's supervision. Of the total 139 useful replies, 71.9\% indicate that the accounting manager is under the controller's supervision. This is followed by the vice-president in finance, 20.1\%.

The integration of the information processing function and the controller's function. The question of whether the information processing function and the controller's function have been divided in regard to reporting to the top corporate level can be answered by Exhibit 3-3.

\textsuperscript{4}This number is greater than the total responses received, since the question called for more than one answer if any different organization charts are used among their divisions or plants.
Exhibit 3-3

The Distribution of the Information Processing Functions as to Reporting to the Top Corporate Level

<table>
<thead>
<tr>
<th>From</th>
<th>Director of M. I. S.</th>
<th>Controller</th>
<th>Vice-president in finance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct from EDP manager</td>
<td>42.8%</td>
<td>26.9%</td>
<td>18.6%</td>
</tr>
<tr>
<td>Converted from director of M. I. S. (see below)</td>
<td>-</td>
<td>18.3%*</td>
<td>14.1%*</td>
</tr>
<tr>
<td>Direct from accounting manager</td>
<td>-</td>
<td>71.9%</td>
<td>20.1%</td>
</tr>
<tr>
<td>Converted to 100% base</td>
<td></td>
<td>68.7%</td>
<td>31.3%</td>
</tr>
</tbody>
</table>

* Controller:

1. Immediate supervisor of EDP manager is the director of management information systems 42.8%
2. Immediate supervisor of director of management information systems is the controller 42.7%
3. Proportion conversion: 42.8% x 42.7% 18.2%

* Vice-president in Finance:

1. Immediate supervisor of EDP manager is the director of management information systems 42.8%
2. Immediate supervisor of director of management information systems is the controller 33.0%
3. Proportion conversion: 42.8% x 33.0% 14.1%

In other words, 68.7% of the firms indicate that the information processing functions and controller's functions in regard to
reporting to the top corporate level have been integrated with the controller, while 31.3% indicate that these two functions are divided.

The proportion of the 1000 firms having the information processing divided from the controller's functions in regard to the top corporate level ranges from 23.5% to 39.1% at 95% statistical confidence interval. Since the hypothesis $H_0 \geq 50\%$ does not fall within the confidence interval, the hypothesis must be rejected.

Summary and Conclusion

The accounting department appears to be no longer solely responsible for the routine financial data and information processes in the large industrial firms. The result is revealed in Exhibit 3-4.

Thus the subhypothesis 1, that there is at least 50% of the 1000 large industrial firms in which the accounting department's primary responsibility in performing routine financial data and information processes have been transferred to the other departments or subsystems must be accepted.

The acceptance of this hypothesis is based on the sample results of the statistical confidence interval that the accounting department is not primarily responsible for the process. Note that the accounting department, which is jointly responsible with the other departments, is included in this category, since the hypothesis is centered around "primarily."

Almost 74% indicate that there is either no change or a slight increase (10% in most cases) in the size of the accounting department resulting from the implementation of modern information systems in
## Exhibit 3-4

The Accounting Department and the Financial Data and Information Processes

<table>
<thead>
<tr>
<th>Financial Data and Information Processes</th>
<th>Total Useful Replies</th>
<th>The accounting dept. is primarily responsible for the process</th>
<th>The accounting department is not primarily responsible for the process</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Firms</td>
<td>Percent of total useful replies</td>
<td>Firms</td>
</tr>
<tr>
<td>Sales-order billing</td>
<td>135</td>
<td>36</td>
<td>26.7</td>
</tr>
<tr>
<td>Accounts receivable</td>
<td>136</td>
<td>72</td>
<td>52.9</td>
</tr>
<tr>
<td>Accounts payable</td>
<td>137</td>
<td>87</td>
<td>63.5</td>
</tr>
<tr>
<td>Inventory updating</td>
<td>136</td>
<td>37</td>
<td>27.2</td>
</tr>
<tr>
<td>Payroll</td>
<td>137</td>
<td>61</td>
<td>44.5</td>
</tr>
<tr>
<td>Cost accumulating</td>
<td>134</td>
<td>65</td>
<td>48.5</td>
</tr>
<tr>
<td>Product cost analysis</td>
<td>135</td>
<td>74</td>
<td>54.8</td>
</tr>
<tr>
<td>Sales margin analysis</td>
<td>135</td>
<td>75</td>
<td>55.6</td>
</tr>
</tbody>
</table>
their firms. If this is the case, then we must reject subhypothesis 2, that at least 50% of the 1000 largest industrial firms have reduced the size of the accounting department, even though rejection of subhypothesis 2 is not consistent with the acceptance of subhypothesis 1.

As shown in Exhibit 3-3, the integration, rather than a separation, of the information processing functions and the controller's functions is found in this study. Thus, subhypothesis 3, that there is at least 50% of the 1000 industrial firms in which the information processing functions and the controller's functions have been separated in regard to reporting to the top corporate level, must be rejected.
THE ROLE OF THE ACCOUNTING SYSTEM AND OF ACCOUNTANTS IN PROVIDING INFORMATION FOR DECISION MAKING

Introduction

The roles of the accounting system and of accountants in a business organization are to perform financial data and information processing services, to provide information for managerial planning and control, and to design and influence the corporate information systems, data base design and management control systems.

Some may predict that accountants, especially management accountants, will vanish as a new breed of information specialists emerges in the firms. Accountants would serve strictly as data collectors, scorekeepers in the most mundane sense. Nevertheless, the findings of the previous chapter conclude that in at least 50% of the 1000 largest industrial firms their accounting departments are not primarily responsible for the routine data and information processes.

Because the primary objective of this chapter is to test empirically the importance of the accounting system in providing information for the purposes of managerial planning and control, the questionnaire in this section is also directed to inquire into the extent to which the modern information systems have been implemented. It also serves to review managerial decision models that are currently in use for the purpose of examining the roles of the accounting system and of accountants in implementing the
managerial decision models and techniques.

In light of these purposes, the hypothesis is that in at least 50% of the 1000 largest industrial firms:

1. The operating departments participate in the firm's central information system.

2. The routine operating decisions are made by the system.

3. The decision models and management science techniques are used by the firms.

4. The accounting information and accountants play no significant roles in the identified decision models and techniques.

The formalization and the integration of the operating and information processing subsystems and the computerized information networks in a firm characterize modern information systems as stated in Chapter 2. The purpose of this chapter is to inquire into the extent of the integration of the operating and information processing subsystems. Then follows a discussion of the use of decision models, such as inventory models, multiple-regression models, and so on, and the roles which the accounting system and accountants play in the models.

Current State of the Operating and the Information Subsystems in an Industrial Firm

The application of modern information technology and the integration of operating subsystems with the information processing subsystems are the two major characteristics of modern information systems. While the findings of the previous chapter confirm that the application of modern information processing technology varies widely in practice, the first section of this Chapter inquires into
the degree of the integration of the operating subsystems and the information processing subsystems that may have taken place.

Question 1 of Section II of the questionnaire states:

Many firms today have information systems so organized that each operating department (production, sales, etc.) is served by the central system. In this case, the operating department inputs certain data, such as production or sales facts; these data are merged with those of other departments, processes, and the resultant information available to the operating department. Some systems are informational only, while in more advanced systems the system itself is capable of making routine decisions, such as placing purchasing orders when dates have been set and the like. Information structures such as this are the basis for the next three questions:

1. Do your company's operating departments participate in a system such as described above?
2. Are routine decisions made by the system?
3. Do the operating department managers have the ability to modify the decision process?

The operating departments participate in the firm's central system. Of a total of 141 useful replies, 71.6% (101 firms) indicate that their company's operating departments participate in the firm's central system. The estimated proportion of the 1000 largest industrial firms whose operating departments participate in the firm's central system, based upon the sample result, ranges from 64.2% to 79.0% at 95% statistical confidence interval. The hypothesis that in at least 50% of the 1000 largest industrial firms the operating departments participate in the firms' central system must be accepted.

The routine decisions are made by the system. The essence of an operating processing subsystem is decision making, that is,

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1 Detailed computations of the statistical confidence interval and the test of the hypothesis for this section and the sections that follow are attached in the Appendix B.
choosing from among a set of alternative courses of action in the light of the managerial goal(s) or objective(s). These decision making processes are two-fold: a routine and structured decision process and a special, unstructured decision process.

The routine structured decisions, such as the inventory reorder point, the accounts receivable credit due notice, and scheduling a job on a particular machine can be programmed into the system and does not require the intervention of the operating managers. The question is asked, and 50.8% (67 firms) of 132 responses indicate that the routine and structured decisions are made by the system.

The estimated proportion of the 1000 largest industrial firms whose operating departments' routine decisions are made by the system ranges from 42.3% to 59.3% at 95% statistical confidence interval. Since the null hypothesis, $H_0 \geq 50\%$ falls within the confidence interval, the hypothesis that in at least 50% of the 1000 largest industrial firms the operating routine decisions are made by the system must be accepted.

The operating managers have the ability to modify the decision process. The essence of the operating managers' abilities to modify the decision processes which are made by the system is the key factor in the modern total system environment. While a significant proportion of the 1000 industrial firms indicate that the operating routine decisions are made by the system, a very high percentage (95%) state that the operating managers are able to modify the decision processes that are already in the system.
Summary of the current state of the operating and information subsystems in an industrial firm. The findings confirm the assertion made by the AAA 1970-1971 Committee on Accounting and Information Systems:

The current developments in information processing began with the formalization and automation of essentially separate operating processes and relatively independent information subsystems. Experience in this systemation and the technological advances in computer capabilities provided the basis for the next step of combining previously separate processes.²

Integration is taking place in operations. This in turn reinforces further integration of the information systems and finally the automation of the routine and structured decision making tasks.³

The Committee, however, warns that "integration of formal information subsystems and the resulting close contact of the decision maker with the data has diminished the role of the accountant as chief source of decision making information. Once an information handling function has been created, the accounting subsystem is called upon for fewer decision-related data requests."⁴ The next section examines the roles of the accounting system and the accountants in the operating decision making processes.

The Managerial Decision Models and the Roles of the Accounting System and of Accountants

A decision model, depicting the relationships among the

³Ibid., p. 339.
⁴Ibid., p. 347.
recognized factors in a particular situation, is a method used by the operating managers for choosing from among a set of alternatives as they conduct their planning and control functions.

While a decision model provides a conceptual representation which enables the operating manager to measure the effects of alternative action, it could also be constructed and implemented to some extent to perform managerial planning and control functions. For instance, if and when the inventory level is regulated by a system based on a decision model that specifies when to order and how much to order, the system can fully perform the delegated inventory planning and control functions without the operating manager's intervention.

Nevertheless, decision models have been criticized because the process of abstraction oversimplifies the problems and ignores important underlying factors, such as behavior, environment and sometimes politics.

The American Accounting Association's 1968-1969 Committee on Managerial Decision Models cites:

The judicious use of decision models supplements intuition and implicit guides with explicit assumptions and criteria. If the decision can be depicted by a mathematical model, and if the model builder captures within this model the critical factors bearing on the decision, the resulting model is likely to lead to decisions that are more consistent with a firm's objectives.

The question this writer observes, however, is not whether the output of a decision model is a perfect answer to the operating manager. Rather it is whether such a model could provide a better

answer with consideration of costs and benefits analysis than would be achieved by alternative techniques.

The motivation to examine the role of accounting information in managerial decision models was inspired by the AAA 1968-1969 Committee report of Managerial Decision Models. It states, "Too often, decision model information is considered as being separate and distinct from management accounting information; each set of information may be accumulated and used without ever being viewed as interlocking subparts of a cohesive overall information system."6

Based upon this premise, the questionnaire's Section II states:

Please indicate (✓) the role of accounting information in each of the following decision models and management science techniques used by you and/or your associates. If you do not use any of these models or techniques, check 'Not Applicable'.

The decision models were identified, for the purpose of this study, as: inventory model; queuing model; multiple-regression model; mathematical programming: PERT and CPM; and discounted cash flow model.

Analysis of the results of the responses in this section involves two phases: (1) to determine the extent to which the decision models and techniques are used; and (2) to determine the roles of accounting system and of accountants in the decision models or techniques.

The Extent to Which the Decision Models and Techniques Are in Use

Inventory planning and control models are generally used. Inventory management problems exist because there are two dangerous

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6Ibid., p. 43.
points which the operating management wishes to avoid. On the one hand, there is a danger of inadequate inventories which disrupts production and, consequently, loses sales. On the other hand, there is an excessive inventory, which introduces unnecessary carrying costs and obsolescence risks. An inventory model abstracts the behavior of such a system in order to provide the operating manager an optimum inventory level that lies somewhere between the two extremes. In most cases, an inventory model identifies the timing and the size of inventory orders and provides a solution which will minimize the costs associated with administering the inventory.

Fifty-seven and two-tenths percent (79 firms) of a total of 138 useful responses indicate that inventory models are used. The estimated proportion for the 1000 largest industrial firms using inventory planning and control models ranges from 48.9% to 65.5% at the 95% statistical confidence interval. Since $H_0 \geq 50\%$, which falls within the interval, the hypothesis that at least 50% of the 1000 firms use the inventory models for inventory planning and control must be accepted.

**Queuing model is used by a few industrial firms.** A queuing model provides a supply of service facilities in order to satisfy random arrivals demanding these services. Since the quantity of units which will at any time be waiting in line (queue) for access to these services depends upon the number and type of service facilities established, it is apparent that an increase in the number of service facilities will decrease the average number of units in the queue. However, there are costs associated with provision of each additional service facility which must be weighed...
against the corresponding reduction in costs incurred when units reside in the queue.

The basic management problem is, therefore, the determination of the optimal number of service facilities which will minimize the sum of these costs. Probably because the firms under this survey are industrial firms, that is, more production oriented firms than services, a small percentage of the responses indicate that queuing models are used.

Seventeen and five-tenths percent (24 firms) of a total of 137 useful responses indicate that queuing models are used. The estimated proportion for the 1000 industrial firms using the queuing models ranges from 11.1% to 23.9% at the 95% statistical confidence interval. Since the hypothesis is stated at equal to or larger than 50%, which falls outside of the statistical interval, the hypothesis that at least 50% of the 1000 industrial firms use the queuing models must be rejected.

Multiple-regression analysis is not popularly used for predicting cost behaviors. Predictions of production cost behaviors under a variety of influences have an important bearing on managerial decision making. The operating managers and accountants often use linear functions to approximate the relationships of total cost to a given range of inputs or outputs. Professor Horngren cites two common assumptions which are widely used in the determination of cost functions. First, cost behavior can be sufficiently explained by one independent variable (that is, $Y = bX$, where $X$ is independent variable). Second, linear approximations to cost functions are
"good enough," even though nonlinear behavior is more likely.\(^7\)

The purpose of regression analysis is to assist the task of cost production, which in turn affects decision making. Though, in some cases, satisfactory predictions of a cost may be based upon only one variable, there are instances where accuracy can be significantly improved by basing the prediction on more than one independent variable. A multiple-regression analysis enables the operating managers and accountants to predict the amount by which the various cost causing factors affect costs.

Nevertheless, 28.8% (40 firms) of a total of 139 useful responses indicate that multiple-regression analysis is used. The estimated proportion for the 1000 industrial firms using multiple-regression analysis ranges from 21.3% to 36.3% at the 95% statistical confidence interval. Because the largest part of the interval is smaller than 50%, the hypothesis that at least 50% of the 1000 firms use multiple-regression analysis to determine cost behaviors must be rejected.

Mathematical programming techniques have not been popularly used. Mathematical programming techniques are primarily tools for planning rather than controlling; that is, they are a rigorous means for discovering feasible alternatives, evaluating them, and choosing the best alternative. Mathematical programming techniques include linear programming and dynamic programming.

Linear programming is an efficient search procedure for computing the best solution to certain business problems which

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contain many interacting variables and which essentially involve selecting the combination of resources which maximize profits or minimize costs. Dynamic programming is a technique for optimizing the overall effect of a time sequence of interrelated decisions by working backward from the last point to the first point in a complex network of decisions.

Examples of mathematical programming applications include determination of optimal product mixes, material mixes, machine and man power, materials, and equipment put to best advantage when many combinations are possible. The advent of modern computer technology makes mathematical programming more feasible.

Thirty-one and nine-tenths percent (44 firms) of a total of 138 useful replies indicate that mathematical programming techniques are used. The estimated proportion for the 1000 industrial firms using the mathematical programming techniques for their planning processes ranges from 24.1% to 39.7%. Since the largest percentage of the interval is smaller than 50%, the hypothesis that at least 50% of the 1000 industrial firms use mathematical programming techniques must be rejected.

