Types of Computers and their uses by Agricultural Cooperatives

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TYPES OF COMPUTERS AND THEIR USE BY AGRICULTURAL COOPERATIVES

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INTRODUCTION

"The computer systems function, not only technologically, but also managerially, has come to age. As a result, it has become an extraordinarily important quantitative tool at the disposal of management at all levels in the intense competitive market which manufacturing companies in the United States face today." (Dean, 1968, p. 91) This was the conclusion of a recently completed survey of 108 leading manufacturing companies. Moreover, the survey clearly indicated that the computer increasingly is penetrating and permeating all areas of major manufacturing corporations.

Similarly, farmer cooperatives are rapidly adopting the computer as a managerial tool as indicated by their attempts to make greater and more sophisticated use of their computers since their initial installation. Notwithstanding these efforts, a popular criticism has been that many cooperatives are not using this powerful tool to its fullest potential in their attempt to develop an effective information system. Therefore, this report presents factual data which will shed light on this conjecture. The following two means were used to accomplish this end: first, the determination of the hardware capabilities of a selected group of agricultural cooperatives, and second, the determination of the types of information generated by the cooperative's computer system. It is not the purpose of this report to evaluate the effectiveness of the computer system; however, much of the information presented has implications for effectiveness evaluation.

This report is designed to provide general management and individuals responsible for computer installations with criteria that can be used for evaluating their particular computer effort with that of other agricultural cooperatives. In addition, it is designed to provide extension economists with an evaluation of cooperative effectiveness in using the computer for managerial decision making.

Information was obtained from general managers and individuals responsible for computer installations in a selected group of marketing, processing, and farm supply cooperatives. The information was obtained from 66 cooperatives, of which 54 were using the facilities of a computer and 12 were not. Of the 12 firms not using a computer, all but two planned to use a computer in the next 3 to 5 years. Of those using a computer, 82% were owned or leased, 10% were using the facilities of another company or institution, and 8% were provided services by a professional service group. Also, of the cooperatives that were using a computer, 32% had less than five years experience with the hardware, 42% from five to 10 years experience, and 26% over ten years experience.

Finally, the average annual sales of all the surveyed cooperatives is approximately $85 million, with a sales range from $5 million to $435 million.

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THREE GENERATIONS OF HARDWARE

An unusually rapid rate of technical advance has been, perhaps, the most conspicuous characteristic of the computer industry. As a consequence, in the past 20 years, the computer age has evolved through three generations of computer hardware.[1/]

First generation computers emphasized record keeping and scientific computational capabilities and lasted from 1945 to 1957. During this period, the basic techniques and systems essential to the building of a new technology were developed.

Second generation computers emphasized automatic decision and control functions. This generation, which has just passed, encompassed the application of computers to almost every area of business science.

Today, the third generation has evolved emphasizing real time processing and control. Business and scientific applications are more complex and of a greater magnitude than ever before in history.

The next generation is difficult to predict; however, many feel that this generation will place an even greater emphasis on real time multi-processing machines. The objective of this generation will be to develop a better, more versatile, more useful computer, one that will function faster, store more information, occupy less space, and cost less (Harris, 1968).

HARDWARE CAPABILITIES

As a point of departure it is well to note that an information system consists of computer components, people, and information. The computer components can be said to include hardware and software (programs). People determine the computer usage, and information relates to the interpreted data in terms of decisions made at specific levels of management. The determination of hardware capabilities is of major concern at this time, and attention is first given to this topic.

Capability is defined as that which represents the capacity of being used or developed, and existing capacity cannot be used or developed without the involvement of people. Consequently, people are a necessary component of the capability of a computer effort, because, as Peter Drucker succinctly concludes, the computer by itself is a moron:

> We are beginning to realize that the computer makes no decisions; it only carries out orders. It's a total moron, and therein lies its strength. It forces us to think, to set criteria. The stupider the tool, the brighter the master has to be--and this is the dumbest tool we have ever had. (Drucker, 1957 a., p. 24)

Therefore, capability must be defined both in terms of computer components and the manner in which people manipulate the components.

1/ For clarification of terms used throughout this report, see the Glossary.

The determination of hardware capabilities is difficult. Even more difficult is the task of meaningfully analyzing the hardware owned or leased by 45 cooperatives that are all utilizing different combinations of computer hardware. Consequently the following contrivance does not present a universal set of criteria for system comparison; however, it does meaningfully serve the objectives of this report.

Perhaps the most general criterion used for determining the capability of a computer system is core memory capacity of the central processor and determining cost per bit. However, memory capacity by itself does not determine the full capability of a digital computer system; additional information is necessary.

The procedure taken in this study to determine the capabilities of the surveyed firms was to group the cooperatives that are owning or leasing their computers in four groups, (i.e., I, II, III, IV) ranging from those firms with the limited smaller systems to the larger, more complex systems. The grouping was performed by professionals well experienced with computer hardware. The criteria used for the grouping were varied, encompassing the areas believed to have a significant effect on the capability of the system. The following criteria were used:

1. Make and model number of computer owned or used.
2. Core memory capability.
3. Capacity of card reader(s).
4. Capacity of card punch(s).
5. Capacity of printer(s).
6. Capacity of magnetic disk(s).
7. Capacity of magnetic tape drive(s).
8. Other input/output devices.
9. Supporting unit record equipment.

Collectively, the above criteria were employed, resulting in the following frequency distribution:

	Group				
	I	II	III	IV	Total
Number of firms	11	10	12	10	43[2/]

2/ Even though 45 cooperatives indicated an ownership or leasing arrangement, 43 cooperatives responded with hardware specifications (see Appendix Table A).

In order for each cooperative to identify its respective group, the general nature of each group is given. However, each firm is unique and the placement of an individual firm in a group can vary when all of the above nine criteria are collectively considered. Also, the hardware capabilities were considered jointly for those firms with more than one computer.

In the determination of the types of information generated by Group I systems, the five areas of Table 1 were used. The following percentages are established.

Group I

Area	Percent
Bookkeeping	70
Financial Analysis	8
Production-Distribution	12
Marketing-Sales Analysis	10
Operations Research, Economic Research, Engineering	0
	100%

The above results are consistent with the previously established capability characteristics of Group I hardware. An overwhelming percent of use is in the bookkeeping-financial reporting areas, with no use occurring in the research-engineering area. The types of activities Group I is performing have resulted from economic constraints on the firm which are primarily attributed to its limited hardware capabilities. In other words, it is possible for the cooperative to enter the latter four areas of Table II to a greater degree, but not economically with their present hardware.

However, there is an economically feasible alternative; the use of a computer utility. The cooperatives have the alternative of continuing use of their present hardware for the types of activities they are currently performing and time-share the more sophisticated applications. The use of a computer utility could then enable the more limited firms in Groups I and II to realize some of the business management benefits that their large competitors now enjoy. However, the use of a computer utility may not be a feasible alternative for all firms. Each firm is unique, and depending upon the particular firm, the disadvantages may outweigh the advantages.

Group I: Consists mainly of very small systems, mostly second generation.

Group II: Typically IBM 360/20's or the equivalent.

Group III: Typically IBM 360/30's or the equivalent.

Group IV: Consists mainly of large systems, all third generation. Typically IBM 360/40's and larger or the equivalent. Mostly capable of real time processing.

Table 1. Computers Owned by Selected Cooperatives by Type and Manufacturer.

Manufacturer & Model No.	Computer Frequency
Burroughs Corporation	
B282	1
B300	1
B3500	1
General Electric Company	
GE 415	1
Honeywell, Inc.	
H120	5
H2200	1
H4200	1
International Business Machines, Inc.	
IBM 1130	1
IBM 1401	2
IBM 1410	2
IBM 1440	3
IBM 6400	1
IBM 6420	1
IBM 360/20	9
IBM 360/25	4
IBM 360/30	14
IBM 360/40	4
IBM 360/50	1
National Cash Register Company	
NCR 315 RMC	3
NCR 500	1
NCR Century 200	1
Univac, Division Sperry Rand Corp.	
Univac 418	1
Univac 9200	1
TOTAL RESPONSES	60*

*Although 43 firms responded, total responses include those cooperatives with more than one computer.

The above nine criteria were used to determine the hardware groupings; reflecting increasing capability as the group number increases. However, the capability of a computer system must be defined in terms of the functions it can perform which in turn must also include the effectiveness of the system's software.3/

Given an individual sampled cooperative, it is possible to estimate hardware capacity, most of the specific performance functions, and the approximate speed of performance. However, it is difficult to meaningfully generalize hardware specifications and the system's application potential in terms of the five general areas used in the survey (see Table 2).

Given any particular problem, most of the computer systems in the survey are capable in arriving at a solution. For example, most of the systems can solve a linear programming problem; however, it may take a system in Group I and II many times longer than a system in Group IV (assuming adequate software and a capable computer staff). The reason for this variance can be traced to the high likelihood of a second generation computer occurring in Groups I and II. Despite the capability of a Group I or II system to perform some of the more complex functions, the speed of performance places economic constraints on most of these applications.

Groups I and II are composed of both second and third generation computers. To generalize, Groups I and II are primarily limited to the accounting-bookkeeping applications. These two groups are more conducive to the bookkeeping activities primarily because of their limited memory capacity, speed, and peripheral hardware capabilities. Most of the cooperatives in Groups I and II would have difficulty in developing a total computerized management information system because of the real time involved in receiving timely decision-making information.

Group III is capable of supporting a modest management information system. Most of the systems in this group are capable of real time processing; however, as is shown later, few are utilizing this desirable hardware characteristic.

Group IV computers are all third generation computers. Moreover, most Group IV computers are capable of real time processing. Such a characteristic is usually considered a prerequisite for the development of an effective total management information system.4/

3/ Software efficiency is greatly reflected in the information demands of each cooperative and its respective programming language. Since the present concern is with computer hardware, a discussion of the various programming languages is presented later in this report within the aggregate analysis.

4/ See Glossary for definitions.

Table 2. Application Areas of Computers Operated by Cooperatives

Area	Examples
Basic Bookkeeping - Financial Reporting	Billing, invoicing, payroll accounting, etc.
Financial Analysis	Capital investment analysis, cash flows, general and tax budgeting, etc.
Production-Distribution Operations	Production scheduling, inventory control, quality control, distribution scheduling.
Marketing Operations-Sales Analysis	Sales forecasting, sales analysis and control, advertising, new product scheduling.
Operations Research - Economic Research - Engineering	Linear programming, critical path, simulation, product design.

It should be understood that the hardware capability of a firm does not determine the effectiveness of the information system; the computer is only a tool used to enhance an existing information system. Drucker makes the following analogy:

> The computer is to information what the electric power station is to electricity. The power station makes many other things possible, but it is not where the money is. The money is the appliances, the motors and facilities made possible and necessary by electricity, which didn't exist before. Information, like electricity, is energy. Just as electrical energy is energy for mechanical tasks, information is energy for mental tasks. (Drucker, 1967, b, p. 23).

Moreover, Drucker relates, the real value is not in the electrical power station, but is found in the generated energy. In the same manner, the real value of the computer lies not in the physical hardware but rather in the effective utilization of the generated information.

The development of an effective information system should not be construed to only consist of computer hardware. As indicated above, an information system is much more than the computer. Moreover, an effective information system must start with the understanding of management together with a capable technical staff rather than a survey of computer hardware.

Considered next is an analysis of use by groups in the hope that some meaningful relationships can be found between actual and potential utilization.

Analysis of Use by Groups

The analysis of use is first conducted according to the four groups. Following the group analysis is an aggregate analysis; the latter not only encompasses an analysis of use, but also other information relating to performance evaluation, both of which will be compared to an analysis of a study of 108 leading manufacturing companies conducted by Dean (1966 a). It is hoped that by presenting a group analysis prior to the aggregate analysis an individual cooperative can identify its grouping and thereby compare itself with similar cooperatives.

Group I

The eleven cooperatives in this group used their computers an average of 118 hours per month. The average computer experience of these cooperatives is five years. They have an average annual sales of $53,597,471, with a range from 11.5 million to 125 million, and spend an average of $105,193 per year on their computer activities (hardware rental or the equivalent, operating costs, staff systems planning, design, and programs planning). Within Group I there is no apparent relationship between annual computer expenditures and sales. The average annual computer expenditures break down to 47% operating expense, 45% rental or the equivalent, and 8% for systems

design and programs planning (see Figure 1).

For example, in many cases it may be more advantageous in the long run for the firm to allocate the expenditures to the development of its present system rather than subsidize a computer utility; each alternative should be considered in the long-range planning strategies of the cooperative.

The following are typical responses from Group I, referring to their future plans for expanding their computer effort:

> "To install a complete system of order entry, sales, and production control resulting in a complete system from entry of orders to summary of sales."
>
> "Add additional disk drives and increase core and speed of component equipment."
>
> "Upgrade equipment to provide greater storage capacity, access to data, cut down on key punching, and improve membership records."
>
> "Plan to have all accounts except general ledger on computer records, sales, and inventory analysis...."

The above indicate that in the near future Group I will continue to emphasize the bookkeeping applications in their expansion plans.

Group II

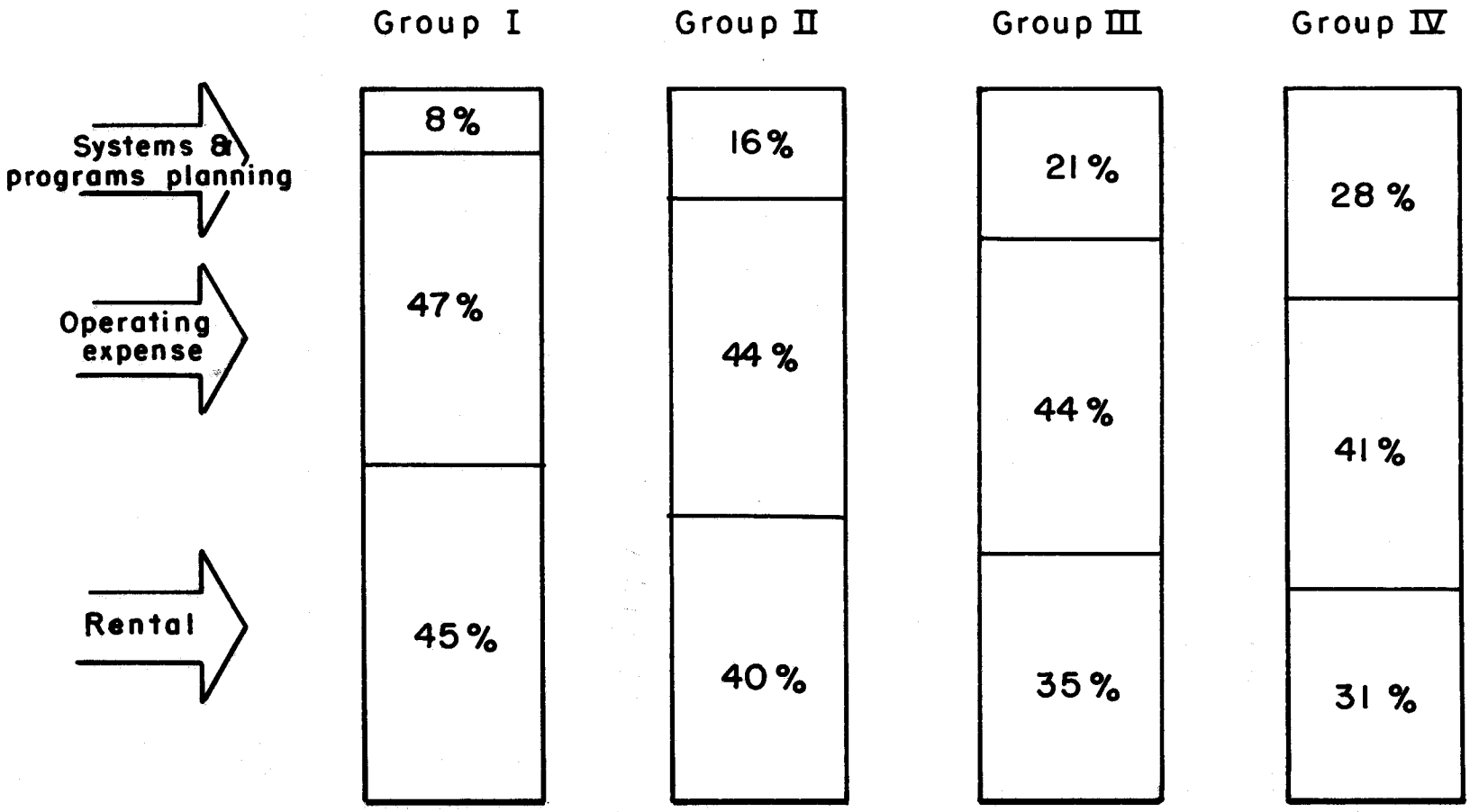
The ten cooperatives in this group on the average use their computers 235 hours per month, and have an average of six years of computer experience. Their average annual sales is $99,935,791, with a range from $21 million to $390 million; and they spend $212,375 on their computer activities each year. The annual computer expenditure of Group II breaks down to 44% operating expense, 40% rental or equivalent, and 16% for systems design and programs planning (see Figure 1).

In the determination of the types of information generated by Group II systems, the five areas of Table 1 were used. The following are the results:

Group II

Area	Percent
1. Bookkeeping	72
2. Financial Analysis	6
3. Production-Distribution	13
4. Marketing-Sales Analysis	9
5. OR., Economic Research, Engineering	0
	100%

Figure I. Allocation of Computer Expenses by Groups



Similarly, Group II systems are performing much within the capabilities of their hardware. Analogous to Group I, if the management of this group has the desire to extend to new and more complex applications which are beyond the capabilities of their present system, the alternative of using a computer utility is likewise available. The present functions can continue to be performed on their present system while the more sophisticated applications are done by a computer utility. A discussion of time-sharing criteria is discussed later.

The following are typical responses from Group II referring to their future plans for expansion:

"Expand to linear programming"

"Expansion to activities other than processing financial information."

"A complete information system to cover our entire organization related to cost and need."

The management of Group II indicate a desire to extend their applications beyond their initial clerical applications. However, most of these cooperatives are economically constrained to their present activities, resulting from limited hardware capacity.

Group III

The twelve cooperatives in this group, on the average, use their computers 344 hours per month. They have an average of 8 years of experience with their present or similar system. Their average annual sales is $130,620,270, with a sales range from $30 million to $370 million. On the average they spend $375,637 annually on their computer activities. The average annual computer expenditure breaks down to 44% operating expenses, 35% rental or the equivalent, and 21% for systems, design, and programs planning (see Figure 1).

Group III allocates its total computer time in the following manner:

Group III

Area	Percent
1. Bookkeeping	55
2. Financial Analysis	12
3. Production-Distribution	15
4. Marketing-Sales Analysis	16
5. Operations Research, Economic Research, Engineering	2
	100%

As the above percentages show, computer use of Group III is significantly different from that of the two previous groups. Perhaps the most obvious difference is the increasing percentage of computer time in areas 2 to 5; these four areas increased at the expense of a significant decrease in relative allocated computer time to area I.