**PERT and CPM network analyses are not generally used.** Program evaluation and review techniques (PERT), which is a product of the concept of system management, is a probabilistic diagram of the interrelationships of a complex time series of events. The events represent the beginning and/or ending of activities. After a flow of activities and events is mapped, schedule timing can be superimposed. When completion times are included on the activities, the critical path (that is, the longest time path) can be determined.
The objective of PERT and CPM network analyses is to discover potential bottlenecks and to chart progress. The network presents a clear picture of all the activities and events that must be accomplished before the end objective can be obtained.

As PERT and CPM have been popular in the defense contract firms and the construction industries, 36.5% (50 firms) of a total of 137 useful responses from the largest industrial firms indicate that network analysis is used. The estimated proportion for the 1000 large industrial firms using the network techniques ranges from 28.4% to 44.6% at the 95% statistical confidence interval. Since the largest end of the interval falls below 50%, the hypothesis that at least 50% of the 1000 largest industrial firms use PERT and CPM network analysis must be rejected.

Discounted cash flow model is generally used by the industrial firms. As an accrual accounting model maximizes net income based on the book value, a discounted cash flow model maximizes the net present value as its objective function. The former uses the realization principle and accrual concepts to generate accounting profit flows. Relevant inputs for the latter are cash flows and other factors related to changes in the firm's wealth. Although each of these two models must deal with uncertainty, each does so in different ways.

If management's broad objective is to increase value for the benefit of stockholders, and if management also sees reported growth in earnings per share as instrumental variable in achieving this objective, then a discounted cash flow model for investment decisions may not be particularly useful to management, since it
does not take into account the earnings the company reports to shareholders. This may in part explain the relatively slow acceptance of discounted cash flow models among the largest companies in this country.\footnote{E. M. Lerner and A. Rappaport, "Limit DCF in Capital Budgeting," \textit{Harvard Business Review}, XXXXVI (Sept.-Oct., 1968), pp. 133-139.}

Nevertheless, this study found that 55.1\% (75 firms) of a total of 136 useful responses indicate that a discounted cash flow model is used in making capital budgeting decisions. The estimated proportion for the 1000 largest industrial firms using a discounted cash flow model ranges from 46.7\% to 63.5\% at the 95\% statistical confidence interval. Because the hypothesis is stated either equal to or larger than 50\%, which falls within the interval, the hypothesis that at least 50\% of the 1000 largest industrial firms use discounted cash flow models must be accepted.

\textbf{Summary of the decision models and management science techniques in use.} The vastness and complexity of the entire managerial process precludes a complete takeover of managerial planning and controlling operating activities by the decision models and techniques. However, as shown in Exhibit 4-1, a low proportion of the 1000 industrial firms under this study use the managerial decision models and managerial techniques.

\textbf{The Roles of the Accounting System and of Accountants in the Managerial Decision Models and Techniques in Use}

Though the findings of the previous section offer no compelling empirical evidence to prove that at least 50\% of the 1000 largest industrial firms use the decision models and the managerial techniques,
## Exhibit 4-1

### Summary of the Managerial Decision Models and Techniques in Use

<table>
<thead>
<tr>
<th>Managerial Decision Models</th>
<th>Total Useful Responses</th>
<th>The model or technique is used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Firms</td>
<td>Percent</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-------</td>
<td>---------</td>
</tr>
<tr>
<td>Inventory model</td>
<td>138</td>
<td>100.0</td>
</tr>
<tr>
<td>Queuing model</td>
<td>137</td>
<td>100.0</td>
</tr>
<tr>
<td>Multiple-regression analysis</td>
<td>139</td>
<td>100.0</td>
</tr>
<tr>
<td>Mathematical programming techniques</td>
<td>138</td>
<td>100.0</td>
</tr>
<tr>
<td>PERT &amp; CPM feedback network</td>
<td>137</td>
<td>100.0</td>
</tr>
<tr>
<td>Discounted cash flow model</td>
<td>136</td>
<td>100.0</td>
</tr>
</tbody>
</table>
the situation does exist. The operating managers are using the managerial decision models and techniques to some extent. This author believes that as the usefulness of quantitative decision models becomes more understood by the operating managers, the more the decision models and techniques will be used, and the demand for information to implement the models will grow.

What types of information or data are required by decision models and techniques? What types of information should be considered as falling within the boundaries of the management accounting system? Examination of decision models reveals that there are generally four basic categories of information needed for the managerial decision models: (1) the decision variable or variables; (2) the environmental variable or variables; (3) the cost components; and (4) a performance evaluation system that is consistent with methodology used in the model or technique and feedback of the performance of the decision made.

To examine the role of the accounting system in providing information for the managerial decision models and techniques is to identify the relationship between the accounting system and the managerial decision models and techniques. This determines whether the information requirements or data inputs of the models can be provided by the managerial accounting system in that firm.

In a traditional role, the objective of the managerial accountant is to provide service and information for the operating managers, who use the powerful decision models or techniques available to carry out their planning and control functions. However, in a total system environment where the accounting system
has become one of the several information subsystems in a firm, accountants are not only the information providers, but they are also the information receivers from the other formal subsystems (both operating and informational) as discussed in Chapter 2. That is to say, the accountants should no longer be information processors in the traditional sense; rather they are members of the management team who participate in implementing the managerial decision models and techniques.

This section examines the role of the accounting system in the managerial decision models and techniques that are found in use in the previous section, and analyzes the role of the accountants in the implementation of the models and techniques.

The accounting system is the key information source for the inventory planning and control models. The decision variables in inventory models are the order quantity and the reorder point. The environmental variables include unit purchase costs of inventory, demand rate, and order lead time. The major independent cost components are carrying costs, ordering costs, shortage costs, and overstock costs.

Does an accounting subsystem provide the information requirements for the inventory models? Twenty and three-tenths percent (16 firms) indicate that accounting is not a key information source for the inventory model. Based upon this sample result, the estimated probability that the accounting system is not a key information source in the inventory model ranges from 11.4% to 29.2% at the 95% statistical confidence interval. Since the largest percentage of interval is smaller than 50%, the hypothesis
that at least 50% of the 1000 largest industrial firms in which
the accounting system plays no significant role must be rejected.
That is, the accounting system is the key information source for
the inventory model.

Does the accountant participate in implementing the inventory
model? Twenty-seven and eight-tenths percent (22 firms) of a total
of 79 firms using the inventory model indicate that the accountants
in their firms do not participate in implementing the inventory
model. The estimated probability for the accountants not participating
in implementing the inventory model ranges from 17.9% to 37.7%
if and when the model is used. Since the largest percentage of
the interval is smaller than 50%, the hypothesis that at least
50% of the accountants in the 1000 large industrial firms do not
participate in the inventory model implementation must be rejected.
That is, the accountants participate in the implementation of the
inventory planning and control in at least 50% of the 1000 large
industrial firms.

The accounting system is not the key information source for
the queuing model. The single decision variable for a queuing
model is the quantity of services or number of service facilities.
The environmental variables are the rate of demand for the services
provided and the service rate of each service facility. In most
practical situations, analytical solution of the arrival pattern
is generally not feasible, and recourse must often be made to the
Monte Carlo Simulation technique.\(^9\)

\(^9\)Miller and Starr, Executive Decisions and Operations Research
Cost components for the queuing model are the operating costs, including both monetary costs (i.e., labor and other direct expenses) and opportunity costs (i.e., the implicit interest on funds invested in the existing facilities), standby facility costs (i.e., cost incurred to maintain and occasionally implement the capability for expanding the quantity of service available), and waiting costs (i.e., cost incurred whenever the source facility is not immediately able to satisfy demands for the services). One of the ingredients of the decision is the computation of the waiting time costs. Although the cost of operating extra facilities may be obtained from the traditional accounting system, the cost of waiting may not be so easy to obtain from it.

Because data inputs for a queuing model, such as payroll records, materials, used costs records equipment schedule, may be extracted from the traditional accounting systems, the required information for the basic environmental variables (i.e., rate of demand for the services provided, the service rate of each service facility) are not found in a traditional cost system, and probably never will be. This can be reflected in the survey in this study.

Eighty percent (20 firms) of a total of 24 using the queuing model indicate that the accounting system is not the key information source for the model. If and when the queuing model is used, the probability that the accounting system is not a key information source ranges from 68.4% to 98.2% at the 95% statistical confidence interval. The hypothesis that at least 50% of the 1000 industrial firms in which queuing models are used, the accounting system is not the key information source for the model must be accepted.
Eighty-three and three-tenths percent of a total 24 firms using the queuing model indicate that the accountant does not participate in the implementation of the model. The probability for the accountants participating in the implementation of the queuing model when it is used ranges from 68.4% to 98.2% at the 95% statistical confidence interval. The hypothesis that the accountants do not participate in the queuing model in at least 50% of the 1000 largest industrial firms must be accepted.

The accounting system is not the key information source for multiple-regression analysis. The decision variable in a multiple-regression analysis is the determination of the cost behaviors. The environmental variables are the independent variables, such as labor productivity, labor costs, new or old machine, weather conditions, and so on. The decision variable and the environmental variables must be closed within a relevant range of activity where the relationship among the variables can be validly expressed. The cost components include fixed costs, variable costs, and semivariable costs.

Use of the multiple-regression model or analysis requires several input data which depend upon the cost accounting records of the firm. That is, the initial accounting data must be carefully coded and recorded if the output of the regression model will be meaningful.

While the accountant might not be expected to determine the cost functions, the accounting system should be able to offer the classification of the cost components with a specified range of time to the cost analyst, who examines the accounting records as
the first step of the regression analysis.

Nevertheless, 55% (22 firms) of a total of 40 firms using the multiple-regression analysis indicate that the accounting system is not the key information source for the multiple-regression model. Based upon the sample result, the probability for the accounting system as a key information source ranges from 39.6% to 70.4% at the 95% statistical confidence interval. Since the null hypothesis is stated $\geq 50\%$, the hypothesis that at least 50% of the 1000 industrial firms in which the accounting system plays no significant role in multiple-regression analysis must be accepted.

Meanwhile, 70% (28 firms) state that the accountants do not have any role in implementation of the multiple-regression model. If multiple-regression analysis is used, the probability for the accountants to participate in the implementation ranges from 55.8% to 84.2% at the 95% statistical confidence interval. Since the lowest percentage of the interval is larger than 50%, the hypothesis that accountants do not have significant roles in the implementation of the multiple-regression model in at least 50% of the 1000 largest industrial firms must be accepted.

The accounting system is not the key information source for mathematical programming techniques. The decision variable or variables for mathematical programming techniques depends upon the objective or goal of a decision maker. In cases of linear programming, for instance, the decision variable is the objective function, which in a specific case may be one of a number of possibilities: sales maximization, minimization of labor or machine idle time, and so on. The environmental variables, as in
the case of linear programming, are the constraints and resources. The relationships among the constraints must be determined before any available feasible alternatives can be identified and the optimum solution computed.

Since the objective function of mathematical programming is not limited in the financial planning areas, the cost components for the programming techniques depend upon the objective function, the decision variable.

Are the accounting system and the accountants able to help in specifying the objective, the constraints, and other variables for mathematical programming techniques? Fifty-four and five-tenths percent (24 firms) of a total of 44 firms using mathematical programming techniques for planning processes indicate that accounting is not the key information source for mathematical programming techniques. The probability that the accounting system is not a key information source when the mathematical programming techniques are used ranges from 39.8% to 69.2% at the 95% statistical confidence interval. Since the hypothesis is stated as equal to or larger than 50%, which falls within the confidence interval, the hypothesis that the accounting system is not the key information source for mathematical programming techniques must be accepted.

Sixty-three and six-tenths percent (28 firms) of a total of 44 firms using the techniques indicate that the accountants do not participate in implementing the mathematical programming analysis. The estimated probability for the accountants not participating in implementation of the techniques ranges from 49.4% to 77.8% at the 95% statistical confidence interval. The hypothesis that
accountants do not participate in implementing the mathematical techniques in at least 50% of the 1000 largest industrial firms must be accepted.

The accounting system is not the key information source for PERT and CPM network analyses. An operating project manager is often faced with a two-fold job: he is responsible for the financial planning and control of his firm's resources, and at the same time he is committed to delivery of the products with a minimum of cost to the customers. Where the PERT network technique is used, the decision variable of the network analysis is the optimum mix of time and costs. The environmental variables are the resources of time, the labor skills, the labor productivity. The cost components are the costs (materials, labor, and overhead charges) assigned to the operating project manager as his working levels in the detail needed for planning and evaluation.

In the network analysis, the focal point of the cost accumulation is on the project work package rather than on the department; and the costs are activity oriented rather than oriented toward the traditional accounting period. Theoretically, the accountant should be able to use the flexible budget and the expense forecasts as the tools for financial planning and control in the project or activities.

Is the accounting system the key information source for all levels of the activities in the project? Fifty-eight percent (29 firms) of a total of 50 firms using the network analysis state that the accounting system is not the key information source for the PERT and CPM. The estimated probability that the accounting system
is not a key information source when the network analysis is used ranges from 44.3% to 71.7% at the 95% statistical confidence interval. The hypothesis that the accounting system is not the key information source for the PERT and CPM in at least 50% of the 1000 largest industrial firms must be accepted.

Do the accountants participate in the network analysis? Sixty-six percent (33 firms) indicate a negative answer. The estimated probability that the accountants do not participate in the network analysis ranges from 52.9% to 79.1% at the 95% statistical confidence interval. Since the lowest percentage of the interval is larger than 50%, the hypothesis that accountants do not participate in implementation of the PERT and CPM in at least 50% of the 1000 industrial firms must be accepted.

The accounting system is the key information source for discounted cash flow model. The decision variable of a discounted cash flow model to maximize the current monetary value of internal investments where that present value is the sum of all expected cash flows associated with the investments, discounted to the present. Nonmonetary objectives are not explicitly included in the model. The important environmental variables are the potential cash flows and the structure of interest rates confronting the firm.

The information requirements for a discounted cash flow model are the identification of the decision variables: the evaluation leading to a decision whether the asset should be acquired; the accumulation of costs identified with the asset as it is acquired or constructed; and the evaluation of the performance of the investment after it begins operations.
In identifying the decision variables, the feasible investment alternatives, the accounting system could play an important role by identifying the areas and types of investment which are presently producing high returns.

After potential investments are identified, the net present value is then computed. Future cash flows from operations are primary inputs into the present value calculations. The accounting system should be able to supply the historical record of the past performance which can then be the basis for a predicting process, though the accounting system could not directly supply the necessary information.

If the investment is accepted and the asset acquisition occurs, the accounting system acts as an accumulator of information and then reports the results of the economic activity in the form of a comparison of actual and budgeted costs. Although the traditional accounting system is able to report the cost of the capital investment if the funds have been obtained using debt type securities, the principle of opportunity cost is not widely recognized by a traditional accounting system.

Nevertheless, 21.3% (16 firms) of a total of 75 firms using the discounted cash flow model for capital investment decision making indicate that the accounting system is not the key information source. The estimated probability that the accounting system is not the key information source for the capital budgeting decision model ranges from 12.0% to 30.6% at the 95% statistical confidence interval. The hypothesis that the accounting system is not the key information source for the discounted cash flow model in at least 50% of the
1000 largest industrial firms must be rejected.

Twenty percent (15 firms) of a total of 75 firms using the model indicate that the accountants participate in implementation of the discounted cash flow model. The estimated probability that the accountants do not participate in the implementation of the discounted cash flow model ranges from 10.9% to 29.1% at the 95% statistical confidence interval. The hypothesis that the accountants do not participate in implementation of the discounted cash flow model in at least 50% of the 1000 industrial firms must be rejected.

Summary of the roles of the accounting system and of accountants in the managerial decision models and techniques. There is no significant empirical evidence that the currently available powerful decision models or techniques are widely used. As shown in Exhibit 4-2, the accounting system is not the key information source for the managerial decision models, except inventory model and the discounted cash flow model, and accountants do not participate in implementation of these models and techniques.

An interesting correlation exists between the accounting system as a key information source for the models and the accountants as the participants in the models. The higher the percentage that the accounting system is the key information source for the model, the more the accountant participates in the implementation of the model or technique. This suggests that if the accountant is to participate in any decision making role, the prerequisite is that he must design an accounting system which is capable of providing relevant information for the managerial decision model and management techniques.
### Exhibit 4-2 (A)

The Role of the Accounting System in the Managerial Decision Models in Use

<table>
<thead>
<tr>
<th>Managerial Decision Models and Techniques</th>
<th>Total firms using the model</th>
<th>Accounting System is the key information source</th>
<th>Accounting System is not the key information source for the model</th>
<th>Estimated probability that accounting is not key information source for the 1000 firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total firms</td>
<td>Firms</td>
<td>Percent of total firms using model</td>
<td>Firms</td>
</tr>
<tr>
<td>Inventory model</td>
<td>79</td>
<td>63</td>
<td>79.7%</td>
<td>16</td>
</tr>
<tr>
<td>Queuing model</td>
<td>24</td>
<td>4</td>
<td>16.7%</td>
<td>20</td>
</tr>
<tr>
<td>Multiple-regression analysis</td>
<td>40</td>
<td>18</td>
<td>45.0%</td>
<td>22</td>
</tr>
<tr>
<td>Mathematical programming techniques</td>
<td>44</td>
<td>20</td>
<td>45.5%</td>
<td>24</td>
</tr>
<tr>
<td>PERT &amp; CPM network analysis</td>
<td>50</td>
<td>21</td>
<td>42.0%</td>
<td>29</td>
</tr>
<tr>
<td>Discounted cash flow model</td>
<td>75</td>
<td>59</td>
<td>78.7%</td>
<td>16</td>
</tr>
</tbody>
</table>
### Exhibit 4-2 (B)

The Roles of the Accountants' Participation in the Managerial Decision Models in Use

<table>
<thead>
<tr>
<th>Managerial Decision Models and Techniques</th>
<th>Total firms using the model</th>
<th>Accountants participate in implementation of model</th>
<th>Accountants do not participate in implementation of the model</th>
<th>Estimated probability for accountants not participating in model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Firms</td>
<td>Percent of total firms using model</td>
<td>Firms</td>
<td>Percent of total firms using model</td>
</tr>
<tr>
<td>Inventory model</td>
<td>79</td>
<td>57</td>
<td>72.2</td>
<td>22</td>
</tr>
<tr>
<td>Queuing model</td>
<td>24</td>
<td>4</td>
<td>16.7</td>
<td>20</td>
</tr>
<tr>
<td>Multiple-regression analysis</td>
<td>40</td>
<td>12</td>
<td>30.0</td>
<td>28</td>
</tr>
<tr>
<td>Mathematical programming techniques</td>
<td>44</td>
<td>16</td>
<td>36.4</td>
<td>28</td>
</tr>
<tr>
<td>PERT &amp; CPM network analysis</td>
<td>50</td>
<td>17</td>
<td>34.0</td>
<td>33</td>
</tr>
<tr>
<td>Discounted cash flow model</td>
<td>75</td>
<td>60</td>
<td>80.0</td>
<td>15</td>
</tr>
</tbody>
</table>
Summary and Conclusions

Based upon the findings of this Chapter and the 95% statistical confidence interval which is used to estimate the proportion of the 1000 largest industrial firms, the hypotheses that there are at least 50% of the 1000 industrial firms in which (1) the operating departments participate in the firm's central system must be accepted; and (2) the routine operating decisions are made by the system also must be accepted.

Where the operating routine decisions are made by the system, a high percentage of firms indicate that the operating managers have the ability to modify the decision processes that have already been in the system.

However, the use of the current available powerful managerial decision models and the management science techniques in dealing with the managerial planning and controlling activities are slow, as shown in Exhibit 4-1 (p. 85). The hypothesis that at least 50% of the 1000 industrial firms use the identified decision models and techniques, except for the inventory model for inventory planning and control and the discounted cash flow model for capital investment decisions, generally must be rejected.

Even though a small proportion of the 1000 firms uses the decisions models and techniques, evidence exists that the accounting system and the accountants play no significant roles in the managerial decision models and management techniques. The hypothesis that the accounting system is not the key information source and accountants do not participate in implementing the managerial decision models and techniques where the decision models and techniques are used
At this point, several questions arise. Where the integration of the operating and the information subsystems seem to have taken place in at least 50% of the 1000 largest industrial firms, and the accounting system is no longer the key information source for the managerial decision models and management techniques, as found in this Chapter, what is the exact role of the managerial accountants in the large industrial firms? Do the accountants design and improve the firms' information systems? And, finally, who is in charge of the firm's total system? The answers to these questions and others are found in the following chapter.
Chapter 5

THE SPECIFIC ROLES OF THE ACCOUNTANTS
IN THE MODERN INFORMATION SYSTEM ENVIRONMENT

Introduction

Thus far, as found in the previous chapters, the financial data and information processing activities have been transferred out of the accounting department in at least 50% of the 1000 largest industrial firms. There has been no compelling empirical evidence to prove that the modern decision models and techniques have been widely used, nor has the accounting system been the key information source for the decision models and techniques.

The purpose of this Chapter is to ask the following questions:

1. Does the accounting department maintain the centralized data base?

2. Has the accountant's expertise in data classification influenced the formalization of the other formal information and operating subsystem's design?

3. Does the accountant play a role in designing and preparing the management control systems?

4. Is the person in charge of the firm's overall information system an accountant by training?

In light of these questions, the hypothesis is stated that there is at least 50% of the 1000 industrial firms in which:

1. A centralized data base is established.
2. The accounting department or the controller's office does not maintain the centralized data base.

3. The information subsystems and the operating subsystems are formalized.

4. The accountants have no influence on the formalization of the other information and operating subsystems.

5. The advanced management control systems are established.

6. The accountants do not design and prepare the management control systems.

7. There is a firm's management information system.

8. The accountant does not direct the firm's management information system.

The Centralized Data Base and the Accounting Department

One of the direct results of modern information technology has been a centralized data base from which a user has rapid access to the facts that interest him. As discussed in Chapter 2, there are numerous advantages to a corporate-wide centralized data base. One is the minimization, if not elimination, of duplication that might be present when different managerial groups use separate aspects of the same resource and each maintains its own information system. Another result is the ready availability and the ability to pull together and integrate related data from various applications as the need arises.

There is a centralized data base in the large industrial firms. The findings of this section reveal that 68.8% (97 firms) of a total of 141 useful replies indicate that there is a centralized data base in their firms. The estimated proportion for the 1000 largest
industrial firms having the centralized data base ranges from 61.2% to 76.4% at the 95% statistical confidence interval. The hypothesis that there is at least 50% of the 1000 largest industrial firms in which a centralized data base must be accepted.

The accounting department maintains the centralized data base. Only 28.9% (28 firms) of a total of 97 firms having the centralized data base indicate that the accounting department does not maintain the centralized data base. The estimated probability for the 1000 industrial firms in which the accounting department does not maintain the centralized data base ranges from 19.9% to 37.9%. The hypothesis that there is at least 50% of the 1000 largest industrial firms in which the accounting department does not maintain the centralized data base must be rejected.

The Influence of the Accountants on the Formalization of the Information and the Operating Subsystems

The firm's centralized data base present challenges to the information system designer. The first is the level of detail in the data base. The second is for the report generation capability to aggregate detail into meaningful and relevant reports tailored into the users and/or decision models needs.

Since the accountant has a traditional expertise in the areas of data classification, summarization and reporting, has he extended the expertise to the other information and the operating subsystem design? With this question in mind, the following appears

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1Detailed computations of the statistical confidence level and the test of the hypothesis for this section and the remaining sections of this chapter are attached in the Appendix.
In the design of a data base from which meaningful management information can be obtained, three activities are of very great importance. They are: (1) Deciding upon a data classification structure. Unless the structure is sound, data will lose its identity and cannot be converted into meaningful information. The main manifestation of this function is in the preparation of code structures governing the classification of accounts, personnel, inventory, and other items. (2) Selecting a proper level of aggregation. If data are kept separate by event, the resultant mass precludes interpretation. On the other hand, over-summarization by aggregating data makes it impossible to see characteristics. (3) Integration. Data will flow into the system from many points: finance, production, personnel, and so on. Production of meaningful management information makes it essential that data from these sources are brought together in a meaningful manner.

The persons who make decisions on classification, aggregation govern the conceptual framework of the information system and its value. Do the accountants influence the characteristics of data classification, aggregation, and integration in any of the following data areas?

There are two phases involved in analyzing the results of the questionnaire. The first phase is to determine the extent to which the information subsystems and the operating subsystems have been formalized; the second is to determine if the accountant influences these subsystem designs.

Formalization of the information subsystems and the operating subsystems has taken place. As shown in Exhibit 5-1, a very high percentage of the firms have the information subsystems, such as finance, and personnel; and the operating subsystems, such as production, and marketing.

Ninety-six and nine-tenths percent (126 firms) of 130 useful responses indicate that the financial information subsystem has been formalized in their firms. The estimated proportion for the 1000 industrial firms formalizing financial information systems ranges from 93.9% to 99.9% at the 95% statistical confidence interval.
### Exhibit 5-1

**Formalization of Information and Operating Subsystems**

**in the Large Industrial Firms**

<table>
<thead>
<tr>
<th>Do Accts Influ­ence?</th>
<th>Financial Subsystem</th>
<th>Estimated proportion for the 1000 industrial firms</th>
<th>Production Subsystem</th>
<th>Estimated proportion for the 1000 industrial firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Firms</td>
<td>Percent of total useful replies</td>
<td></td>
<td>Firms</td>
</tr>
<tr>
<td>yes</td>
<td>126</td>
<td>96.9</td>
<td>93.9 - 99.9%</td>
<td>118</td>
</tr>
<tr>
<td>no</td>
<td>4</td>
<td>3.1</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>total useful responses</td>
<td>130</td>
<td>100.0</td>
<td>-</td>
<td>122</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Marketing Subsystem</th>
<th>Estimated proportion for the 1000 industrial firms</th>
<th>Personnel Subsystem</th>
<th>Estimated proportion for the 1000 industrial firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Firms</td>
<td>Percent of total useful replies</td>
<td></td>
<td>Firms</td>
</tr>
<tr>
<td>yes</td>
<td>116</td>
<td>95.9</td>
<td>92.4 - 99.4%</td>
<td>111</td>
</tr>
<tr>
<td>no</td>
<td>5</td>
<td>4.1</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>total useful responses</td>
<td>121</td>
<td>100.0</td>
<td>-</td>
<td>121</td>
</tr>
</tbody>
</table>
Ninety-five and nine-tenths percent (116 firms) of 121 useful responses indicate the formalization of the marketing operating subsystems in their firms. The estimated proportion for the 1000 industrial firms formalizing the marketing operating subsystem ranges from 92.4% to 99.4% at the 95% statistical confidence interval.

Ninety-one and seven-tenths percent (111 firms) of a total of 121 useful replies indicate that the personnel information subsystem has been formalized. The estimated proportion for the 1000 industrial firms formalizing the personnel information subsystem ranges from 86.8% to 96.6% at the 95% statistical confidence interval.

Since the lowest range of the proportion 86.8% is beyond 50%, the hypothesis that in at least 50% of the 1000 largest industrial firms the information and the operating subsystems have been formalized must be accepted.

If the formalization of the information and the operating subsystems has taken place, as it has been proved, then has the accountant had any influence on the characteristics of the subsystem design?

The accountants influence the formalization of the information and operating subsystems. Three and two-tenths percent (4 firms) of a total of 126 firms formalizing the financial information subsystem indicate that the accountant has no influence on the subsystem design. The estimated proportion for the 1000 firms in which the accountant does not influence the financial information subsystem design ranges from .01% to 6.3% at the 95% statistical confidence interval. That is, the accountant significantly influences the financial information design.
Eighteen and six-tenths percent (22 firms) of a total of 110 firms formalizing the production operating subsystem indicate that the accountant has no influence on the production subsystem design. The estimated proportion for the 1000 firms in which the accountant does not influence the production operating subsystem design ranges from 11.6% to 25.6% at the 95% statistical confidence interval. That is, the accountant influences the production subsystem design.

Twenty-five percent (29 firms) of a total of 116 firms formalizing the marketing operating information subsystem indicate that the accountant has no influence on the subsystem design. The estimated proportion for the 1000 industrial firms in which the accountant does not influence the marketing operating subsystem design ranges from 17.1% to 32.9% at the 95% statistical confidence interval.

Thirty-two and four-tenths percent (36 firms) of a total of 111 firms having the personnel information subsystem indicate that the accountant has no influence on the subsystem design. The estimated proportion for the 1000 industrial firms formalizing the personnel information subsystem in which the accountant has no influence ranges from 23.7% to 41.1% at the 95% statistical confidence interval.

Since the highest range of the foregoing intervals is smaller than the 50%, as illustrated in Exhibit 5-2, the hypothesis that there is at least 50% of the 1000 industrial firms in which the accountants do not influence the formalization of the information and other subsystems must be rejected.
Exhibit 5-2

The Influences of the Accountants on the Characteristics of the Various Subsystem Design

<table>
<thead>
<tr>
<th>Do Accountants have Influences on the Subsystem Design?</th>
<th>Financial Subsystem</th>
<th>Production Subsystem</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent of total firms having the subsystem</td>
<td>Estimated proportion for the 1000 industrial firms</td>
</tr>
<tr>
<td>yes</td>
<td>122 96.8</td>
<td>-</td>
</tr>
<tr>
<td>no</td>
<td>4 3.2</td>
<td>.01 - 6.3%</td>
</tr>
<tr>
<td>total firms having subsystem</td>
<td>126 100.0</td>
<td></td>
</tr>
</tbody>
</table>
Exhibit 5-2 (cont’d.)

The Influences of the Accountants on the Characteristics of the Various Subsystem Design

<table>
<thead>
<tr>
<th>Do Accountants have Influences on the Subsystem Design?</th>
<th>Marketing Subsystem</th>
<th>Personnel Subsystem</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent of total firms having the subsystem</td>
<td>Estimated proportion for the 1000 industrial firms</td>
</tr>
<tr>
<td>yes</td>
<td>87</td>
<td>75.0</td>
</tr>
<tr>
<td>no</td>
<td>29</td>
<td>25.0</td>
</tr>
<tr>
<td>total firms having subsystem</td>
<td>116</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Uses of the Management Control Systems--The Sensor Elements in the Total System

Professor R. N. Anthony defines management control as "the process by which the manager assures that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objective." A management control system is a sensor element in a total system, and with rare exceptions, it is built around a financial structure. That is, inputs and outputs for control purposes are expressed in monetary terms, though some non-financial measures, such as direct labor hours, material quality, and reject rate for the finished goods are also important parts of the systems. In typical industrial firms where management control is expressed in various responsibility centers, inputs for the control systems are heterogeneous mixtures of resources. The degree to which outputs and inputs can be measured quantitatively varies greatly in different responsibility centers. When the outputs are services or other intangibles, the problem of measuring them becomes formidable, as in the case of research and development costs appropriated to the discretionary center.

While the formalization of the information and the operating subsystems is one of the essential developments in the modern information system environment, the AAA 1970-1971 Committee on Accounting and Information Systems states:

Control is also being effected by the information systems' growth capabilities for (a) the collection and retention of large amounts of data in relatively great detail and (b) the collection and availability of almost instantaneous information.

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The first factor makes possible the centralization of routine structured decisions and the decentralization of the non-routine unstructured ones—even more decentralization than was feasible heretofore because of the detailed controls applied on a timely basis to prevent poor decisions from getting out of hand .... The second factor is producing a new type of control policy.³

Leavitt and Whisler predicted in 1958 that there would be a movement toward recentralization, made possible by the new information technology by 1980:

One important reason for expecting fast changes in current practices is that information technology will make centralization much easier .... It will allow the top level of management intelligently to categorize, digest, and act on a wider range of problems .... In addition, more efficient information processing techniques can be expected to shorten radically the feedback loop that tests the accuracy of original observations and decisions.⁴

The first part of this section tests empirically the validity of the prediction that the advancement of modern information processing technology would have caused recentralization. The focal point of the testing is on the establishment of the responsibility centers; namely, cost center, profit center, discretionary expense center, and investment center, because these forms of organization represent the detailed degree of decentralization in a large industrial firm. Modern information processing technology and data communicating system equipment have permitted many corporations to begin the use of the real-time on-line system. Real-time monitoring performance reporting, on-line feedback control network, and the rules for allocating man and machine tasks were asked in the questionnaire.

This is an attempt to inquire into the extent to which modern information processing techniques that may have been used to test and feed back the accuracy of original decisions in the shortest time lapse.

Cost center performance reporting is widely in use. Cost center performance reporting is a device for the accumulation of costs to be charged to products or services. Ninety-seven and one-tenth percent (134 firms) of a total of 138 useful replies indicate that cost center performance reporting is being used. The estimated proportion for the 1000 largest industrial firms using the cost center performance reporting ranges from 94.3% to 99.9% at the 95% statistical confidence interval.

Profit center performance reporting is widely in use. Profit center organization delegates the independent profit generating responsibilities. It does not originate from the complexity or the size of the firm. A profit center system is appropriate where a firm can be more logically broken down by type of business, such as divisions, than by type of activity, such as production or marketing. In the profit center setting, the manager in charge of the center is a professional in the particular type of business.