Once again, the explanation for the variance among groups is linked to their hardware capability. All of the Group III systems are third generation computers, maintaining a larger core memory and greater speed which are necessary for many of the more complex applications. However, this difference can also be viewed by management's attitude toward the importance of its applications in the latter four areas, and the amount of experience the firm has with a digital computer system.

The following comments reflect the future plans for the expansion and reorganization of the management in Group III:

> "(We have) recently established a management systems committee of top management to guide, monitor, and establish priorities for systems development activities."
>
> "To incorporate teleprocessing into the system and thereby secure more timely management information..."
>
> "Management information system in the implementation stage."
>
> "Development of on-line total information system."
>
> "Continued expansion of applications--time sharing and data transmission oriented..."

As the above indicate, Group III is not only capable of a modest information system, but their plans indicate their desire to implement one.

Group IV

The ten cooperatives in this group each use their computer 456 hours per month. The average cooperative has 8 years of experience with the present or similar system. Their average annual sales is $152,637,800, with a range from $50 million to $434 million. On the average, they spend $621,806 annually on their computer activities. This average annual computer expenditure breaks down to 41% operating expense, 31% rental or the equivalent, and 28% for systems planning and design (see Figure 1).

Group IV presently allocates its total computer time in the following manner:

Group IV

	Area	Percent
1.	Basic Bookkeeping	50
2.	Financial Analysis	10
3.	Production-Distribution	18
4.	Marketing-Sales Analysis	17
5.	Operations Research, Economic Research, Engineering	5
		100%

Most of the computers in this group are capable of maintaining an on-line real time computer system. And in short, most of the systems of Group IV have the capability of providing a total management information system. The following indicate the management's anticipation of achieving that goal:

> "...We are presently developing a total management system. We also have under development an accounting and reporting system for our member cooperatives."

> "To develop a total information system."

However, the management from one of the more limited systems responded:

> "Upgrade core size to permit on line multiprocessing operations and additions to peripheral equipment teleprocessing and CRT input and inquiry to basic data files."

The above indicate Group IV's intentions to develop a total computerized management information system.

Summary of Group Analysis

By using the four groupings established to determine hardware capabilities, some very significant relationships are revealed.

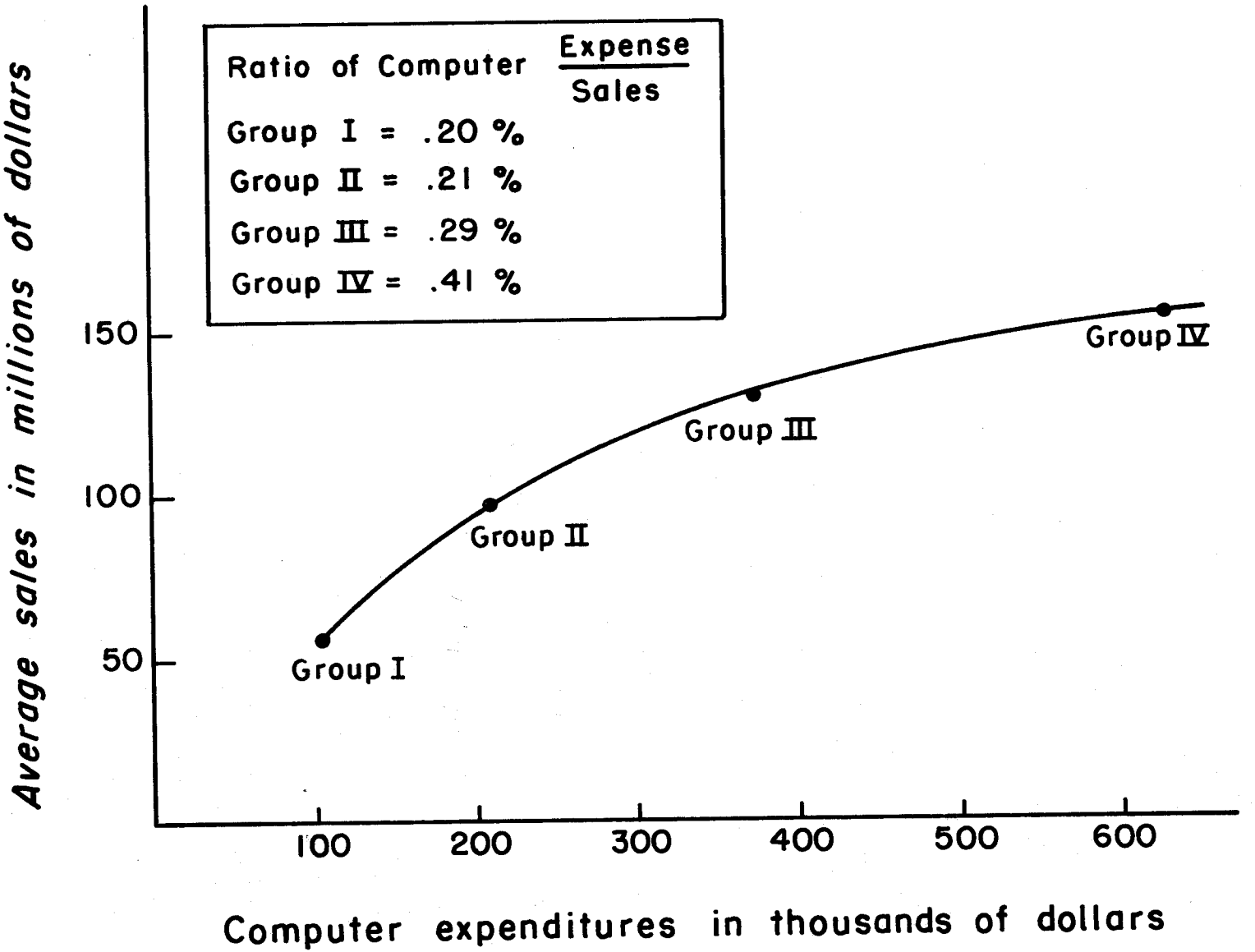
Average sales progressively increase from a low of $53,597,471 in Group I to a high of $152,637,800 in Group IV. Similarly, average costs progressively increase from $105,193 to $621,806 for Groups I to IV respectively.

There is a direct relationship between sales volume and amount spent on the computer effort by groups (see Figure 2). This relationship suggests that the cooperatives with a more capable system spend proportionately more on their computer efforts and maintain a higher volume of sales.

The cost-sales ratios are .20%, .21%, .28% and .41% for Groups I, II, III, and IV respectively. These ratios indicate that the cooperatives with the more capable computer systems spend a greater percent of their annual sales on their computer systems than do the cooperatives with the more limited systems. Furthermore, Figure 2 shows that as group sales increase, the amount spent on the computer system also increases; however, this increase occurs at a decreasing rate. The computer expense/sales ratio is often used as a criterion for allocating computer funds.

There is also a direct relationship among the four groups and the allocated percentages on computer expenditures. Perhaps the most significant expenditure relationship is the proportion spent on systems planning and design, which increases progressively from 8% in Group I to 28% in Group IV (see Figure 1). Operating costs decrease as does the proportion spent on lease or the equivalent. Consequently, the cooperatives with the more capable systems spend proportionately more on planning and developing new applications.

Figure 2. Relationship of Computer Expense to Sales by Groups



Perhaps one of the more interesting relationships is the present types of information generated among the four groups (see Figure 3). This relationship shows that as firms acquire more capable systems, there is a proportionate increase in computer time allocated to areas in addition to basic bookkeeping. Much of this can be attributed to the years of computer experience for each group and the more intense information demands of the larger cooperatives.

Finally, by interviewing many computer managers, it can be concluded that in most cases the hardware capability is not the primary limitation in the cooperatives' quest to expand to new and more complex applications. Instead, the software (programs) and people elements provide even greater limitations. It is difficult to acquire and maintain competent people to program and design the information system. Even more important is the need for constructive communication among those who need the information and those who design the system that provides it. These limitations appear much more crucial to effective computer utilization than hardware limitations. These problems are further discussed within the following aggregated analysis.

AGGREGATE ANALYSIS OF USE

Cooperatives Which Owned or Leased Their Own Computers

The 43 cooperatives that own or leased their computers in this survey on the average used their computers 252 hours per month. Individually they spend from .03% to .99% of their annual sales on their computer activities (hardware rental or equivalent, operating costs, staff systems planning, design, and programming), with the average at .39% of annual sales. In all, these cooperatives spend a total of over $11.5 million annually on their computer. Individually, computer expenditures by cooperative size vary widely (see Figure 4)5/. Such disparities usually can be traced to the type of products marketed, processed, or supplied and the maturity of the installation, which very likely determines the extent and type of applications. Application of regression analysis reveals a significant relationship between annual sales and annual computer expenditures. However, sales alone is not an exact predictor; other factors have a significant effect on computer expenditures such as the type of product marketed, processed, supplied, the maturity of the computer installation, management attitude towards computer utilization, etc.

Although it is not the purpose of this study to evaluate effectiveness, at this point the question arises: is there any relationship between the amount spent on the computer and its effectiveness in managing it? Dean (1966 b) indicates that there is some correlation among industrial corporations, but not a strong one. Dean's study reveals that the companies with the highest effectiveness rating spend on the average 1.0% of sales on computer activities while the lowest rated companies average .23% of sales. Dean continues, "However, there are enough exceptions to indicate that dollars spent are not a major criterion of usage effectiveness."

As Figure 5 indicates, average computer expenditures for the sampled cooperatives break down to 46% operating expense, 37% rental or equivalent,

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5/ The time specified by the cooperatives represents actual operating time of the central processing unit.