Ninety-five and seven-tenths percent (133 firms) of a total of 139 useful responses state that the profit center performance reporting is being used. The estimated proportion using profit center performance reporting in the 1000 largest industrial firms ranges from 92.3% to 98.2% at the 95% statistical confidence interval.

Discretionary expense center performance reporting is widely
used. The inputs for the discretionary expense center are measured in monetary terms, but no attempt has been made to measure the output in monetary terms or to relate the output and the input in monetary units due to the measuring difficulty as previously mentioned. In most large firms, the discretionary expenses or costs include costs of all general and administrative functions, and a great many items of factory overhead. In the absence of an acceptable standard, the amount to be spent must be a matter of judgment. A great deal of work has already been done on techniques for the control of engineered costs, such as the use of standard costs, time studies, and analysis of bills of materials.

Ninety-two and seven-tenths percent (127 firms) of a total of 137 useful replies indicate that discretionary expense center performance reporting is used. The estimated proportion for the 1000 firms using discretionary expense center performance reporting ranges from 88.3% to 97.1% at the 95% statistical confidence interval.

**Investment center performance reporting is moderately used.** The investment center is an extension of the management control system concept. Where the investment center is used, the center manager is responsible not only for profit but also for the capital assets that the center uses. That is, profit is related to assets employed.

Eighty-one and five-tenths percent (110 firms) of a total of 135 responses indicate that investment center performance reporting is used. The estimated proportion for the 1000 industrial firms using the investment center performance reporting ranges
from 74.9% to 88.1% at the 95% statistical confidence interval.

Real-time performance monitoring reporting is not commonly in use. As stated in Chapter 2, the major purpose of using a real-time system in a firm is for its management control functions—measurement, situation analysis, corrective action. Though the critical time cycle for management control varies greatly depending upon what is to be accomplished, shortening the management control cycle permits substantial economic benefits to be realized.

Thirty-four and six-tenths percent (45 firms) of a total of 130 useful replies indicate that real-time monitoring performance reporting is used. The estimated proportion for the 1000 industrial firms using real-time performance monitoring reporting ranges from 26.4% to 42.8% at the 95% statistical confidence interval.

The on-line feedback control network is not popularly in use. The on-line feedback control network refers to a complete network of information flow mechanically which would perform accumulating, recording, updating, summarizing and reporting without continued physical surveillance. With real-time technology in use, there will be fast response on-line computer processing, which obtains data from an activity or process, performs computations, and returns a response rapidly enough to control, direct or even influence the outcome of the activity or process.

But only 34.4% (45 firms) of a total of 131 firms responses indicate that on-line feedback control network is used. The estimated proportion for the 1000 industrial firms using on-line feedback control network ranges from 26.3% to 42.5% at the 95% statistical confidence interval.
The rules for allocating man and computer tasks have been significantly established. As indicated earlier, the crucial point to the success of the computer-based information system is the management's prompt response to the computer. Rules allocating the tasks between the man and the computer are needed for a large scale computer-based managerial information system.

Fifty-seven and seven-tenths (71 firms) of a total of 123 useful responses indicate that rules for allocating tasks between man and computer are being used in their firms. The estimated proportion for the 1000 industrial firms having rules for allocating tasks between man and computer ranges from 49.0% to 66.4% at the 95% statistical confidence interval.

Summary of the management control systems in use. As shown in Exhibit 5-3, a high percentage of the firms indicate that the management control systems, except in the areas of real-time monitoring performance reporting and on-line feedback control network, are widely in use. The hypothesis that in at least 50% of the 1000 industrial firms the management control systems, except those mentioned above, have been established must be accepted.

The Roles of the Accountants in Designing and Preparing the Management Control Systems

Though a management control system is a sensor element in the total system, its focal point is on the operating manager. He is the person whose judgment is incorporated in the approved plan, who executes the plan, and whose performance is measured. The information needed for the control systems is financially oriented and more internal and historical. The inputs and outputs
Exhibit 5-3

The Uses of the Management Control Systems
in the Large Industrial Firms

<table>
<thead>
<tr>
<th>Management Control Systems</th>
<th>Total Useful Replies</th>
<th>The control system is not used</th>
<th>The control system is used</th>
<th>Estimated proportion for the 1000 industrial firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Percent of total firms</td>
<td>Percent of total useful replies</td>
<td>Percent of total useful replies</td>
</tr>
<tr>
<td>Cost center performance reporting</td>
<td>138</td>
<td>4</td>
<td>2.9</td>
<td>134</td>
</tr>
<tr>
<td>Profit center performance reporting</td>
<td>139</td>
<td>6</td>
<td>4.3</td>
<td>133</td>
</tr>
<tr>
<td>Discretionary expense center performance reporting</td>
<td>137</td>
<td>10</td>
<td>7.3</td>
<td>127</td>
</tr>
<tr>
<td>Investment center performance reporting</td>
<td>135</td>
<td>25</td>
<td>18.5</td>
<td>110</td>
</tr>
<tr>
<td>Real-time monitoring perform. reporting</td>
<td>130</td>
<td>85</td>
<td>65.4</td>
<td>45</td>
</tr>
<tr>
<td>On-line feedback control network</td>
<td>131</td>
<td>86</td>
<td>65.6</td>
<td>45</td>
</tr>
<tr>
<td>Rules for allocating man/computer tasks</td>
<td>123</td>
<td>52</td>
<td>42.3</td>
<td>71</td>
</tr>
</tbody>
</table>
are collected, measured, classified, summarized, and presented by the information processors (staff), who make calculations and translate the operating manager's judgment into a quantitative format in the system.

Accounting has traditionally been considered as more a control oriented system than a planning one. Has the accountant's expertise in the control functions been changed as the result of more advanced controlling concepts in use?

Cost center performance reporting is designed and prepared by the accountant. Six percent (8 firms) of a total of 134 firms having the cost center performance reporting system indicate that the accountant does not design the cost center performance report. The estimated probability for the 1000 industrial firms in which the accountant does not design the cost center performance reporting ranges from 2% to 10% at the 95% statistical confidence interval. That is, the accountant does design cost center performance reporting.

Ten and nine-tenths percent (14 firms) out of a total of 128 useful replies indicate that the accountant does not prepare the performance report. The estimated proportion for the 1000 industrial firms not having the cost center performance reporting prepared by the accountant ranges from 5.5% to 16.3% at the 95% statistical confidence interval. That is, the performance reporting is prepared by the accountant.

Profit center performance reporting is designed and prepared by the accountant. Four and five-tenths percent (6 firms) of a total of 133 firms having profit center performance reporting state that the accountant does not design the profit center performance report.
The estimated proportion for the 1000 industrial firms in which the accountant does not design the performance reporting ranges from 1% to 8% at the 95% statistical confidence interval.

Does the accountant prepare the profit center performance reporting? Six and five-tenths percent (8 firms) of a total of 124 firms indicate a negative answer. The estimated proportion for the 1000 industrial firms in which the accountant does not prepare the performance report ranges from 2.5% to 10.5% at the 95% statistical confidence interval.

Discretionary expense center performance reporting is designed and prepared by the accountant. Only 11% (14 firms) of a total of 127 firms using the discretionary expense center performance reporting indicate that the performance report is not designed by the accountant in their firms. The estimated proportion for the 1000 industrial firms in which accountants do not design the performance report ranges from 5.6% to 16.4% at the 95% statistical confidence interval.

Thirteen and three-tenths percent (16 firms) of a total 120 firms indicate that the accountant does not prepare the discretionary expense center performance report. The estimated proportion for the 1000 industrial firms not having the accountant prepared the reporting ranges from 7.3% to 19.3% at the 95% statistical confidence interval.

Investment center performance reporting is designed and prepared by the accountant. Fifteen and five-tenths percent (17 firms) of a total of 110 firms having the investment center performance reporting indicate that the accountant does not design
the performance reporting. The estimated proportion for the 1000 industrial firms in which the accountant does not design the investment center performance report ranges from 8.5% to 22.5% at the 95% statistical confidence interval.

Twelve and six-tenths percent (13 firms) of a total of 103 useful responses indicate that the accountant does not prepare the performance reporting. The estimated proportion for the 1000 industrial firms in which the accountant does not prepare the performance report ranges from 6.6% to 18.6% at the 95% statistical confidence interval.

Real-time performance monitoring report is neither designed or prepared by the accountant. Of a total of 45 firms using real-time monitoring performance reporting, 60% (27 firms) indicate that the accountant does not design the real-time performance monitoring report. The estimated proportion for the 1000 industrial firms in which the accountant does not design the real-time monitoring performance report ranges from 45.7% to 74.3% if and when performance reporting is used.

Sixty and five-tenths percent (26 firms) of a total of 43 responses indicate that the accountant does not prepare the report. If and when performance reporting is used, the probability that the accountant does not prepare the real-time monitoring performance report ranges from 45.9% to 75.1% at the 95% statistical confidence interval.

On-line feedback control network is not designed and prepared by the accountant. Sixty-four and four-tenths percent (29 firms) of a total of 45 replies indicate that the accountant does not
design the on-line feedback control network. If and when the control network is used, the probability that the accountant does not design the 1000 industrial firms ranges from 50.4% to 78.4% at the 95% statistical confidence interval.

Sixty-seven and five-tenths percent (27 firms) of a total of 40 replies indicate that the accountant does not prepare the feedback control network. The probability that the accountant does not prepare the feedback control network ranges from 53.0% to 82.0% at the 95% statistical confidence interval, if and when the feedback control network is used in the 1000 industrial firms.

The rules for allocating man and computer tasks are not designed and prepared by accountant. Fifty-four and nine-tenths percent (39 firms) of a total of 71 firms establishing the rules indicate that the accountant does not design the rules. The estimated proportion for the 1000 industrial firms in which accountant does not design the rules of man and computer interfacial operations ranges from 43.3% to 66.5% at the 95% statistical confidence interval.

That the accountant does not prepare the rules for allocating the tasks between man and computer is indicated by 58.7% (37 firms) out of a total of 63 replies. The estimated proportion for the 1000 industrial firms in which the accountant does not prepare rules for man and computer tasks ranges from 46.5% to 70.9% at the 95% statistical confidence interval.

Summary for the role of the accountant in design and preparing the management control systems. The findings of this section reveal that where a higher percentage of control systems, except for those computer oriented control systems, are used, there is a higher
probability that the accountant is involved in the design and preparation of the management control systems, as shown in Exhibit 5-4. There is also an identical relationship between the design and the preparation of the control systems. That is, if the control system is designed by the accountant, the control system is also prepared by the accountant. The findings confirm that the management control systems are built around the financial structure, and the system processes follow a definite time pattern and historical nature.

Based upon these findings, the hypothesis that the accountant does not design and prepare the management control systems, except the real-time monitoring performance and on-line feedback control network, in at least 50% of the 1000 largest industrial firms must be rejected.

**The Director of the Firm's Management Information System**

The integration of the operating and the information processing subsystems, one of the major characteristics of modern information systems, has produced the following phases:

1. Centralization of information processing is under a high executive responsible for the coordination of all system planning system operation, and the system control.\(^5\)

2. The responsibilities of the director of information systems

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\(^5\)This centralization of data and/or information processing can have no effect on the decentralization of responsibility centers, such as cost center and profit center as discussed in the previous section. If the same information is available at the same time, the place where it is processed makes no difference. Furthermore, a responsibility center manager does not have to control directly the process of information that is reported to him, as long as he can determine what that information will be.
Exhibit 5-4 (A)

The Roles of the Accountants in Designing

of the Management Control Systems

<table>
<thead>
<tr>
<th>Management Control Systems</th>
<th>Total Firms Having Control System</th>
<th>Accountants Design Control System</th>
<th>Accountants Do Not Design Control System</th>
<th>Estimated proportion for the 1000 industrial firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost center performance reporting</td>
<td>134</td>
<td>126</td>
<td>8</td>
<td>6.0</td>
</tr>
<tr>
<td>Profit center performance reporting</td>
<td>133</td>
<td>127</td>
<td>6</td>
<td>4.5</td>
</tr>
<tr>
<td>Discretionary expense center performance reporting</td>
<td>127</td>
<td>113</td>
<td>14</td>
<td>11.0</td>
</tr>
<tr>
<td>Investment center performance reporting</td>
<td>110</td>
<td>93</td>
<td>17</td>
<td>15.5</td>
</tr>
<tr>
<td>Real-time monitoring performance reporting</td>
<td>45</td>
<td>18</td>
<td>27</td>
<td>60.6</td>
</tr>
<tr>
<td>On-line feedback control network</td>
<td>45</td>
<td>16</td>
<td>29</td>
<td>64.4</td>
</tr>
<tr>
<td>Rules for allocation of man and computer tasks</td>
<td>71</td>
<td>32</td>
<td>39</td>
<td>54.9</td>
</tr>
</tbody>
</table>
Exhibit 5-4 (B)

The Roles of the Accountants in Preparing the Management Control Systems

<table>
<thead>
<tr>
<th>Management Control Systems</th>
<th>Total Firms Having Control System</th>
<th>Accountants Prepare Control System</th>
<th>Accountants Do Not Prepare Control System</th>
<th>Estimated proportion for the 1000 industrial firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost center performance reporting</td>
<td>128</td>
<td>114</td>
<td>14</td>
<td>10.9</td>
</tr>
<tr>
<td>Profit center performance reporting</td>
<td>124</td>
<td>116</td>
<td>8</td>
<td>6.5</td>
</tr>
<tr>
<td>Discretionary expense center performance reporting</td>
<td>120</td>
<td>104</td>
<td>16</td>
<td>13.3</td>
</tr>
<tr>
<td>Investment center performance reporting</td>
<td>103</td>
<td>90</td>
<td>13</td>
<td>12.6</td>
</tr>
<tr>
<td>Real-time monitoring performance reporting</td>
<td>43</td>
<td>17</td>
<td>26</td>
<td>60.5</td>
</tr>
<tr>
<td>On-line feedback control network</td>
<td>40</td>
<td>13</td>
<td>27</td>
<td>67.5</td>
</tr>
<tr>
<td>Rules for allocation of man and computer tasks</td>
<td>63</td>
<td>26</td>
<td>37</td>
<td>58.7</td>
</tr>
</tbody>
</table>

*The total firms answering this question is less than the total firms answering the previous question because some firms failed to complete this part of the questionnaire.
are to design, and implement and update the firm's management information system by applying modern information technology and management science techniques.

The effect of integrating information processing subsystems and operating processing subsystems in an organization is likely, as the accounting activities, to cut across traditional functional and departmental boundaries. In this respect, the accountant by training would seem to be the right man to institute and direct an integrated total information system for the firm.

This section of the questionnaire has a three-fold purpose: (1) is there a management information system in the surveyed firms? (2) does the accountant direct the information system? and (3) if the accountant does not direct the information system, then why not?

A management information system has been established. Ninety-seven and eight-tenths percent (135 firms) of a total of 138 useful responses indicate that there is a firmwide information system in their firms. The estimated proportion for the 1000 industrial firms having the management information system ranges from 95.4% to 100.0% at the 95% statistical confidence interval. That is, the hypothesis that in at least 50% of the 1000 industrial firms there is a firmwide management information system must be accepted. Then who directs the management information system?

The accountant does not direct the firm's management information system. Forty-five and two-tenths percent (61 firms) of a total of 135 firms having the firmwide management information system indicate that the person who directs the management information system is not an accountant by training. The estimated proportion for the 1000
industrial firms in which the accountant does not direct the firm's information system ranges from 36.8% to 53.6% at the 95% statistical confidence interval. The null hypothesis is set equal to or larger than 50%, which falls within the interval, so that the hypothesis that in at least 50% of the 1000 largest industrial firms in which the person who directs the management information system is not an accountant by training could not be rejected.

The reasons for the accountant not directing the firm's management information system are various, as indicated in Exhibit 5-5. "Not familiar with the computer system and the operation research techniques" takes almost half the credit.

Exhibit 5-5

The Reasons for the Accountant Not Directing the Firmwide Information System

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Firms</th>
<th>Percentage of the firms not having the accountant directing the MIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not familiar with the computer systems and the operation research techniques</td>
<td>29</td>
<td>47.5%</td>
</tr>
<tr>
<td>Personnel education and talents not for the job</td>
<td>10</td>
<td>16.3%</td>
</tr>
<tr>
<td>Lacks an overall corporate view</td>
<td>5</td>
<td>8.2%</td>
</tr>
<tr>
<td>Not independent objectives</td>
<td>3</td>
<td>4.9%</td>
</tr>
<tr>
<td>Others</td>
<td>2</td>
<td>3.4%</td>
</tr>
<tr>
<td>Unspecified reason</td>
<td>49</td>
<td>80.3%</td>
</tr>
<tr>
<td>Total firms not having accountant directing the management information system</td>
<td>61</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
Summary and Conclusions

The findings of this Chapter conclude the hypotheses as follows:

1. Whereas there is a centralized data base in the largest industrial firms, the hypothesis that the accounting department of the controller's office does not maintain the centralized data base in at least 50% of the 1000 industrial firms must be rejected.

2. Since the formalization of information processing subsystems and the operating subsystems are the case as found in this Chapter, the hypothesis that the accountant has no influence on the formalization of these subsystems, such as finance, production, marketing, and personnel in at least 50% of the 1000 industrial firms must be rejected.

3. The advancement of modern information processing technology has not caused a recentralization as Leavitt and Whisler predicted in 1958, though modern computer oriented control techniques in such areas of real-time performance monitoring and on-line feedback network have not been commonly used either. Where the decentralization, in terms of delegating various responsibility centers, is the common practice among the 1000 largest industrial firms, the role the accountant plays in designing and preparing the management control systems is significant. The hypothesis that in at least 50% of the 1000 industrial firms the accountant has no role in the management control systems design and preparation must be rejected.

4. Though there is a wide establishment of the firmwide information system, the accountant does not direct the information system. The hypothesis that in at least 50% of the 1000 industrial firms the person directing the information system is not an accountant by training must be accepted.
Chapter 6

CONCLUSIONS OF THE FINDINGS OF THIS STUDY AND IMPLICATIONS FOR MANAGEMENT ACCOUNTING

Modern Information Systems--The Current State of the Art

The essence of the information system is the activities of the firm involving collecting, processing, storing, retrieving, and reporting information to management. When an operating subsystem is formalized, the information requirement should become more explicit and precise. A sensor control system monitors the performance of the operating subsystem against the plans and feeds back the results of the information subsystem.

The computer-based formalized and integrated information and operating subsystems are branded as modern information systems in this study. The modern information systems may become decision oriented systems since all of the relevant data for operating processes (decision processes) can be stored in computer memory and disseminated as needed in appropriate form to all those requiring such data.

Are the modern information systems realistic or purely academic? Professor Anthony remarks, "It is because of the varied and unpredictable nature of the data required for strategic planning that any attempt to design all purpose, internal information system is probably hopeless."\(^1\) The results of this empirical study, however, reveal that modern information systems do exist to a large extent.

\(^1\) R. N. Anthony, \textit{op. cit.}, p. 45.
extent, though in various degrees, among the large industrial firms.

The first step is the extensive formalization of the information processing subsystems in such areas as finance and personnel, and the operating subsystems in such areas as production and marketing. A very high percentage of the firms under this study indicate that they have formalized their information subsystems in finance (96.9%) and personnel (91.7%) and their operating subsystems in production (96.7%) and marketing (95.9%).

Experience in this systematic formalization, coupled with the advancement of modern information technology, provides the basis for the next step of integrating the information and the operating subsystems, and provides the automation of the routine and structured decision making tasks. Seventy-one and six-tenths percent of the firms surveyed indicate that the operating department have participated in the firm's central system in which the operating department inputs data, these data merge with those of other departments, processes, and the resultant information is made available to the operating department. And more than 50% of the firms indicate that the routine decisions are made by the system.

The prerequisite for the integration of the information and the operating subsystems is a centralized data base, where data sources are merged, common data files are constructed, and outputs are blended. A moderately high percentage (68.8%) reply that there is a centralized data base in their firms.

Though the findings of this study confirm the assertion that the routine decisions are made by the centralized system in the majority of the 1000 industrial firms, the firms using the current
powerful mathematical decision models for managerial planning and control purposes are in the minority. Except inventory planning and control models and discounted cash flow models, there is a low percentage of use of queuing models, multiple-regression, mathematical programming techniques, and PERT and CPM.

The sensor subsystem for the modern information system is expressed in this study at each level of the responsibility centers, such as cost center performance reporting; profit center performance reporting; discretionary expense center performance reporting; and computerized controlling techniques, such as real-time performance monitoring, on-line feedback control network, and the rules for allocating man and computer tasks. The survey reveals the two categorical results: (1) A very high percentage indicate that those traditional control systems, such as performance reporting in cost center (97.1%), profit center (95.7%), discretionary expense center (92.7%), and investment center (81.5%) are used. (2) A low percentage indicate that modern computer oriented control systems, such as real-time monitoring performance reporting (14.6%), and on-line feedback control network (34.4%) are used.

**The Roles of the Management Accounting System and of Accountants in the Modern Information System Environment**

How have recent developments in modern information systems impinged upon the management accounting system and accountants? The accounting information functions for managerial use in the typical industrial firms are identified in this study as (1) performing financial data and information processing duties; (2) providing information for managerial planning and control; (3) designing and
maintaining the centralized database; and (4) designing and providing an overall management control function.

This study surveys the current state of the arts revealing that in the 1000 largest industrial firms in this country where modern information systems and technology have been implemented, the impact on the traditional roles of management accounting systems and of accountants vary.

The accounting department is no longer primarily responsible for the financial data and information processes. One of the early effects of computer technology on accounting is that the financial data and information processing services have been taken over by the computer (the EDP department), as found in this study. Except the accounts payable process, the identified financial data and information processes, namely, sale-order and billing, accounts receivable, payroll, product cost accumulating, production cost routine analysis, and sales margin analysis, have been shifted from the primary responsibility of the accounting department. The hypothesis that in at least 50% of the 1000 largest industrial firms, the accounting department is no longer primarily responsible for the financial data and information processing activities must be accepted.

Nevertheless, there is an indication that the information processing function and the controller's function have generally been integrated in regard to reporting to the top corporate management level.

The accounting system is not the key information source for the managerial decision models. The role of accounting information in the managerial decision models and techniques is similar to the
role of mathematical decision models and techniques to the managerial decision making processes. While there is no compelling evidence that the decision models and techniques are widely used, where the decision models and techniques are used, the accounting system does not play the key role in the models, nor do accountants participate in implementing the decision models. The hypothesis that in at least 50% of the 1000 largest industrial firms the accounting system and accountants play no significant roles in the managerial decision models must be accepted.

These findings confirm the 1968-1969 American Accounting Association's Committee report on Managerial Decision Models which states:

Too often, decision model information is considered as being separate and distinct from management accounting information; each set of information may be accumulated and used without ever being viewed as interlocking subparts of a cohesive overall information system. 2

Accountants influence the formalization of the information and operating subsystems. Whereas the formalization of the information and the operating subsystems are common practices in the 1000 largest industrial firms, the expertise of the accountants in classifying and summarizing are still useful to the subsystems design.

A lower percentage indicate that the accountants have no influence on the financial information subsystem (3.2%), on the personnel information subsystem (32.4%), on the production operating subsystem (18.6%), and on the marketing operating subsystem (25%).

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2"Report of Committee on Managerial Decision Models," op. cit., p. 43.
The hypothesis that in at least 50% of the 1000 largest industrial firms accountants do not influence the formalization of the information and the operating subsystems must be rejected.

**Accountants design and prepare the management control systems.** Traditionally, the accountants appear to have had the responsibilities for ex post financial control systems to a large extent. The involvement of accountants in designing and preparing performance reporting for cost center, profit center, investment center, and discretionary expense center generally supports the contention. The hypothesis that the accountants do not design and prepare the non-computerized management control systems in at least 50% of the 1000 largest industrial firms must be rejected.

However, the survey reveals that accountants are less involved in modern computerized control techniques in such areas as real-time monitoring techniques and on-line feedback control network. A low percentage indicate that the accountants design and prepare the two computerized control systems. The hypothesis that the accountants do not design and prepare the computer based control systems must be accepted.

Real-time performance monitoring and on-line feedback network are the product of the use of computer systems. The findings of this section coincide with the assertion by the respondents in following sections in which a high percentage (47.5%) indicate that the accountants are not familiar with the computer systems and the operation research techniques.

**The accounting department maintains the centralized data base.** Seventy-one and one-tenth percent (69 firms) of a total of 97 firms
having the centralized data base indicate that the accounting department or the controller's office maintains the centralized data base. The hypothesis that in at least 50% of the 1000 largest industrial firms the accounting department or the controller's office does not maintain the centralized data base must be rejected.

The accountant does not direct the firm's management information system. While the accounting department or the controller's office maintains the centralized data base, the accountant is not the one who directs the firm's overall management information system. Forty-five and two-tenths percent (61 firms) indicate that the accountant does not direct the management information system. The estimated proportion for the 1000 industrial firms not having the accountant direct their firm's management information system ranges from 36.8% to 53.6% at the 95% statistical confidence interval. Since the hypothesis is stated at equal to or greater than 50%, which falls within the interval, the hypothesis that in at least 50% of the 1000 industrial firms the accountant does not direct the information system could be accepted.

The reasons for the accountant not directing the firm's information system vary, but the accountant's unfamiliarity with the computer systems and the operation research techniques takes most of the blame. Lack of overall corporate view, need for independent objective view of the system, too little attention to the information users' needs are other causes. These factors and the findings that are reported in this study have some implications for the management accounting system in general and the future management accountant's education in particular.
Implications

The nature of management accounting is that of a management information system and management control system. The 1958 American Accounting Association's Committee on Managerial Accounting defines management accounting as the application of appropriate techniques and concepts in processing the historical and projected economic data of an entity to assist management in establishing plans for reasonable economic objectives and in the making of rational decisions with a view toward achieving these objectives.\(^3\)

Evidence exists that though the accounting department maintains the centralized data base, it is not primarily responsible for the financial data and information processes. The findings imply reorganizing the accounting department in order to meet its changing role.

The formalization of the operating and the information subsystems and the integration among them have resulted in closer contact of the operating managers with the information; and, consequently, the role of the management accounting system has diminished as one of the major formal information subsystems in a firm. Though the powerful mathematical decision models and techniques have not been widely used as claimed by some professional literature, where a model or technique is used, the accounting system is not the key information source for the model or technique. The concern of the traditional management accounting system with historical financial data and highly structured information processes are probably responsible for forcing

management to look elsewhere for relevant information. These findings imply that changes in the management accounting concepts and thinking are required. If the management accounting system is to fuse with the managerial decision models and techniques, for instance, consistency between managerial decision models and managerial accounting system must be established.

Though, as indicated in the study, the accountants do have influence to various degrees on each of the various subsystems formalization and control, the advanced computerized control systems in such areas of real-time on-line have not been with the management accountants. Moreover, the accountant does not direct the large industrial firm's information system. Unfamiliarity with the computer systems and the operation research techniques are the major cause. This implies a need to re-examine the present accounting education curriculum and/or to design a program that is relevant to the future management accountant's needs.

Changes in the Organization of the Accounting Department Required Because of Changes in Financial Data and Information Processing Functions

As depicted in Exhibit 3-1 (p. 54), the traditional accounting department's operating duties involve the routine financial data and information processes, such as sales-order billing, accounts receivable, accounts payable, payroll, cost information accumulating, inventory updating, routine production cost analysis, and sales margin analysis. The implication of this study's finding that the primary responsibility of the accounting department in the financial data and information processes has been taken over by the other departments is clear. Loss of the routine data processing duties
to other departments might net some gains to management accountants, if they realize that their focal point in other important areas could be sharper, such as classification of basic primitive transactions. Furthermore, management accountants should have no excuse for being tied up any more with the routine data processes and for lack of time to examine "relevance of information" that they ought to generate.

The reorganized accounting department, proposed by this study as shown in Exhibit 6-1, may consist of three major sections: (1) a centralized data base maintaining section; (2) an alternative information generating system selecting section; and (3) a control system designing section. Within the data base maintaining section, three separate units may be established: (a) the data collecting, coding, classifying, and aggregating unit; (b) a data and information library; (c) an EDP coordinating unit, which serves as a coordinator with the computer room or the EDP department. The alternative information system selecting section may contain: (a) an information system designing and implementing unit, which deals changes in information processing technology and management science techniques; (b) another information subsystem coordinating unit, which is to serve a coordinating function and to avoid duplicating system designing and operating efforts. Of course, the overall responsibility of this section is to select the most economically feasible information system to implement for the firm. The control system section may consist of: (a) routine control systems operations including interfacial operation between man and computer, and (b) managerial control system design and implementation. Of course, cost and benefit analysis should be incorporated in the process of selecting and
Exhibit 6-1

The Reorganization of the Accounting Department--

A System Approach

Management Accounting System Manager

- Alternative Information System Selecting Section
  - Other Formal System Coordinating Unit
  - Information System Designing-Improving Unit

- Centralized Data Base Maintaining Section
  - Routine Control System Operating Unit
  - Control System Designing-Improving Unit

- Management Control Systems Section
  - EDP Coordinating Unit
  - Data Library
  - Data Input Unit
implementing a new control system.

Changes in Management Accounting Concepts and Thinking Required for Fusing Managerial Decision Models

The 1970-1971 American Accounting Association's Committee on Accounting and Information Systems concludes:

The modern information function is the result of a number of developments stemming from many diverse disciplines. Where accounting was, historically, the primary information discipline, technology and especially computer technology has broadened the information function and accounting is now only one of many disciplines underlying formal information systems—albeit an important one.4

This study finds that the accounting system is not the key information source for the managerial decision models, nor do the accountants participate in implementation of these decision models.

Reviewing the current accounting literature reveals three distinct schools dealing with the information needs of managerial decision models and the application of modern information technology. The first school concerns the extension of the conventional accounting system to include more diversified types of information for managerial decision models' needs. Ijiri, for example, presents a discussion of the extension of accounting to include multi-dimensional measures and multi-dimensional accounting.5 A second school concerns the modification of the traditional accounting process necessary to make it more compatible with modern information technology. Mathews, for instance, proposes changing the double entry system through a matrix

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approach, to minimize input and storage requirements while maximizing computational capabilities. While the foregoing proposals are restricted to modification or extension, a third school proposes a unified approach which would (1) utilize the computer efficiently, and (2) introduce flexibility for expansion to multi-dimensional data files through the use of binary coding and storage techniques.

This section is directed toward fusing the management accounting model with managerial decision models and proposes what seems to be a new avenue for changing managerial accounting concepts and thinking through the following areas:

1. The consistency to managerial decision models be the foundation of the future managerial accounting and accounting system design.

2. The filtering concept of the accounting system be redefined.

3. Modern information sciences and system technology in managerial accounting system design be applied.

The consistency in management decision models be the foundation of the future management accounting research. The American Accounting Association's Committee on A Statement of Basic Accounting Theory states:

... Accounting for external users has generally received more attention in the literature than has accounting for internal management. In addition, the theory of management itself has, until recently, provided little guidance for management accountants. As a consequence, management accounting is less

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well developed and the foundations for it are less well understood that is the case with externally oriented accounting theory.\textsuperscript{8}

Consistency is an essential ingredient of financial accounting reporting, and such consistency is explicitly stated in the independent auditor's report, which is attached with the certified financial statements. Although the role of consistency in financial accounting interperiod reporting is well defined, its applicability to evaluating the types of data used by the planning and control functions is not so well defined.

The American Accounting Association's 1968-1969 Committee on Managerial Decision Models is explicit on the need for performance evaluation systems consistency with methodology used in the decision making. They state:

As mathematical decision models become more widely utilized, accountants and managers will be confronted with some serious problems in coordinating the models and the accounting reports that are commonly used for evaluating management performance. That is, planning and control decisions will be made using concepts of incremental costs, cash flows, and opportunity costs. Unless subsequent performance reports are prepared on a consistent basis, the manager may be inclined to make decisions which will bolster his performance as monitored by the conventional accounting model. This may often lead to dysfunctional decision-making.\textsuperscript{9}

In 1969 the Association formed a Committee on Managerial Accounting to study the types of data currently provided to facilitate the control function and those provided for the planning function in order to explore ways of maximizing the consistency of the measurements.

\textsuperscript{8}"A Statement of Basic Accounting Theory," \textit{op. cit.}, p. 37.

\textsuperscript{9}"Report of Committee on Managerial Decision Models," \textit{op. cit.}, p. 57.
Management planning and control include the following decision activities: (1) planning decision model validation and updating, (2) performance evaluation, and (3) process control. While planning decision is generally periodic, the control decisions of performance evaluation and process control are generally made more frequently. A decision planning model is surrounded by a number of unknown variables. Faced with uncertainty, if an information user knows at the beginning that the information he receives is well defined and understood, one source of uncertainty is removed.