Figure 3. Present Use by Cooperatives Classified by Computer Type and Capability (Percent of Total Hours)

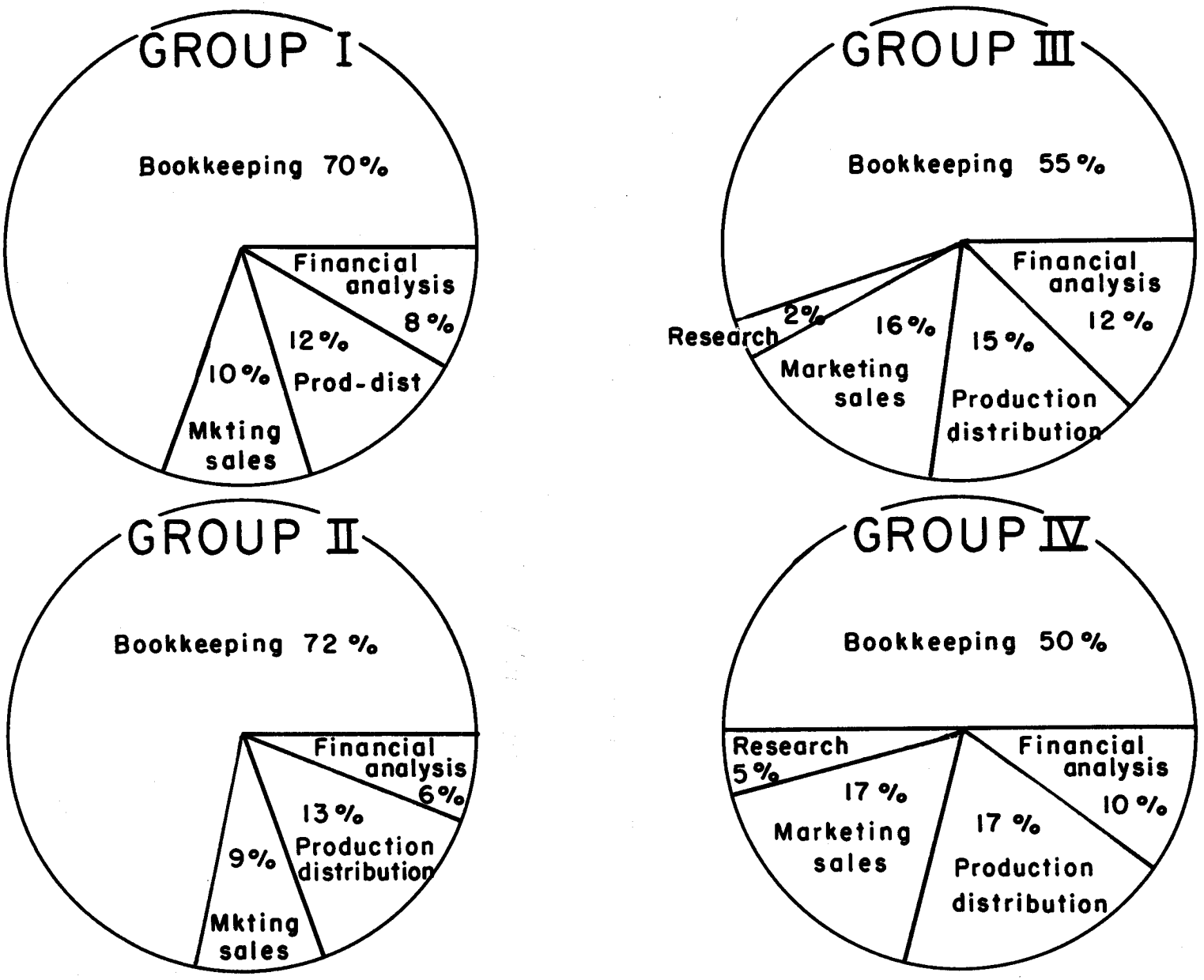


Figure 4. Relationship of Computer Expense to Sales Volume
(39 Cooperatives)

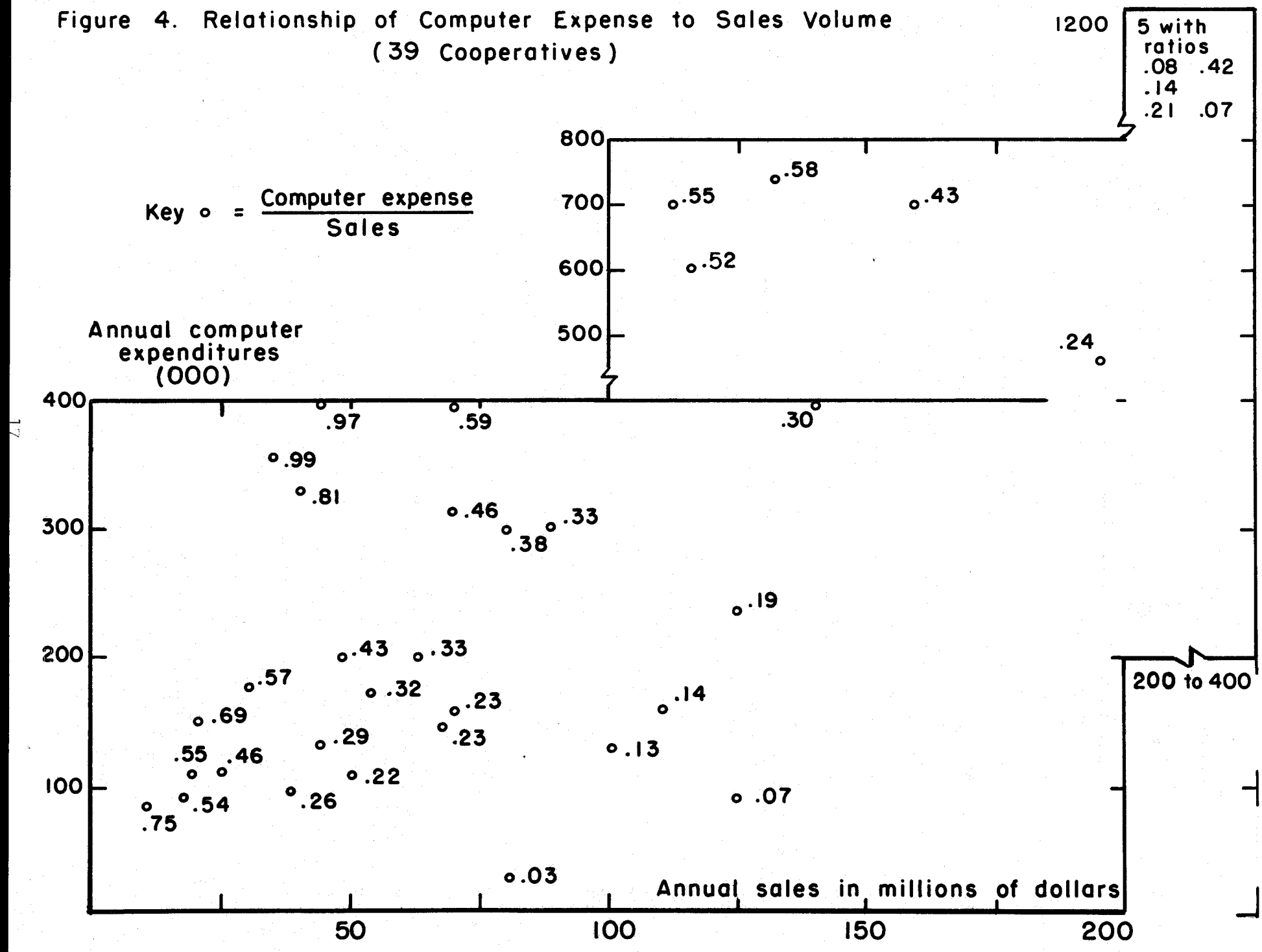
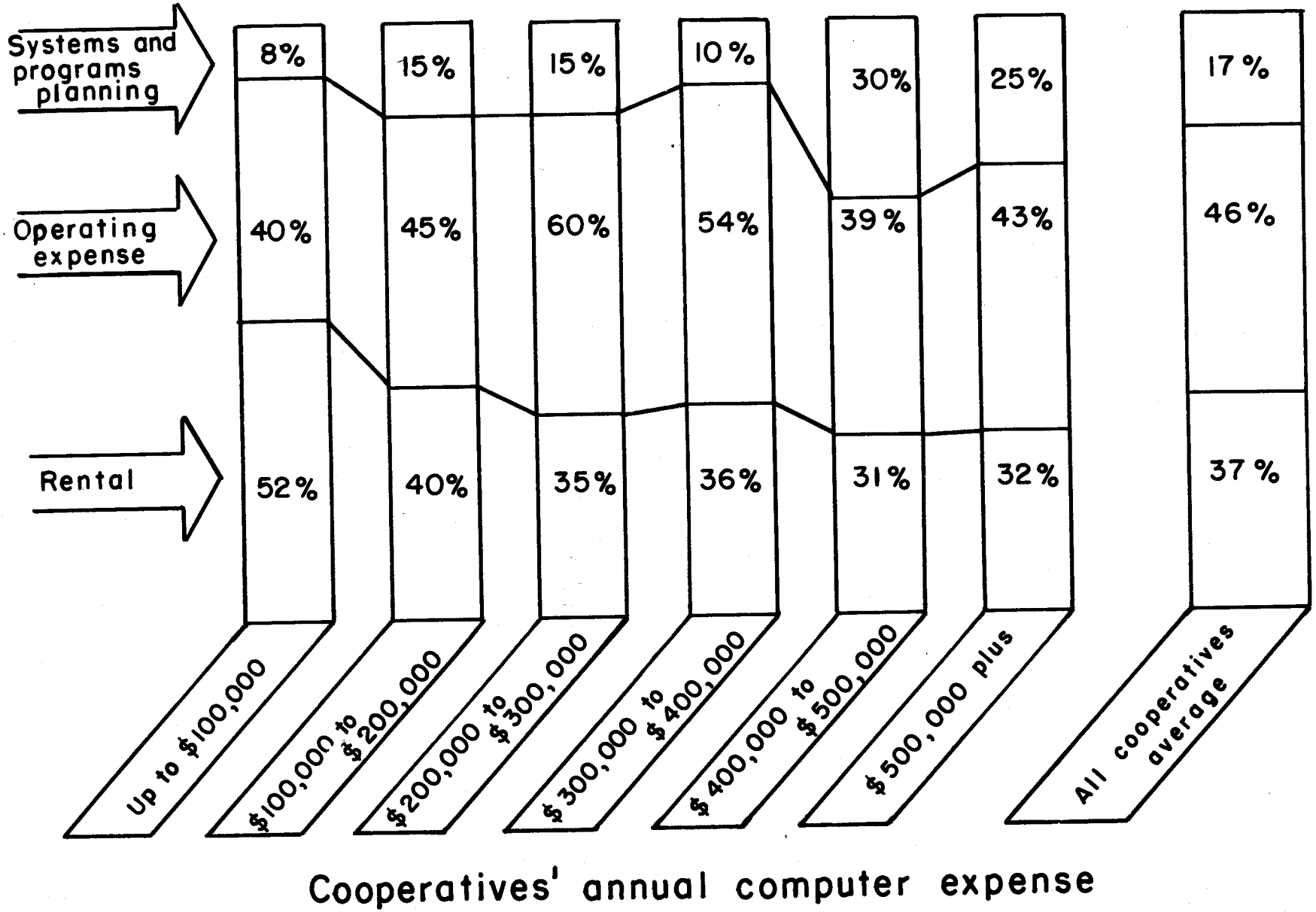