The traditional cost accounting system is inconsistent with managerial decision models in several ways. One inconsistency is the variance analyses of the standard costing system, where the actual value (cost) is compared to the expected value (standard cost) rather than using entirely a priori probability distribution for the control purpose. The inconsistency arises between the conventional cost system and managerial decision models, because the actual value as accumulated by traditional cost accounting is unlikely to be exactly equal to the expected value.

Though the management accounting concept essentially belongs to the general theory of information, the consistency of management decision models should be the future management accounting system research. That is, the future managerial accounting system should be built on a structure that is pertinent to managerial planning and control processes, and which can be utilized simultaneously in a

variety of forms. Only when the foundation of the managerial accounting system is established can the objective of the managerial accounting system in different stages of managerial planning and control processes be defined or identified. Based upon this foundation a separation of the managerial accounting theory from the financial accounting model is also necessary.

The 1966 Statement says that the standards for accounting information and the guidelines for communicating this information may be applied equally to the general purpose reports to the various studies and reports prepared for internal management use, and there may be considerable variation in the degree of conformity with the various standards required for each particular management use.\(^\text{11}\)

The following differences provide obvious distinction between the financial accounting and the proposed managerial decision oriented accounting.

1. While both financial and managerial accounting reportings are on the concept of "usefulness," the outputs of the financial accounting model to a large extent are governed or programmed by so called generally accepted principles and the various governmental regulations. Since the consistency of the managerial decision models is the foundation of the managerial accounting system, the latter should be so designed or improved as changes occur in information needs of the managerial decision models.

2. The financial accounting model favors historical exchange-based data. Though they are frequently single valued and generally

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\(^{11}\)"A Statement of Basic Accounting Theory," _op. cit._, p. 51.
are easily verified, its scope is far too narrow for a managerial
decision oriented information system. For managerial planning and
control processes, relevant information are those expected future
costs or benefits which will be different for one or more of the
alternatives under management consideration. Historical data may
be the basis for predicting expected future information, but only
future information is relevant input to the managerial decision
models.

3. The concept of the opportunity cost, which is not
considered by the traditional financial accounting model, is not
only relevant but also vital in some cases to managerial decision
models. The increased use of future oriented opportunity costs is
another reason for the managerial accountant to divorce himself
from the conventional financial accounting model.

In summary, the conventional financial accounting model
attempts to measure the entire wealth structure of the firm, that
is, profit flow, and the changes in the pertinent wealth aggregates
of economic entities. A managerial oriented accounting system should
emphasize the measurement and the analysis of a series of specific
aspects needed for managerial planning and control. These fundamental
differences between the structure and requirements of managerial
decision models at one extreme, and the conventional financial
accounting model at the other, create a discontinuity of fundamental
assumptions between accounting and management sciences.

**Designing A Managerial Decision Model Oriented Management
Accounting System**

Because decision models require many types of information
and in order to be effective decision models often use information originating outside the firm, it is difficult to determine what types of information should fall within the boundaries of the accounting system. This author believes that management accountants should concentrate on designing a managerial decision oriented accounting system rather than an entire area of management information systems. A managerial decision oriented accounting system does not merely consider historical data as the basic input, the chart of accounts as the basic classification model, or the financial statements as the basic outputs.

A managerial oriented accounting system should be designed to insure ready accessibility to the information required by managerial decision models. There are two avenues that could lead management accountants to design such an accounting system: (1) redefining the filtering concept of the accounting system; and (2) the application of modern information sciences and computer system technology in the accounting system design.

The filtering concept of the management accounting system should be redefined. Filter for an information system is a tool to sense and measure the events which occur in the real world and that are included as inputs to the system.

The traditional accounting filter is the accounting transaction, a complex set of rules defining what accounting shall, and even more important, shall not see in the real world. The real world may

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have an indefinity of characteristics through time and space which the traditional accounting filter might not recognize. Accounting deals with economic events and their effects on an entity, but not all economic, relevant events, such as industrial output trend, are recognized by the traditional accounting system. Accountants have scrutinized many economic events, and labeled these events as accounting transactions. When a significant event occurs, the decision whether it should be recorded in the accounting system depends primarily on whether it can be expressed in monetary units, and non-quantifiable events are ignored.

If managerial accounting is to be consistent with managerial decision models, the accounting system filtering rules should be changed or expand to adapt to the information needs of managerial decision models. Janet Smith proposes an adaptive filter, where the filtering rules in the double entry system are modified over time according to criteria related control and cost consideration. Under Smith's model, the filter is allowed to take one of several forms, depending upon the system's control needs for the moment.

Modern information sciences and technology to managerial accounting system design be applied. Since modern information technology and information sciences have contributed to the developments and improvements of information systems, these techniques and systems technology should be an extension of, not an alternative to, managerial information systems. As the language of data and information aggregation becomes arithmetic, so too the language

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13 Ibid., p. 464.
of the relationship becomes mathematics. Here lies the reason for managerial accounting to adapt modern information sciences and technology in its information processes. The redefined filtering rules of the accounting system proposed in the earlier section can be made possible by the application of modern information sciences and technology.

**Measurement theory.** A problem which has long been of interest to accountants is that of identifying and measuring costs and benefits with sufficient verifiability (or objectivity) to insure the reliability of the information process. Providing multiple-dimensional information for managerial decision models involves searching for a proper measurement method for the data collected, stored, and processed by an information system. A modern information system must be a measurement system. As found in this study, the current trend is toward the development of a centralized data base, the basic data entries are on-line and real-time, and an integrated firmwide system must be multi-purpose. At this point, coding and sorting are important in the design and potential uses of a computer-based managerial accounting system. A coding scheme needs to be flexible so that it meets the complete needs of a firmwide data base.

**Communication theory.** Data gathering and information processing involve some degree of aggregation. One of the crucial issues for managerial accountants in designing the accounting system for output signals to the operating managers is whether descriptions of detailed items should be aggregated for reporting purposes. The economics of information processes usually necessitate a level of aggregation that results in a considerable loss of detail and
information potential. If accountants are to be involved in the process of aggregating these microunits into transactions, the basic elements of accounting function and must acquire the required knowledge and skills associated with the communication theory.

Probability theory. If management accounting is to expand its boundaries in order to deal with the uncertainties surrounding managerial decision models, the issue arises of the relationship of probability theory and managerial accounting. To illustrate the effect of uncertainty upon the managerial accounting system, we must

... consider the problem of determining the value (opportunity cost) of a productive factor, a necessary step for many decision models. The value of the factor will depend on the other opportunities, which arise for using it, and those opportunities are uncertain and can only be expressed as probabilities.14

Although the probability theory is used widely in other disciplines, the accounting profession is slow in applying this concept. Thus far, the specific techniques of accounting which deal with prediction are the standard costing system and budgeting control system. However, this application is incomplete. The variance analyses of the standard costing system, in which the actual value (cost) is compared to the expected value (standard cost) rather than using a prior probability, is inconsistent with managerial decision models, since the actual value is unlikely to be exactly equal to the expected value.

Managerial planning models typically deal with uncertainty either through the use of expected values (that is, explicitly

weighing possible outcomes by their probabilities of occurrence), or through sensitivity analyses, in which the values of possible alternative outcomes are compared. In either case, it is helpful to have reliable estimates of the probabilities of the future states. Such information is often very difficult to obtain, but the information about the past given by the traditional accounting system could be a great help in assigning the probability.¹⁵

The gap between the managerial accounting system and managerial decision models may be narrowed by incorporating the probabilistic concept as an extension of the boundaries of the managerial accounting system, as shown in Exhibit 6-2.

Computer and information technology. The impact of computer and information technology is reflected in the development of centralized data. Modern information technology provides new, less expensive data gathering and storage; and accessibility capabilities of computers will enhance the feasibility of having a system that essentially contains a library of raw data in as elementary, unstructured but well defined form as possible, properly indexed for subsequent retrieval and stored to facilitate a wide variety of manipulation, classification, and aggregation. As found in Chapter 5, the accounting department maintains a centralized data base, thus the management accountant must know how his classification, summaries, and reports may affect the validity of models and decisions. For example, the future managerial decision oriented accounting system may routinely contain for each product a library of functional

¹⁵Ibid., p. 56.
relationships such as cost-volume-profit data.

Developments in data input devices in various ways of capturing data and data communication system in various ways of transmitting data from where it originates directly into the location of information users via computer systems have significantly reduced the time lag in updating information. These developments also answer the user's inquiry at the starting point of decision analysis; thus, speed is no longer a prerequisite of the modern information processing system. The basic criteria for a user oriented information processing system is the amount of delay decision makers are willing to tolerate in getting information. The implication for managerial accountants as systems designers is that of economic feasibility. Economic feasibility may be measured by using cost and value of information models for making decisions about the design of information systems.\(^{16}\)

In summary, this writer concludes that as there are constant changes that occur in the structure of modern industrial firms and managerial decision making processes, a managerial oriented accounting system is required to expand and keep pace with rapid changes. Management accountants who attempt to extend their efforts to design the entire area of the information system assume an impossible task at the present time and in the near future, due to the accountants' lack of technical knowledge, which is an essential tool in designing and analyzing information systems. Nevertheless, if the management accountants are to be members of the modern information system team, they must not only be effectively familiar with modern management

\(^{16}\text{Ibid.}, \ p. \ 52\).
science techniques and computer system technology, but also be able
to integrate them in their practices. A discussion of the management
accountant education process which will enable a management accountant
to obtain these techniques is presented in the following section.

Changes in Future Management Accounting Education as a Result of the
Accountants' Lack of Computer Systems and Operation Research Techniques

As stated in the previous section, management accounting should
be a discipline that incorporates concepts and techniques from other
fields—information sciences, management sciences, quantitative
techniques from mathematics, and computer system technology. A
management accounting system should provide relevant information
for the purpose of managerial decision making, so should the management
accounting education define the relevant subjects to be taught in order
to equip the management accountant as an information specialist or
manager who is to direct the overall information system.

This section involves three phases of discussion and proposals.
First, what is the current state of the management accounting courses
(but not the management accounting program, since we do not have it
yet) including computer systems required for an accounting major (not
a managerial accounting major)? Second, is there any feasible way
to have a speciality in managerial accountant who is independent from
the public accountant? Third, if so, what are the basic levels of
both computer systems and operation techniques, in addition to the
accounting courses that are required to provide adequate training
for such a specialty in management accounting or more futuristically,
for the information manager?
Contradiction and negligence of the computer system courses in the accounting curriculum—the current state of the art. Among those firms indicating that the person who directs the firm's information system is not an accountant by training, a high percentage state that the accountant is unfamiliar with the computer systems and the operation research techniques. This is the consequence of a contradiction of the computer system courses in the current accounting curriculum, and to some extent negligence of the relevant courses taught by accounting educators.

A view of today's accounting curriculum in various colleges and universities in this country reveals a confusing and contradicting patchwork. There are two extremes, for example, in the introductory accounting course. One extreme is that the beginning course is heavily oriented toward procedures in accounting such as record-keeping in the historical sense. Another extreme is an attempt to present an undefined, unshaped framework of management information systems.

There is also a conflict over the introduction of computers into the accounting curriculum. Although the advancement of computer technology has a variety of impacts and implications on accounting, there are relatively few programs which have found a comfortable place for computer training within the accounting curriculum. Those who pay more than lip service to computer training develop a technical speciality in computer technology or programming. This is partly a result of the accounting educator (and the accounting practitioners as well, perhaps) not spelling out clearly the ultimate influence of computer technology on accounting education and on accounting
practices.

The 1959 AAA Committee on Accounting Instruction and Electronic Data Processing states:

... accounting instruction in data processing should deal with existing problems rather than futuristic problems and rely on an evolutionary approach. The business-wide implications of new processing methods should be squarely faced via the systems or comprehensive approach to design rather than a fragmentary approach which ignores the interrelationships of operations, namely, labor and cost accounting or production and inventory control.\(^{17}\)

The ad hoc committee recommends the computer as an elective course, a variety of possibilities for course emphasis, ranging from complete emphasis on programming, flowcharting, and coding, to an emphasis which focuses primarily on case studies selected to develop a theory of application. No specific emphasis is recommended as the preferable one, however.

In 1963 the American Accounting Association's Committee on System Instruction was asked to "consider whether a system course should be part of the accounting curriculum, including whether the course should be required or elective."\(^{18}\) It concludes that "an important and substantial body of specific, teachable system subject material did exist, and that such a course should be required of all students planning to enter the field of accounting."\(^{19}\) In their view, this body of knowledge includes a broad outline of possible


\(^{19}\) Ibid.
subject matter, ranging from very general concepts to other specific techniques; yet, no specific recommendation for relative emphasis is presented.

The 1964 Association's Committee on EDP in Accounting Education concludes that accounting students at the undergraduate level should be exposed to electronic data processing in three stages: (1) concurrent with or prior to the introductory accounting course, students should receive instruction in a basic programming language; (2) accounting instruction in a variety of subject matter courses should incorporate some computer oriented problem; and (3) the traditional accounting system course should continue to include a coverage of electronic data processing as one of the aids to accounting.  

The 1969 AAA Committee report on the Role of the Computer in Accounting Education recognizes that there is a need among accounting students for instruction about the computer at two levels: (1) instruction for all accounting students who should be prepared to act effectively in situations in which he is (a) a user of information that has been processed on the computer; (b) a user of canned programs for analysis; (c) a specific of processes and operations that are to be carried out using a computer; and (d) as an auditor who must evaluate the processes and results of computer data processing; and (2) instruction for accounting students who wish to study computer data processing in more depth and will be engaged in the design and

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implementation of computer-based management information systems. 21

The ad hoc Committee states that the accounting student should also be provided with a general orientation to the following introducing computer materials: (1) analyzing and planning for computer processing; (2) computer hardware; (3) computer software; (4) flow charting; (5) programming; (6) data processing approaches; (7) operation and management of computer data processing. 22

Increasing emphasis on greater knowledge of the computer systems, as indicated in the foregoing authoritative statements are parallel with the chronological sequences of these reports. But these reports, apparently as evidenced by this study, have not been given much attention by the accounting educators.

As far as introducing operation research techniques to the accounting curriculum is concerned, it seems to this author that the accounting curriculum is more conservative than the professional literature. Take the last two decades' issues of The Accounting Review for example, in 1950 out of 45 articles none could be classified as operation research oriented; in 1960, there were 12 (or 17%) out of 71 that were related to operation research and quantitative techniques; in 1970, 31 (or 60%) out of 52 were operation research and quantitative methods. But the quantitative methods and operation research techniques have been introduced into the accounting classroom only to a limited extent, if at all.

Specialty in management accounting proposed. By whatever name


22Ibid., pp. 34-35.
he is called, the future management accountant should be a systems analyst or information specialist. A systems analyst or information specialist who will design and implement future managerial accounting systems must have capabilities far beyond those now possessed by most accountants. Moreover, as the American Institute of Certified Public Accountants' past president, Marvin Stone, says:

It is estimated that the total fund of knowledge has quadrupled since 1950. Specialization is a logical result of this "knowledge explosion." .... No one of us is equipped to absorb all the new knowledge which is uncovered in our respective lines of endeavor. Consequently, it becomes necessary for each of us to stake out for himself a narrow area in which to become expert.23

System designs, implementaiton and control often demand a high degree of technical knowledge in computer systems and management sciences. The traditional accounting curriculum that is currently available in the department of accounting may not alone be adequate for the future management accountant's need.

This study recommends that there is a need to break down different specialized areas within the broad discipline of accounting. This suggestion is nothing new to other professions, such as medicine, where a specialty of pediatrics is divided into several subspecialties in such areas as pediatric cardiology, pediatric hematology, pediatric allergy, neurology, neonatology, pediatric surgery, and so on.

This study proposes that the department of accounting in universities and colleges offer the following subspecialties

23Adapted from Dr. J. W. Pattillo's New Developments in Professional Accounting, Speech delivered to the Business Faculty at Jacksonville State University, Jacksonville, Alabama, February 6 and April 7, 1969, p. 20.
programs that lead to a bachelor (or master, even doctoral) degree in: (1) public accounting that lead eventually to a CPA certificate; (2) taxation that leads to some sort of tax specialty; and (3) management accounting with aims at managerial planning and control, and eventually to obtain the certificate of management accountant (CMA), as recently instituted by the National Association of Accountants.

Basic level of the requirements for a subspecialty in management accounting. This study does not attempt to propose a detailed and complete accounting education curriculum, which needs thoughtful research efforts (usually involving team work) and is a formidable task to an unexperienced accounting educator. This author does believe that designing an accounting education curriculum for the future management accountants must determine the proper role of management accounting and accountants in managerial planning and control processes first.

Design and implementation of information systems for managerial use often demand a high level of technical knowledge of computer systems. This level of instruction should be provided by the proposed management accounting education program for the students in methods for analysis and design of computer processing systems and computer software systems. Or, more specifically, the following elements should be considered for inclusion: (1) processing approaches in batch, on-line, time-sharing; (2) theoretical concepts of systems, information, and information economics; (3) analysis of information and processing requirements; (4) approaches for systems analysis and design; (5) data management; (6) selection and implementation of new
Closely related to computer systems and technology is that the accountant is blamed for not being familiar with the operation research techniques—a diffused collection of mathematical and statistical models that are applied to decision making. Nevertheless, this empirical study provides no compelling document visualizing that mathematical decision models in such areas of mathematical programming techniques, multiple-regression analysis, and queuing theory are widely in use. This makes it more difficult to outline the ideal mathematics and statistics requirements for a management accounting education program. Besides, technical competence in mathematics and statistics can be achieved only by specialized study.

In considering the question of operation research in the accounting curriculum, we might focus upon six levels of operation research competency: (1) An awareness of the existence of quantitative methods and an appreciation of their value; (2) Appreciation of the variables involved; (3) Problem recognition, the ability to recognize which quantitative techniques would be useful to solve the problem; (4) Ability to use a conceptual approach; (5) Problem solution, achieved after one acquires quantitative technique knowledge; (6) Refinement and elaboration, the ability to generate and solve problem formulation different from those already solved by others.

As the objective of operation research and quantitative method courses in the accounting program is to provide the students a conceptual understanding rather than a manipulative skill, the following courses seem to be relevant enough to include in the curriculum: (1) linear programming; (2) application of queuing

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24 "Report of Committee on the Role of Computers in Accounting Education," op. cit., p. 35.

25 Pattillo, op. cit., p. 41.
theory; (3) critical path methods and other network analysis; and (4) statistical decision theory. These courses should be problem oriented and directed to the development of understanding methodologies and their limitations.

While there is little doubt that the management accountant or information manager should obtain a thorough knowledge of accounting, the first course of accounting for management accounting students should be conceptually oriented, rather that the present emphasis on procedures, pencil pushing on debits and credits. Changes should also be made to emphasize the use of accounting information in managerial decision making processing, and to de-emphasize product costing procedures. This proposal is supported by the recent CPA examinations. Though the request of the AICPA's Management Advisory Service Committee in 1970 to admit non-CPA specialists to full membership via a special qualifying examination has not been officially accepted by the AICPA, the CPA examination itself has broadened its scope, pruned the procedural, and accentuated the analytical. There has been a wise use of optional questions so that the management accountant may avoid answering a question that is highly tax oriented. Since the CPA examinations are regarded by many as a test of a minimum level of professional competence, its inclusion of new topics and analytical materials in the examinations have influenced the accounting curriculum in the many universities and colleges. As the Certified Management Accountant (CMA) may have an influence on the content of the future management accounting curriculum, a proper and well defined and designed managerial accounting program will directly or indirectly influence the future CMA examinations.
Conclusion

These changes suggested in this study are based upon the findings of this empirical survey. As has been indicated throughout the chapters, there are several areas, especially in the management control functions, in which the management accountant continues to be preeminent. Yet there are other areas, such as routine financial data and information processing activities, which have been eroded. Since the dilemma of our society today is that we hate change and love it at the same time, what we really want for the management accounting profession is for good things to remain essentially the same but to get better.
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Appendix A

Questionnaire Preparation

1. The Cover Letter
2. The Questionnaire
November 8, 1972

Dear Sir:

Your company has been chosen to participate in a study of the impact of management information systems upon the specific role of accounting in your firm.

About 20 minutes of your time is needed to answer the questions on the enclosed sheets. Most of the questions can be answered by placing a check mark in the appropriate blank. A few call for short answers. All replies will be kept confidential.

Your response will make an important contribution to this study. Please return them to me by Nov. 30, 1972. May I count on your help?

Sincerely yours,

Chiou-hsiung Chang

Research Project Supervisor:

Dr. James W. Pattillo, CPA
Professor of Accounting
Louisiana State University
Baton Rouge, La. 70803
SECTION I

This section inquires about the accounting department operating duties in your company.

1. Of the following financial information processing functions, please indicate (✓) the department(s) which is (are) responsible for the process. (Process is intended to include preparing data input, manipulating, and information output.)

   The department (or departments) which is (are) primarily responsible for the process

<table>
<thead>
<tr>
<th>Function</th>
<th>Accounting</th>
<th>EDP</th>
<th>Production</th>
<th>Sales</th>
<th>Other (list)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales-order billing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accounts receivable</td>
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<td></td>
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<tr>
<td>Accounts payable</td>
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<tr>
<td>Inventory updating</td>
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<tr>
<td>Payroll</td>
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<tr>
<td>Cost information</td>
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<tr>
<td>Product cost analysis</td>
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<tr>
<td>Sales margin analysis</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Other (list)</td>
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</tr>
</tbody>
</table>

2. Please indicate (✓) the immediate supervisor, at the division or plant level, of each manager listed below. You may check more than one, if there are different organization charts among divisions or plants.

<table>
<thead>
<tr>
<th>Manager</th>
<th>Vice-president in Finance</th>
<th>Director M. I. S.</th>
<th>Controller</th>
<th>Other (list)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDP (or Computing) manager</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Director of (management)</td>
<td></td>
<td></td>
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<tr>
<td>information systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accounting manager</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

3. If there has been any change in the number of accounting department personnel, approximately what percentage of the change is attributed to the implementation of management information systems?

   increased; decreased; no change
   ___% of change caused by implementation of the management information systems.
SECTION II

This section inquires about the role of the accounting system in providing information for your managerial planning and control purposes.

1. Many firms today have information systems so organized that each operating department (production, sales, finance, etc.) is served by the central system. In these cases, the operating department inputs certain data, such as production or sales facts; these data are merged with those of other departments, processed, and the resultant information made available to the operating department. Some systems are informational only, while in more advanced systems the system itself is capable of making routine decisions, such as placing purchase orders when re-order points and materials sources have been predetermined, writing out past-due notices when dates have been set and the like. Information structures such as this are the basis for the next three questions:

(1) Do your company's departments participate in a system such as described above?
   Yes  No

(2) Are routine decisions made by the systems?
   Yes  No

(3) Do the operating department managers have the ability to modify the decision process?
   Yes  No
2. Please indicate (/) the role of the accounting information in each of the following decision models and management techniques used by you and/or your associates. If you do not use any of these models or techniques, check "Not Applicable."

<table>
<thead>
<tr>
<th>Model/Technique</th>
<th>Is the accounting system a key information source for the model/technique?</th>
<th>Does the accountant participate in implementing the model?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventory model</td>
<td>Yes  No  Not Applicable</td>
<td>Yes  No  Not Applicable</td>
</tr>
<tr>
<td>Queuing model</td>
<td>Yes  No  Not Applicable</td>
<td>Yes  No  Not Applicable</td>
</tr>
<tr>
<td>Multiple-regression model</td>
<td>Yes  No  Not Applicable</td>
<td>Yes  No  Not Applicable</td>
</tr>
<tr>
<td>Mathematical programming model</td>
<td>Yes  No  Not Applicable</td>
<td>Yes  No  Not Applicable</td>
</tr>
<tr>
<td>PERT and CPM</td>
<td>Yes  No  Not Applicable</td>
<td>Yes  No  Not Applicable</td>
</tr>
<tr>
<td>Discounted cash flow model</td>
<td>Yes  No  Not Applicable</td>
<td>Yes  No  Not Applicable</td>
</tr>
<tr>
<td>Other (list)</td>
<td>Yes  No  Not Applicable</td>
<td>Yes  No  Not Applicable</td>
</tr>
</tbody>
</table>

SECTION III

This section inquires about the specific role of the accountant in your company.

1. Assuming a centralized data base contains information from many sources, does the accounting department or the controller's office have the responsibility for maintaining the data base?  
   _____yes;  _____no  
   Not Applicable, if there is no centralized data base in use in your firm.

If "No," what department is currently maintaining the data base?
2. In the design of a data base from which meaningful management information can be obtained, three activities are of very great importance. They are:

(1) Deciding upon a data classification structure. Unless the structure is sound, data will lose its identity and cannot be converted into meaningful information. The main manifestation of this function is in the preparation of code structures governing the classification of accounts, personnel, inventory, and other items.

(2) Selecting a proper level of aggregation. If data are kept separate by event, the resultant mass precludes interpretation. On the other hand, over-summarization by aggregating data makes it impossible to see characteristics.

(3) Integration. Data will flow into the system from many points: finance; production, personnel, and so on. Production of meaningful management information makes it essential that data from these sources are brought together in a meaningful manner.

The persons who make decisions on classification, aggregation, and integration govern the conceptual framework of the information system and its value. Do the accountants influence the characteristics of data classification, aggregation, and integration in any of the following data areas?

<table>
<thead>
<tr>
<th>Data Area</th>
<th>Yes</th>
<th>If No, who influences?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marketing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personnel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (list)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Is the person having the responsibility of directing your company's management information systems an accountant by training?

______Yes; ____No. If "No," would you identify the reason or reasons?

______accountants lack an overall corporate view.
______accountants pay too little attention to user information needs.
______accountants are not familiar with computer system and operation research.
______other __________________________
______other __________________________
4. Please indicate (✓) any responsibility of the chief accountant or the controller for designing and preparing the following management control systems. If any of this reporting is not used in your company, check "Not Applicable."

<table>
<thead>
<tr>
<th>Cost center (product line) performance reporting</th>
<th>Is the reporting designed by the accountant?</th>
<th>Not Applicable</th>
<th>Are the reports prepared by the accountant?</th>
<th>Not Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit center (division or plant) performance reporting</td>
<td>Yes</td>
<td>No</td>
<td>Applicable</td>
<td>Yes</td>
</tr>
<tr>
<td>Discretionary expense center (R/D, marketing) performance reporting</td>
<td>Yes</td>
<td>No</td>
<td>Applicable</td>
<td>Yes</td>
</tr>
<tr>
<td>Investment center (new plant or project) performance reporting</td>
<td>Yes</td>
<td>No</td>
<td>Applicable</td>
<td>Yes</td>
</tr>
<tr>
<td>Real-time performance monitoring reporting</td>
<td>Yes</td>
<td>No</td>
<td>Applicable</td>
<td>Yes</td>
</tr>
<tr>
<td>On-line feedback network</td>
<td>Yes</td>
<td>No</td>
<td>Applicable</td>
<td>Yes</td>
</tr>
<tr>
<td>Rules for allocating between man/computer tasks</td>
<td>Yes</td>
<td>No</td>
<td>Applicable</td>
<td>Yes</td>
</tr>
<tr>
<td>Other (list)</td>
<td>Yes</td>
<td>No</td>
<td>Applicable</td>
<td>Yes</td>
</tr>
</tbody>
</table>
SECTION IV

Having respondent identification simplifies follow-up procedures, but is not essential to this study. If you prefer to remain anonymous, leave this section blank.

1. Your corporation's industry: __________________________

2. Your corporation's name: ____________________________

3. The respondent's position: ____________________________
   (for statistical purpose only)

THANKS FOR YOUR HELP. Please return to:

Chiou-hsiung Chang
P. O. Box 23712
University Station, LSU
Baton Rouge, La. 70803
Appendix B

Master Tabulation of Survey Returns and
Standard-error Computations
Introduction

Statistical estimation is used to test the hypotheses set in this study, where \( H_0: \pi \geq 50\% \), or \( H_a: \pi < 50\% \)

\[
\pi = \bar{p} \pm Z_{.025} \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}
\]

where \( \pi \) = the estimated proportion for the 1000 large industrial firms
\( n \) = total useful responses
\( \bar{p} \) = the sample results

\[ p = \frac{n_1}{n}, \quad Z_{.025} = 1.96 \]

Chapter 3

I. Statistical estimation for the 1000 industrial firms whose accounting departments are not primarily responsible for the following information processes.

\( H_0: \) In at least 50\% of the 1000 large industrial firms whose accounting departments are not primarily responsible for the following information processes.

\( H_a: \) Less than 50\% of the 1000 industrial firms whose accounting departments are not primarily responsible for the following processes.
1. **Sales-order billing processes**

\[ P = \frac{46 + 53}{135} = .733 \]

\[ \pi = .733 \pm 1.96 \sqrt{\frac{(\pi)(1-\pi)}{135}} = .733 \pm .075, \text{ or } .658 < \pi < .808 \]

2. **Accounts receivable process**

\[ P = \frac{45 + 19}{136} = .471 \]

\[ \pi = .471 \pm 1.96 \sqrt{\frac{(.471)(.529)}{136}} = .471 \pm .0839, \text{ or } .387 < \pi < .555 \]

3. **Accounts payable process**

\[ P = \frac{44 + 6}{137} = .365 \]

\[ \pi = .365 \pm 1.96 \sqrt{\frac{(.365)(.635)}{137}} = .365 \pm .0806, \text{ or } .284 < \pi < .446 \]

4. **Inventory updating process**

\[ P = \frac{38 + 61}{136} = .728 \]

\[ \pi = .728 \pm 1.96 \sqrt{\frac{(.728)(.272)}{136}} = .728 \pm .0739, \text{ or } .654 < \pi < .802 \]
5. Payable process

\[ P = \frac{51 + 25}{137} = .555 \]

\[ \pi = .555 \pm 1.96 \sqrt{\frac{(.555)(.445)}{137}} = .555 \pm .0832, \text{ or} \]

\[ .472 < \pi < .638 \]

6. Cost accumulative process

\[ P = \frac{54 + 15}{134} = .515 \]

\[ \pi = .515 \pm 1.96 \sqrt{\frac{(.515)(.485)}{134}} = .515 \pm .0846, \text{ or} \]

\[ .430 < \pi < .600 \]

7. Product cost variance analysis

\[ P = \frac{42 + 19}{135} = .452 \]

\[ \pi = .452 \pm 1.96 \sqrt{\frac{(.452)(.548)}{135}} = .452 \pm .08396, \text{ or} \]

\[ .368 < \pi < .536 \]

8. Sales margin analysis

\[ P = \frac{34 + 26}{135} = .444 \]

\[ \pi = .444 \pm 1.96 \sqrt{\frac{(.444)(.556)}{135}} = .444 \pm .0838, \text{ or} \]

\[ .360 < \pi < .528 \]
II. Statistical estimation for the 1000 industrial firms in which the accounting department personnel has decreased.

\[ p = \frac{34}{130} = .262 \]

\[ \hat{p} = .262 \pm 1.96 \sqrt{\frac{(.263)(.738)}{130}} = .262 \pm .076, \text{ or} \]

\[ .186 < \hat{p} < .338 \]

III. Statistical estimation for the 1000 large industrial firms in which the information processing function and the controller's function are separated.

\[ p = .313 \text{ (from exhibit 3-3, p. 70)} \]

\[ \hat{p} = .313 \pm 1.96 \sqrt{\frac{(.313)(.687)}{139}} = .313 \pm .078, \text{ or} \]

\[ .235 < \hat{p} < .391 \]

Chapter 4

I. The statistical estimation for the 1000 industrial firms whose operating departments participate in the firm's central system.

\[ p = \frac{101}{141} = .716 \]

\[ \hat{p} = .716 \pm 1.96 \sqrt{\frac{(.716)(.284)}{141}} = .716 \pm .074, \text{ or} \]

\[ .642 < \hat{p} < .790 \]
II. The statistical estimation for the 1000 industrial firms in which
the operating routine decisions are made by the systems.

\[ P = \frac{67}{132} = .508 \]

\[ \pi = .508 \pm 1.96 \sqrt{\frac{(0.508)(0.492)}{132}} = .508 \pm .085, \text{ or} \]

\[ .423 < \pi < .593 \]

III. The statistical estimation for the 1000 industrial firms in which
the following managerial decision models are used.