Figure 5. Allocation of Computer Expenditures by Annual Sales Volume



and 17% for systems and programs planning. Dean's study of the industrial population similarly indicates 37% for rental or equivalent; however, the discrepancy is in the 39% spent for operating expense and 24% for systems and programs planning. Thus, the average of the "effective" industrial firms spend proportionately more on systems and programs planning than do the surveyed cooperatives. As viewed in Figure 5, the cooperatives with the larger expenditures, in general, spend proportionately less on rental or equivalent and more on systems and programs planning. Dean (1966 c) attributes this to the company's maturity as a computer user, and a reflection of their increased emphasis on systems design to implement new, more complex operating applications which are characteristics of experienced companies. Conversely, the cooperatives in this survey indicated only a slight relationship between a cooperative's cost/sales percentage to the cooperative's computer experience.[6/] However, as indicated earlier, there is a relationship among individual groups and their computer experience.

In an attempt to aggregate the types of information being generated, once again the following five areas were specified: basic bookkeeping--financial reporting; financial analysis; production-distribution operations; marketing operations-sales analysis; and operations research, economic research-engineering. Each cooperative indicated its initial, present, and future use in each of the five areas. The main purpose in specifying the three different areas (initial, present, future) was to determine the increase or decrease in each application area since the initial installation (see Figure 6).

Quite clearly, with reference to Figure 6, the basic bookkeeping-financial reporting area has significantly decreased since the initial installation from 76% to 64% to 48% for initial, present, and future use respectively. In the remaining areas the percentages have increased, at the expense of the basic bookkeeping area. Although few responding cooperatives intend to reduce their bookeeping efforts, most all intend to increase their efforts in the remaining four areas, thus reducing the proportion of computer time spent in the basic bookkeeping activities.

As a consequence, the remaining four areas show steady percentage increases since the computer's initial installation. The following percentages represent the initial, present, and future use for each area: basic bookkeeping-financial reporting, 76%, 64%, 48%; financial analysis 6%, 8%, 11%; production-distribution operations, 8%, 14%, 21%; marketing operations - sales analysis 10%, 12%, 15%; and operations research - economic research - engineering, less than 1%, 2%, 5% (see Figure 6). These results clearly indicate a trend away from restricting the computer to the bookkeeping areas. In the next 3-5 years, the cooperatives in this survey expect to direct over half of their total use to operating areas and expect to more than double the time spent in the research areas.

Cooperatives Who do not Own or Lease Their Computers

Four of the firms in this survey were using the computer services of another company or institution. The average annual sales of these four

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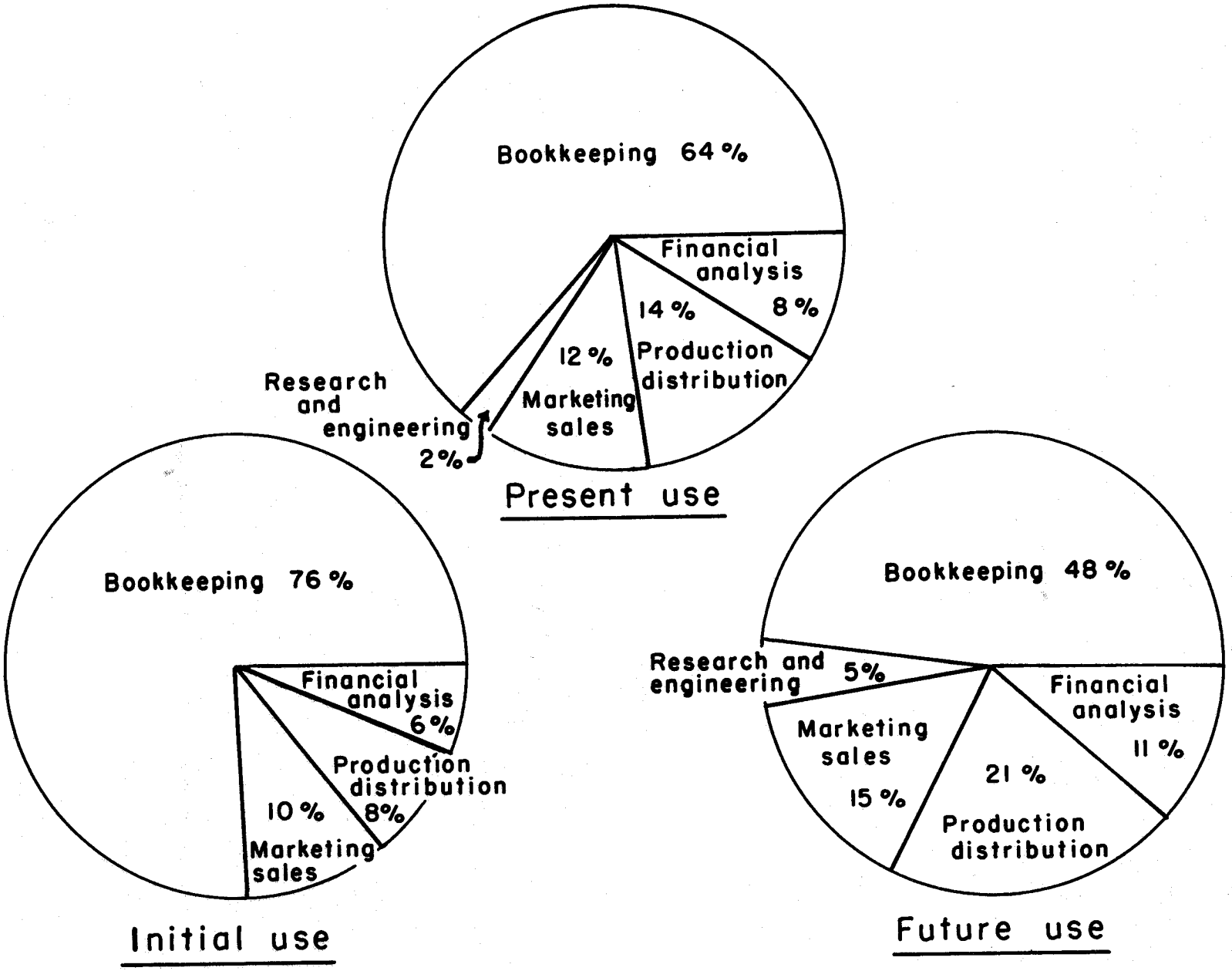
6/ See Appendix B for regression analysis results.

Figure 6. Allocation of Computer and Systems Effort to Different Functions



cooperatives was $30 million, ranging from $8 to $65 million. Average monthly usage ranged from 8 to 30 hours. Two of the four firms leasing computer time indicated that the primary areas of use were the bookkeeping tasks and producer payments. None of the four are using the facilities on line; all four were off line batch processed jobs.

Five of the cooperatives were provided computer services by a service bureau. The average annual sales of the five firms was $20 million with a range from $5 to $49 million. None of the five indicated the types of information they were processing with the service bureau; however, all of the information was processed off line. Those that specified the service bureau hardware indicated one Univac 9300 and two IBM 360/25's; the other two firms did not respond.

Apparently the above firms have not found it feasible to own or lease their own hardware. However, one firm indicated its purchase order of a computer. Evidently smaller firms find it more profitable to utilize the professional services of a service bureau rather than be confronted with many of the problems of other smaller owners. By taking this route, these cooperatives have available the exact computing capacity and memory, and within limits, those computer capabilities that most closely match the problem needs of the moment. Furthermore, they are charged only for the time and capabilities actually used, while the overhead for the unused facilities are shared among other users.