1. **Inventory model**

\[ P = \frac{79}{138} = .572 \]

\[ \pi = .572 \pm 1.96 \sqrt{\frac{(0.572)(0.428)}{138}} = .572 \pm .083, \text{ or} \]

\[ .489 < \pi < .655 \]

2. **Queuing model**

\[ P = \frac{24}{137} = .175 \]

\[ \pi = .175 \pm 1.96 \sqrt{\frac{(0.175)(0.825)}{137}} = .175 \pm .064, \text{ or} \]

\[ .111 < \pi < .239 \]

3. **Multiple-regression analysis**

\[ P = \frac{40}{139} = .288 \]

\[ \pi = .288 \pm 1.96 \sqrt{\frac{(0.288)(0.712)}{139}} = .288 \pm .075, \text{ or} \]

\[ .213 < \pi < .363 \]
4. **Mathematical programming**

\[
p = \frac{44}{138} = .319
\]

\[
\pi = .319 \pm 1.96 \sqrt{\frac{(.319)(.681)}{138}} = .319 \pm .078, \quad \text{or}
\]

\[
.241 < \pi < .397
\]

5. **PERT and CPM network analysis**

\[
p = \frac{50}{137} = .365
\]

\[
\pi = .365 \pm 1.96 \sqrt{\frac{(.365)(.635)}{137}} = .365 \pm .081, \quad \text{or}
\]

\[
.284 < \pi < .446
\]

6. **Discounted cash flow model**

\[
p = \frac{75}{136} = .551
\]

\[
\pi = .551 \pm 1.96 \sqrt{\frac{(.551)(.449)}{136}} = .551 \pm .084, \quad \text{or}
\]

\[
.467 < \pi < .635
\]

**IV. The statistical estimation for the 1000 industrial firms in which the accounting system is not the key information source when the model or technique is used.**

1. **Inventory model**

\[
p = \frac{16}{79} = .203
\]

\[
\pi = .203 \pm 1.96 \sqrt{\frac{(.797)(.203)}{79}} = .203 \pm .089, \quad \text{or}
\]

\[
.114 < \pi < .292
\]
2. Queuing model

\[ P = \frac{20}{24} = .833 \]

\[ \pi = .833 \pm 1.96 \sqrt{\frac{(1.67)(.833)}{24}} = .833 \pm .149, \text{ or} \]

\[ .684 < \pi < .982 \]

3. Multiple-regression analysis

\[ P = \frac{22}{40} = .550 \]

\[ \pi = .550 \pm 1.96 \sqrt{\frac{(1.5)(.550)}{40}} = .550 \pm .154, \text{ or} \]

\[ .396 < \pi < .704 \]

4. Mathematical programming technique

\[ P = \frac{24}{44} = .545 \]

\[ \pi = .545 \pm 1.96 \sqrt{\frac{(1.5)(.455)}{44}} = .545 \pm .147, \text{ or} \]

\[ .398 < \pi < .692 \]

5. PERT and CPM network analysis

\[ P = \frac{29}{50} = .580 \]

\[ \pi = .580 \pm 1.96 \sqrt{\frac{(1.58)(.42)}{50}} = .580 \pm .137, \text{ or} \]

\[ .443 < \pi < .717 \]
6. **Discounted cash flow model**

\[ P = \frac{16}{75} = .213 \]

\[ \pi = .213 \pm 1.96 \sqrt{\frac{(1-.787)(.213)}{75}} = .213 \pm .093, \text{ or} \]

\[ .120 < \pi < .306 \]

V. The statistical estimation for the 1000 large industrial firms in which accountants do not participate in implementation of the decision model or technique.

1. **Inventory model**

\[ P = \frac{22}{79} = .278 \]

\[ \pi = .278 \pm 1.96 \sqrt{\frac{(.278)(.722)}{79}} = .278 \pm .099, \text{ or} \]

\[ .179 < \pi < .377 \]

2. **Queuing model**

\[ P = \frac{20}{24} = .833 \]

\[ \pi = .833 \pm 1.96 \sqrt{\frac{(.833)(.167)}{24}} = .833 \pm .149, \text{ or} \]

\[ .684 < \pi < .982 \]

3. **Multiple-regression analysis**

\[ P = \frac{28}{40} = .7 \]

\[ \pi = .700 \pm 1.96 \sqrt{\frac{(.7)(.3)}{40}} = .700 \pm .142, \text{ or} \]

\[ .558 < \pi < .842 \]
4. **Mathematical programming technique**

\[
P = \frac{28}{44} = .636
\]

\[
\pi = .636 \pm 1.96 \sqrt{\frac{(.636)(.364)}{44}} = .636 \pm .142, \text{ or }
\]

\[.494 < \pi < .778\]

5. **PERT and CPM network analysis**

\[
P = \frac{33}{50} = .66
\]

\[
\pi = .660 \pm 1.96 \sqrt{\frac{(.66)(.34)}{50}} = .660 \pm .131, \text{ or }
\]

\[.529 < \pi < .791\]

6. **Discounted cash flow model**

\[
P = \frac{15}{75} = .20
\]

\[
\pi = .200 \pm 1.96 \sqrt{\frac{(.20)(.80)}{75}} = .200 \pm .091, \text{ or }
\]

\[.109 < \pi < .291\]

---

**Chapter 5**

I. The statistical estimation for the 1000 large industrial firms in which a centralized data base is established.

\[
P = \frac{97}{141} = .688
\]

\[
\pi = .688 \pm 1.96 \sqrt{\frac{(.688)(.312)}{141}} = .688 \pm .076, \text{ or }
\]

\[.612 < \pi < .764\]
II. **The statistical estimation for the 1000 industrial firms in which the centralized data base is not maintained by the accounting department.**

\[
p = \frac{28}{97} = .289
\]

\[
\pi = .289 \pm 1.96 \sqrt{\frac{(289)(.711)}{97}} = .289 \pm .09, \text{ or }
\]

\[
.199 < \pi < .379
\]

III. **The statistical estimation for the 1000 industrial firms in which the following information and operating subsystems have been formalized.**

1. **Financial subsystem**

\[
p = \frac{126}{130} = .969
\]

\[
\pi = .969 \pm 1.96 \sqrt{\frac{(969)(.031)}{130}} = .969 \pm .030, \text{ or }
\]

\[
.939 < \pi < .999
\]

2. **Personnel subsystem**

\[
p = \frac{111}{121} = .917
\]

\[
\pi = .917 \pm 1.96 \sqrt{\frac{(917)(.083)}{121}} = .917 \pm .049, \text{ or }
\]

\[
.868 < \pi < .966
\]

3. **Production subsystem**

\[
p = \frac{118}{122} = .967
\]

\[
\pi = .967 \pm 1.96 \sqrt{\frac{(967)(.033)}{121}} = .967 \pm .032 \text{ or }
\]

\[
.935 < .999
\]
4. Marketing subsystem

\[ P = \frac{111}{121} = .959 \]

\[ \pi = .959 \pm 1.96 \sqrt{\frac{(.959)(.041)}{121}} = .959 \pm .035, \text{ or} \]

\[ .924 < \pi < .994 \]

IV. The statistical estimation for the 1000 industrial firms in which the accountants do not have influences on the following formalized information and operating subsystems.

1. Financial subsystems

\[ P = \frac{4}{126} = .032 \]

\[ \pi = .032 \pm 1.96 \sqrt{\frac{(.032)(.968)}{126}} = .032 \pm .031, \text{ or} \]

\[ .001 < \pi < .063 \]

2. Personnel subsystem

\[ P = \frac{36}{111} = .324 \]

\[ \pi = .324 \pm 1.96 \sqrt{\frac{(.324)(.676)}{111}} = .324 \pm .087, \text{ or} \]

\[ .237 < \pi < .411 \]

3. Production subsystem

\[ P = \frac{22}{118} = .186 \]

\[ \pi = .186 \pm 1.96 \sqrt{\frac{(.186)(.814)}{118}} = .186 \pm .070, \text{ or} \]

\[ .116 < \pi < .256 \]
4. Marketing subsystem

\[ p = \frac{26}{116} = .25 \]

\[ \pi = .25 \pm 1.96 \sqrt{\frac{(.25)(.75)}{116}} = .25 \pm .079, \text{ or} \]

\[ .171 < \pi < .329 \]

V. The statistical estimation for the 1000 industrial firms in which the following management control systems are used.

1. Cost center performance reporting

\[ p = \frac{134}{138} = .971 \]

\[ \pi = .971 \pm 1.96 \sqrt{\frac{(.971)(.029)}{138}} = .971 \pm .028, \text{ or} \]

\[ .943 < \pi < .999 \]

2. Profit center performance reporting

\[ p = \frac{133}{139} = .957 \]

\[ \pi = .957 \pm 1.96 \sqrt{\frac{(.957)(.043)}{139}} = .957 \pm .034, \text{ or} \]

\[ .923 < \pi < .982 \]

3. Discretionary expense center performance reporting

\[ p = \frac{127}{137} = .927 \]

\[ \pi = .927 \pm 1.96 \sqrt{\frac{(.927)(.073)}{137}} = .927 \pm .044, \text{ or} \]

\[ .883 < \pi < .971 \]
4. **Investment center performance reporting**

\[ p = \frac{110}{135} = .815 \]

\[ = .815 \pm 1.96 \sqrt{\frac{(1.815)(.185)}{135}} = .815 \pm .066, \text{ or} \]

\[ .749 < \pi < .881 \]

5. **Real-time performance monitoring system**

\[ p = \frac{45}{130} = .346 \]

\[ \pi = .346 \pm 1.96 \sqrt{\frac{(.346)(.654)}{130}} = .346 \pm .082, \text{ or} \]

\[ .264 < \pi < .428 \]

6. **On-line feedback control network**

\[ p = \frac{45}{131} = .344 \]

\[ \pi = .344 \pm 1.96 \sqrt{\frac{(.344)(.656)}{131}} = .344 \pm .081, \text{ or} \]

\[ .263 < \pi < .425 \]

7. **Rules for allocating man and machine tasks**

\[ p = \frac{71}{123} = .577 \]

\[ \pi = .577 \pm 1.96 \sqrt{\frac{(.577)(.423)}{123}} = .577 \pm .087, \text{ or} \]

\[ .490 < \pi < .664 \]
VI. The statistical estimation for the 1000 industrial firms in which the accountants do not design the following management control systems.

1. Cost center performance reporting

\[
p = \frac{8}{134} = .06
\]

\[
\pi = .06 \pm 1.96 \sqrt{\frac{(.06)(.94)}{134}} = .06 \pm .04, \text{ or}
\]

\[
.02 < \pi < .10
\]

2. Profit center performance reporting

\[
p = \frac{6}{133} = .045
\]

\[
\pi = .045 \pm 1.96 \sqrt{\frac{(.045)(.955)}{133}} = .045 \pm .035, \text{ or}
\]

\[
.01 < \pi < .08
\]

3. Discretionary expense center performance reporting

\[
p = \frac{14}{127} = .11
\]

\[
\pi = .11 \pm 1.96 \sqrt{\frac{(.11)(.89)}{127}} = .110 \pm .054, \text{ or}
\]

\[
.056 < \pi < .164
\]

4. Investment center performance reporting

\[
p = \frac{17}{110} = .155
\]

\[
\pi = .155 \pm 1.96 \sqrt{\frac{(.155)(.845)}{110}} = .155 \pm .07, \text{ or}
\]

\[
.085 < \pi < .225
\]
5. **Real-time performance monitoring system**

\[ P = \frac{27}{45} = .6 \]

\[ \pi = .6 \pm 1.96 \sqrt{\frac{(.6)(.4)}{45}} = .600 \pm .143, \text{ or } .457 < \pi < .743 \]

6. **On-line feedback control network**

\[ P = \frac{29}{45} = .644 \]

\[ \pi = .644 \pm 1.96 \sqrt{\frac{(.644)(.356)}{45}} = .644 \pm .140, \text{ or } .504 < \pi < .784 \]

7. **Rules for allocating man and machine tasks**

\[ P = \frac{39}{71} = .549 \]

\[ \pi = .549 \pm 1.96 \sqrt{\frac{(.549)(.451)}{71}} = .549 \pm .116, \text{ or } .433 < \pi < .665 \]

VII. **The statistical estimation for the 1000 industrial firms in which the accountants do not prepare the following management control systems.**

1. **Cost center performance reporting**

\[ P = \frac{14}{128} = .109 \]

\[ \pi = .109 \pm 1.96 \sqrt{\frac{(.109)(.891)}{128}} = .109 \pm .054, \text{ or } .055 < \pi < .163 \]
2. **Profit center performance reporting**

\[ P = \frac{8}{124} = .065 \]

\[ \pi = .065 \pm 1.96 \sqrt{\frac{(0.065)(0.935)}{124}} = .065 \pm .04, \text{ or} \]

\[ .025 < \pi < .105 \]

3. **Discretionary expense center performance reporting**

\[ P = \frac{16}{120} = .133 \]

\[ \pi = .133 \pm 1.96 \sqrt{\frac{(0.133)(0.867)}{120}} = .133 \pm .06, \text{ or} \]

\[ .073 < \pi < .193 \]

4. **Investment center performance reporting**

\[ P = \frac{13}{103} = .126 \]

\[ \pi = .126 \pm 1.96 \sqrt{\frac{(0.126)(0.874)}{103}} = .126 \pm .06, \text{ or} \]

\[ .066 < \pi < .186 \]

5. **Real-time performance monitoring system**

\[ P = \frac{26}{43} = .605 \]

\[ \pi = .605 \pm 1.96 \sqrt{\frac{(0.605)(0.395)}{43}} = .605 \pm .146, \text{ or} \]

\[ .459 < \pi < .751 \]
6. **On-line feedback control network**

\[ p = \frac{27}{40} = .675 \]

\[ \pi = .675 \pm 1.96 \sqrt{\frac{(.675)(.325)}{40}} = .675 \pm .145, \text{ or} \]

\[ .530 < \pi < .820 \]

7. **Rules for allocating man and machine tasks**

\[ p = \frac{37}{63} = .587 \]

\[ \pi = .587 \pm 1.96 \sqrt{\frac{(.587)(.413)}{63}} = .587 \pm .122, \text{ or} \]

\[ .465 < \pi < .709 \]

VIII. **The statistical estimation for the 1000 large industrial firms**

in which account is not directing the firm's information system.

\[ p = \frac{61}{135} = .452 \]

\[ \pi = .452 \pm 1.96 \sqrt{\frac{(.452)(.548)}{135}} = .452 \pm .084, \text{ or} \]

\[ .368 < \pi < .536 \]
Appendix C

The Distribution of the Respondent's Position
Appendix C

The Distribution of the Respondent's Position

<table>
<thead>
<tr>
<th>Position</th>
<th>Firms</th>
<th>Percent of Total Replies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vice-president &amp; controller</td>
<td>23</td>
<td>16.8</td>
</tr>
<tr>
<td>Vice-president or director of systems</td>
<td>17</td>
<td>12.0</td>
</tr>
<tr>
<td>Vice-president in finance</td>
<td>11</td>
<td>7.6</td>
</tr>
<tr>
<td>Assistant controller</td>
<td>11</td>
<td>7.6</td>
</tr>
<tr>
<td>Accounting manager</td>
<td>9</td>
<td>6.4</td>
</tr>
<tr>
<td>Treasurer</td>
<td>4</td>
<td>2.6</td>
</tr>
<tr>
<td>Financial analyst</td>
<td>2</td>
<td>1.3</td>
</tr>
<tr>
<td>Assistant to president</td>
<td>1</td>
<td>.6</td>
</tr>
<tr>
<td>Vice-president in administration</td>
<td>1</td>
<td>.6</td>
</tr>
<tr>
<td>Assistant to vice-president in finance</td>
<td>1</td>
<td>.6</td>
</tr>
<tr>
<td>Manager, special reporting</td>
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<td>.6</td>
</tr>
<tr>
<td></td>
<td>81</td>
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<tr>
<td>Total Replies</td>
<td>143</td>
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</tr>
</tbody>
</table>
VITA

Chiou-hsiung Chang was born in Tou-liou, Yun-lin, Taiwan, on October 15, 1940, the youngest son of the late Mr. and Mrs. Peaceful Chang. He graduated from the Tou-liou High School in June 1960 and entered the Tam Kiang Colleges of Arts and Sciences at Tamsui, Taiwan, in September 1960. After receiving his Bachelor of Science in Business from the Colleges in June 1964, he was inducted into the Navy. His major duty in military service was as supply officer in the Naval Fleet Command, Tso-ying, Taiwan. He returned to work with a CPA firm as an auditor in August 1965 and then as a teaching assistant in the Tam Kiang Colleges until February 1967 when he came to the United States and entered California State University (then California State College) at Long Beach, California. After obtaining the degree of Master of Business Administration, in September 1969 he went to Louisiana State University at Baton Rouge, where he is currently a candidate for the degree of Doctor of Philosophy in Accounting. He has been as assistant professor at the University of Illinois at the Chicago Circle Campus since January 1973.

He is married to the former Dr. Eleanor Man-ying Hung and is the father of a son, Patrick.
EXAMINATION AND THESIS REPORT

Candidate: Chiou-Hsiung Chang

Major Field: Accounting

Title of Thesis: Changes in the Boundaries of Managerial Accounting Required by Modern Information Systems

Approved:

[Signature]
Major Professor and Chairman

[Signature]
Dean of the Graduate School

EXAMINING COMMITTEE:

[Signature]
Clarence L. Dunn

[Signature]

Date of Examination:

July 6, 1973