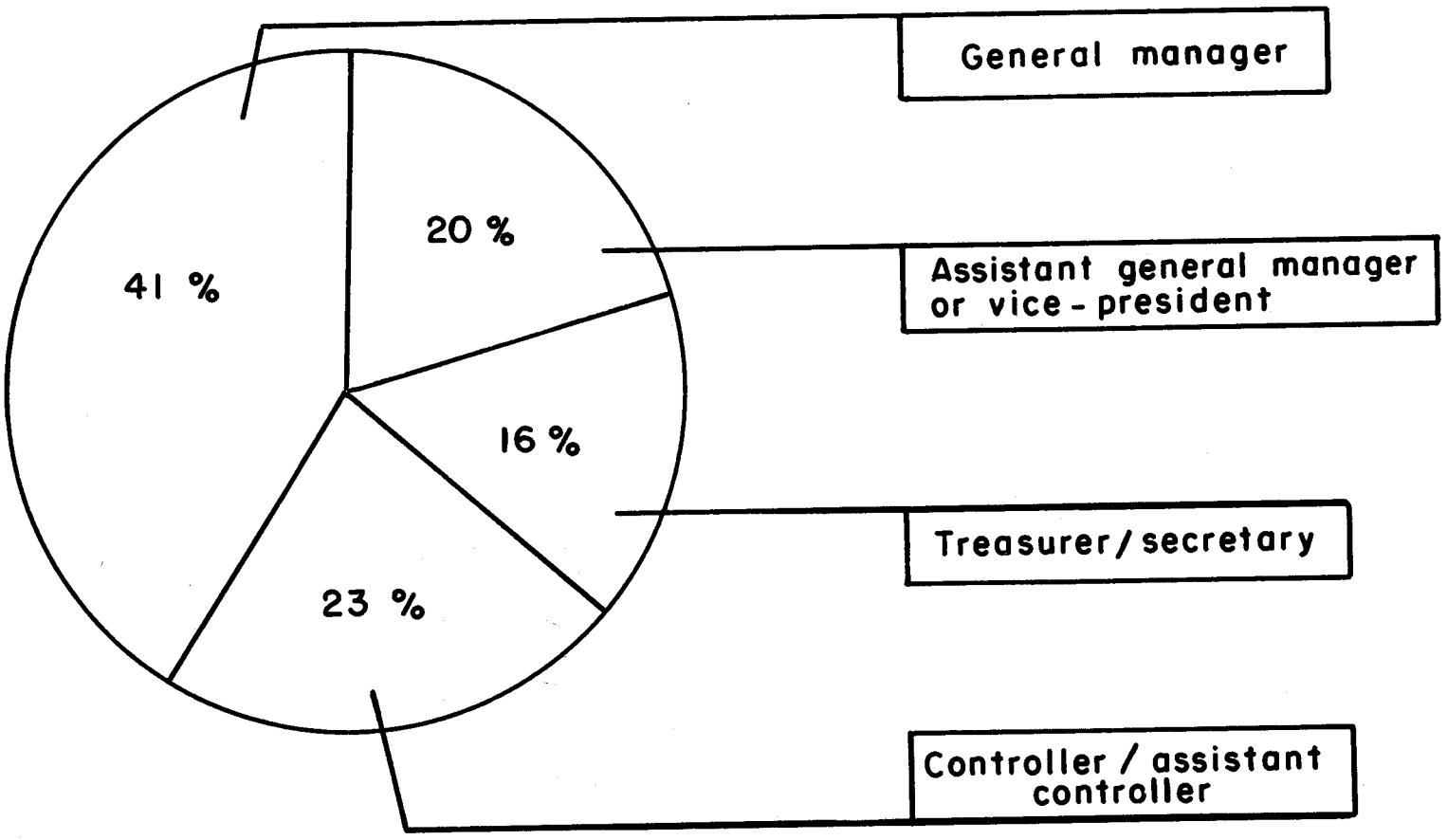
MANAGING THE COMPUTER

The ability of a cooperative to expand its applications to new and more complex areas is a function of hardware, software, and people. The latter variable is now considered.

Virtually all of the cooperatives in the survey maintain an individual who coordinates the computer activities and is responsible for the overall quality, performance, and forward planning of the cooperatives' computer effort. Dean's study (1966 d) revealed an important relationship between the computer manager's previous experience and his reporting responsibilities. Dean found that the more effective computer installations were those where the computer manager had either operating or management experience and reported directly to top management personnel.

In this study the following percentages indicate the previous experience of the individual in charge of the cooperative's computer effort: 44% with data processing and programming experience, 40% with experience in finance and accounting areas, and 16% with operating and management experience. Forty one percent report directly to the general manager, 20% report to the assistant general manager or vice president, 16% report to the treasurer or secretary, and 23% report to the controller or assistant controller (see Figure 7). Upon analysis of the reporting relationships among the four previously established groups, the following hypothesis was rejected: the computer manager in Groups I and II primarily report to the controller or treasurer/secretary and the computer manager of Groups III and IV primarily report to the general manager or vice president. In other words, there was no significant difference in the reporting relationships among the groups.

Figure 7. To whom does the "computer manager" report ?



Many of the surveyed cooperatives indicated difficulty in penetrating application areas and have consequently attributed many of their problems to the previous experience of their computer manager. Moreover, many firms that were concentrating on the bookkeeping areas had individuals with accounting-bookkeeping experience. However, the inability of the firm to expand applications to areas other than bookkeeping cannot be blamed totally on the lack of ability of the computer manager nor can management take the blame. The problem appears to be a communication gap between the computer people and management. To a great extent the lack of progress has been caused by antagonism between management and the computer staff. Management blames the computer people for not providing them with the information they need or with providing too much information. On the other hand, the computer people continually blame management for lack of involvement in the design of the system. In fact, they say, management very often does not even know what information they need for decision making. This lack of communication points to the need for the development of an effective information system which, if designed correctly, will virtually eliminate such problems.

One solution or partial solution suggested is that companies tend to put operating people in charge of the computer because it is believed easier to educate them about computers than to teach systems specialists about business. However, this course of action may not always be practical. In any event, systems specialists should be familiar with operating procedures. As Robert Townsend contends:

> Before you hire a computer specialist, make it a condition that he spend some time in the factory and then sell your shoes to the customers. A month the first year, two weeks a year thereafter... (1970a, p. 37)

Another alternative would be for the firm to clearly and specifically identify its information needs and relative frequency of the needed information. Each individual receiving information should continually ask himself: what am I going to do with this information? and what would I do if I didn't have it? Then his decision making needs should be relayed to the computer people. Otherwise "your managers will be drowning in ho-hum reports they've been conned into asking for and are ashamed to admit they are of no value." (Townsend, 1970 b, p. 36). Such a course of action would significantly narrow, if not in fact close, the communication and information gap.

In some agricultural cooperatives a genuine lack of accurate and timely data exists, while in others excessive computer output and detailed routine reports obscure the few key figures that are needed for effective decision making. Because this information is not properly filtered or screened, an information gap results between the computer people and management. Consequently, the purpose of identifying information needs and attempting to implement an effective information system is to significantly reduce decision making uncertainty by closing the information gap. However, even if this information gap was virtually closed, the particular decision could not always by executed. In other words, accurate and timely data does not guarantee adequate or correct decisions. It only makes possible more rational decisions than decisions based solely on intuition.

In attempting to alleviate many of the computer inefficiencies, approximately 50% of the surveyed firms have established a regular procedure to both control and evaluate the computer's effectiveness, and to determine improvement needs. About 40% of the cooperatives conducting such an audit have formed some type of committee involving general management and operating personnel to perform the audit; 20% are utilizing outside consultants, and 20% are conducted by data processing personnel. Dean's study indicates that the managements of two-thirds of his surveyed industrial firms use regular audits to improve their control of computer activities and performance.

Also, the larger the company, the greater the likelihood that management audits the computer activities. The following areas were emphasized in Dean's (1968 b) study by the firms in conducting their audits in order of their importance.

1. Appraisal of budgets for new computer systems developments and new equipment.

2. Determination of appropriateness of present systems as management and control tools.

3. Review of the usefulness of present systems to operating people.

4. Checking on adherence to operating budgets and output deadlines.

5. Analysis of systems and operations for potential susceptibility to fraud or other financial irregularity.

6. Evaluation of personnel and management practices affecting computer systems.

7. Review and adherence to development project budgets and schedules.

RATED EFFECTIVENESS

Management personnel of the sampled cooperatives indicated their efforts and effectiveness relative to their competitors in expanding their computer effort for activities other than processing financial information or performing clerical-type work (see Figure 8). The authors hypothesized a relationship between the cooperative's effectiveness-ranking and their actual performance; however, the results of this study reveal no such relationship. Furthermore, no relationship existed among the rated-effectiveness of the cooperatives and their respective groups. Collectively, the cooperatives responded with ranking slightly above average.7/

PROGRAMMING LANGUAGES

In an attempt to determine the exact programming language mix utilized by the surveyed cooperatives each firm was asked to indicate the exact percent of their programming conducted in each of the various programming languages

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7/ Scale: High (5), above average (4), average (3), below average (2), low (1). The average ranking of all surveyed cooperatives is 3.2.

Figure 8. Rated Effectiveness of Present Computer Applications to Areas Other Than Processing Financial Information.

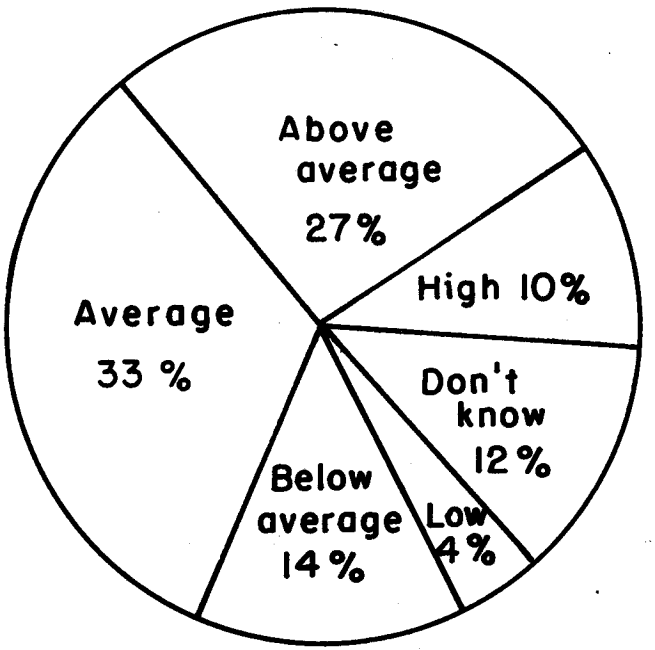
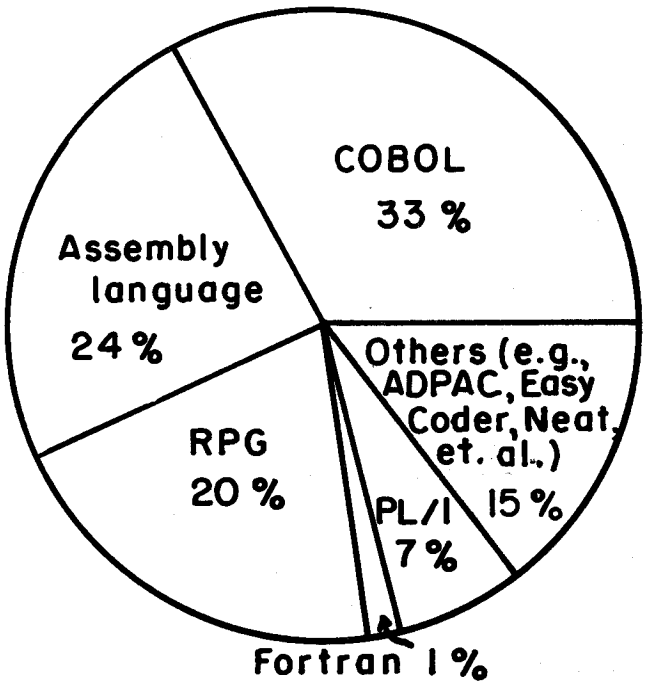


Figure 9. Average Percent of Total Programming Done in Each of the Various Programming Languages by Responding Cooperatives.



(see Figure 9). The percentages in Figure 9 are only averages and do not reflect a suggested programming procedure. Moreover, these percentages indicate only the percent of total programming performed in a particular language and does not reflect the actual usage. Since the usage more accurately reflects the efficiency of the program mixture the exact percent of each programming language actually utilized is desired. For example, if a cooperative was programming in both Assembly Language and Fortran, it is feasible that 50% of the programming could be done in each of the languages and the actual program usage could be significantly different. Further, suppose the cooperative utilizes the Assembly Language programs 80% of the time to 20% Fortran. Within the typical agricultural cooperative business-type utilization circumstances this would appear to be a more desirable program mix than if the two languages were used to the reversed ratio, i.e., 80% Fortran to 20% Assembly Language.

REASONS FOR COMPUTERIZING

Many of the cooperatives indicated, as their initial reason for computerizing, the desire to develop a management information system. Apparently many of the cooperatives believed that by the mere act of installing a computer an effective management information system would evolve. It should be made clear, however, that the computer is only a tool that will, if used effectively, enhance an existing system of collection and distribution of information. Moreover, before the decision to computerize is made, the present system of information retrieval should be reasonably clean and effective; otherwise, the computer will only speed up the inefficiencies of the present system and further complicate matters (Townsend, 1970 c).

The responses of these firms tend to be idealistic rather than realistic in view of the evidence previously presented showing that their initial and present emphasis remain largely with the bookkeeping activities (see Figure 6). The following individual responses reflect a more realistic estimation of the typical cooperative's decision to computerize.

> "Rising labor costs, tight labor markets, lower error rates expected, effective computer salesman, a study of the economics, a desire to be modern.
>
> "Clerical savings plus the knowledge that a computer would be required in the future."
>
> "Data volume--cost reduction."

As the above responses exemplify, many of the cooperatives hoped for significant savings to result from the substitution of the computer for clerical labor. However, today many of these firms are still only receiving those initial benefits and consequently disregarding many of the "decision-making" activities that may have even potentially higher payoffs.

Furthermore, a relationship among the four groups was sought in determining their reasons for computerizing; however, no trend was established.

PURCHASE, RENT (LEASE), OR TIMESHARE

In this section guidelines are presented in the attempt to objectively answer the question--should a firm purchase, rent, or time share?

In general, the decision maker should consider all costs, contingencies, and risks and then choose the cheaper alternative that has strong evidence of effectiveness. In calculating the cost of each alternative, the costs should be stated in terms of their present value. For example, a high purchase/rent ratio does not necessarily indicate that a computer is overpriced and clearly should be rented; it is more likely to indicate that the manufacturer expects the computer to have a relatively long economic life.

A more desirable alternative than only considering the purchase/rent ratio is to calculate the total (present value) cost of each alternative approach--purchase or rent. If one alternative appears to be considerably more desirable than another, the result (if correct) is likely to be caused from significant differences between the situation of the installation in question and that of the typical user. Consequently, it is well for the manager to explicitly identify such differences in order to ensure that they exist and are in fact significant.

An example provided from Sharpe (1969) of computing whether a firm should purchase or rent will illustrate the principle of present value.

Suppose that an agricultural cooperative had decided to use a particular computer for the next 24 month interim period until it purchases new equipment. The relevant decision concerns whether the computer should be purchased or rented? Rental (including maintenance) costs $10,000 per month. The purchase price of the machine is $450,000, the monthly cost of maintenance is $1,200 and the computer's estimated market value 24 months hence is $270,000.

Rental:		
$10,000 per month for 24 months		$240,000
Purchase:		
- Purchase cost	450,000	
- Maintenance ($1200 per month for 24 months)	28,000	
- Less sales value	270,000	$208,800

The above example suggests that it would be cheaper to purchase than to rent; however, this conclusion may be incorrect. The error lies in the addition of dissimilar amounts. A dollar spent 24 months from now is not the same dollar spent today.

In virtually all times and places, goods and services in the present have been considered preferable to equivalent amounts in the future. This problem is coped with by calculating the present value of a dollar given a specific time period and interest rate using the following formula:

$$\text{Present value} = \frac{\text{Future worth}}{(1 + r)^n}$$

where r = interest rate, and n = the period of time covered.

Now suppose that the current rate of interest is 5/12 of 1% (approximately 5% per annum). The policies of renting versus purchasing will indeed be significantly different if the respective cash flows are discounted.

RENTAL:

Period	Cash flow	Present value of $1[8]	Present value of cash flow
1	$-10,000	0.995851	-9,958.51
2	$-10,000	0.991718	-9,917.18
.			
.			
.			
24	$-10,000	0.905025	-9,050.25
		Total present value =	-227,938.98

PURCHASE:

0	-450,000	1.00000	-450,000.00
1	- 1,200	.995851	- 1,195.02
2	- 1,200	.991718	- 1,190.06
.			
.			
.			
24	{ - 1,200 +270,000 }	.905025	{ - 1,086.03 +244,356.75 }
		Total present value	-232,995.93

The above discounting procedure indicates that the original purchase alternative is no longer the financially desirable alternative. Other considerations, however, should also be considered such as the cost of capital and possible tax deductions. For example, if the machine is purchased--outright or on credit--over a period of time the firm may be better off because of possible tax deductions.

A third alternative available to the potential computer user is that of the computer utility or time sharing. Since costs of time sharing computers vary so widely among manufacturers and bureaus, our attempt will be merely to suggest a few guidelines that will provide additional information

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[8] Present value tables are found in most mathematical table texts.

to individuals contemplating time-sharing. The following areas will be discussed regarding the time-sharing alternative.

1) Who are the primary users?

2) What types of applications are conducive to time sharing?

3) What are the advantages and disadvantages of time sharing?, and

4) What is the optimal solution?

Time sharing is used by many small companies which are unable to afford their own computers. However, despite the fact that many small companies are using time sharing they are not the largest consumers; the big users tend to be the large corporations that are also big users of other types of computer equipment. A study by Brandt (1969 a) revealed that 39 percent of time sharing used was by large companies with annual sales in excess of $100 million. However, of these large firms, 93% indicated a decline in time sharing, while firms with sales less than $100 million generally indicated an increasing usage in time sharing.

Many small computer owners have said, "We have our own computer; thus, we have no need for time sharing." A response of this kind is likely to reflect a lack of understanding rather than a measure of cooperative size. There are definite application areas where each type of computer system offers significant advantages over other application areas as the following advantages and disadvantages suggested by Schwab (1968 a).

Beneficial Circumstances of Time Sharing:

1) For the solution of problems with (a) a high amount of computation, to take advantage of economies of scale in processing, and (b) low communication costs for input and output.

2) For the solution of problems requiring a large memory, to take advantage of the economies inherent in sharing a computer's memory (e.g., large linear programming problems).

3) For a relatively small user, in terms of the amount of computation, who has problems with widely varying characteristics; such a user will benefit from a complete programming system, which could not be obtained from renting a small computer of his own.

4) For obtaining the solution of interactive problems common in programming and in research and engineering applications.

Unfavorable Situations:

1) When the penalty of failure is high.

2) For the solution of problems which entail (a) a low amount of computation, in terms of the number of operations, and also (b) high communication costs.

3) For problems whose processing can be easily scheduled and whose execution times are known in advance--as is true, for example, of repetitive problems. (This situation is often found in business applications: a problem such as the payroll processing of a company can be easily scheduled; furthermore, it is repetitive, and thus its execution time is known. Therefore, if problems can be scheduled, a time sharing system, with its capability of program interrupt, may not bring any gains, since a firm can determine its computer needs fairly accurately.)

Optimal Solution

While the large shared computer has significant economic advantages in some situations, it does not provide the optimal solution under all circumstances. Schwab (1969 b) further contends that "in the future users will simultaneously have their own small systems and share larger systems and the combination of small individual computers and a large shared computer may well prove to be the economically optimal solution. Thus, by having access to both a time sharing and a batch-processing system, each problem can be solved with the system best suited for its solution. The question is not whether to have a telephone, write letters, or send wires; we normally have access to all three means of communication. Rather, it is the question of which system is the most appropriate for each type of information to be transmitted."

SUMMARY AND CONCLUSIONS

In the past few years, the major emphasis of the computer industry has been to increase the speed and overall capability of the hardware. The emphasis now, however, involves bringing software in line with the hardware.

Cooperatives in Groups III and IV of this study are confronted with this identical problem. The capabilities of their hardware are beyond the development and sophistication of their software. However, a certain amount of excess capacity should be allowed for future growth and development. The use of the Group III and IV systems in the next few years reflect a shift from the routine bookkeeping chores to those that help management and operating personnel make decisions.

Generally speaking, the hardware of Groups I and II are economically constrained to the bookkeeping activities. In the future most of these managers express the desire for further development of their bookkeeping applications. One alternative available to the managements of Groups I and II is that of time sharing with many of the more sophisticated applications of a computer utility while maintaining their present applications on their given system. In this manner these smaller cooperatives can realize some of the business management benefits that their larger competitors have been enjoying all along. In fact, in many situations the use of a computer utility may also be desirable for many of the firms in Groups III and IV. However, the Group III and IV systems are as fully capable of handling many of the same problems as a computer utility, and in most cases these resources should be allocated towards the development of their own systems.

Perhaps the most important problem affecting the computer utilization of the surveyed cooperatives is reflected in the magnitude of the communication gap between the computer people and management. The firms that were utilizing their systems towards their fullest capability have devised methods of involving management in the determination of new areas of application. Solutions consist of placing management or operating people in charge of the computers, devising regular computer audits involving top management, and explicitly identifying information needs and the relative frequency it is needed. Finally, we would do well to thoroughly consider one computer manager's philosophy, "We must never forget, that it's people who run our computers and not the other way around."

BIBLIOGRAPHY

Brandt, Allen, "Time Sharing Takes Off," Harvard Business Review, March-April, 1969. pp. 128-136.

Dean, Neal J. "The Computer Comes to Age," Harvard Business Review, January-February, 1968, pp. 83-91.

Dean, Neal J. and James W. Taylor, "Managing to Manage the Computer," Harvard Business Review, September-October, 1966, pp. 98-110.

Drucker, Peter, "The Manager and the Moron," condensed from The McKinsey Quarterly, Management Review, pp. 20-26.

Garoian, Leon and Arnold F. Haseley, 1965. Developing Planning Information for Agricultural Marketing Firms. Corvallis. 141 p. (Oregon State University. Cooperative Extension Service).

Harris, Bernard, "Trends in Computer Hardware," Computer Yearbook, Vol. I, American Data Processing, Inc., Detroit, pp. 191-195.

IBM, A Data Processing Glossary (C20-1699-0)(Technical Publications Department, White Plains, New York), 60 p.

Schwab, Bernhard, "The Economics of Sharing Computers," Harvard Business Review, September-October, 1968, pp. 61-70.

Sharpe, William F., The Economics of Computers, (Columbia University Press, New York, 1969) 571 p.

Townsend, Robert, Up the Organization: How to Stop the Corporation from Stifling People and Strangling Profits, (Alfred A. Knopf, New York, 1970) 202 pp.

GLOSSARY[9/]

1. Batch processing: 1) Pertaining to the technique of executing a set of programs such that each is completed before the next program of the set is started. 2) Loosely, the execution of programs serially.

2. Bit: In binary notation, either of the characters 0 or 1.

3. Byte: A sequence of adjacent binary digits operated upon as a unit and usually shorter than a word.

4. Cathode ray tube display: (Abbreviated "CRT display"), 1) A device that presents data in visual form by means of controlled electron beams. 2) The data display produced by the device as in 1).

5. Central processing unit: A unit of a computer that includes circuits controlling the interpretation and execution of instructions.

6. Character: A letter, digit, or other symbol that is used as part of the organization, control, or representation of data. A character is often in the form of a spatial arrangement of adjacent or connected strokes.

7. Computer: 1) A data processor that can perform substantial computation, including numerous arithmetic or logic operations, without intervention by a human operator during the run. 2) A device capable of solving problems by accepting data, performing described operations on the data, and supplying the results of these operations.

8. Core storage: A form of high-speed storage using magnetic cores.

9. First generation computer: A computer utilizing vacuum tube components.

10. Graphic character: A character normally represented by a symbol produced by a process such as handwriting, drawing, or printing.

11. Hardware: Physical equipment, as opposed to the program or method of use, for example, mechanical, magnetic, electrical, or electronic devices. (Contrast with "software").

12. Magnetic Core: A configuration of magnetic material that is, or is intended to be, placed in a spatial relationship to current-carrying conductors and whose magnetic properties are essential to its use. It

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9/ This glossary contains definitions from the following: 1) The U. S. Standard Vocabulary for Information Processing, published by the U. S. of America Standards Institute (USASI); 2) The Proposed U. S. Standard Vocabulary; 3) Sipple, Charles J., Computer Dictionary and Handbook, Howard Sams and Company, Inc., Indianapolis, Ind., 1967.

may be used to concentrate an induced magnetic field as in a transformer, induction coil, or armature, to retain a magnetic polarization for the purpose of storing data, or for its nonlinear properties as in a logic element. It may be made of such material as iron, iron oxide, or ferrite and in such shapes as wires, tapes, toroids, or thin film.

13. Magnetic disc: A flat circular plate with a magnetic surface on which data can be stored by selective magnetization of portions of the flat surface.

14. Magnetic tape: 1) A tape with a magnetic surface on which data can be stored by selective polarization of portions of the surface. 2) A tape of magnetic material used as the constituent in some forms of magnetic cores.

15. Management information system: 1) Specific data processing system that is designed to furnish management and supervisory personnel with information consisting of data that are desired, and which are fresh or with real time speed. 2) A communications process in which data are recorded and processed for operational purposes. The problems are isolated for high-level decision making, and information is fed back to top management to reflect the progress or lack of progress made in achieving major objectives.

16. Memory: See "Storage."

17. Multiprocessing: 1) Pertaining to the simultaneous execution of two or more programs or sequences of instructions by a computer or computer network. 2) Loosely, parallel processing.

18. Multiprogramming: Pertaining to the concurrent execution of two or more programs by a single computer.

19. Offline: Pertaining to equipment or devices not under direct control of the central processing unit.

20. Offline system: In teleprocessing, that kind of system in which human operations are required between the original recording functions and ultimate data processing function. This includes conversion operations as well as the necessary loading and unloading operations incident to the use of point-to-point or data-gathering systems.

21. Online: 1) Pertaining to equipment or devices under direct control of the central processing unit. 2) Pertaining to a user's ability to interact with a computer.

22. Online System: 1) In teleprocessing, a system in which the input data enters the computer directly from the point of origin and/or in which output data is transmitted directly to where it is used. 2) In the telegraph sense, a system of transmitting directly into system.

23. Real time: 1) Pertaining to the actual time during which a physical process transpires. 2) Pertaining to the performance of a computation during the actual time that the related physical process transpires in order that results of the computation can be used in guiding the physical process.

24. Second Generation Computer: A computer utilizing solid state components.

25. Software: 1) A set of programs, procedures, rules, and possibly associated documentation concerned with the operation of a data processing system. For example, computers, library routines, manuals, circuit diagrams. 2) Contrast with "hardware."

26. Storage: 1) Pertaining to a device into which data can be entered, in which data can be held, and from which it can be retrieved at a better time. 2) Synonymous with "memory."

27. Stroke: In character recognition, a straight line or arc used as a segment of a graphic character.

28. Tape drive: A device that moves tape past a head.

29. Telecommunication: 1) Transmission of signals over long distances, such as via telegraph, radio, television. 2) Data transmission between a computing system and remotely located devices via a unit that performs the necessary format conversion and controls the rate of transmission.

30. Teleprocessing: A form of information handling in which a data processing system utilizes communication facilities.

31. Third generation computer: A computer utilizing solid logic technology components, i.e., utilization of miniaturized modules used in computers, which result in faster circuitry because of reduced distance for current to travel.

32. Time-sharing: 1) Pertaining to the interleaved use of the time of a device. 2) Participation in available computer time by multiple users, via terminals. Characteristically, the response time is such that the computer seems dedicated to each user.

33. Total management information system: A system that will instantaneously provide all managers--at every level from plant foreman to chairman of the board--with relevant facts needed in order to make a decision.

34. Word: A character string or bit string considered as an entity.

APPENDIX TABLE A. CURRENT HARDWARE SPECIFICATIONS AS REPORTED BY COOPERATIVES RESPONDING[10/]

Firm	Make & Model No.	Memory Capacity	Card Reader No. & cpm	Card Punches No. & cpm	Printer # & lpm	Magnetic Tapes No. of Tape Drives	Magnetic Disks No. & Capacity
1.	Burroughs 283	96k Characters	800 cpm	100 cpm	750 lpm	3	--
2.	Burroughs 300	98k Chac.	800 cpm	100 cpm	500 lpm	3	1 @ 9.6 Mill. Bytes
3.	Burroughs B-3500	120k Bytes	800 cpm	100 cpm	1040 lpm	-	1
4.	Gen. Elec. Model 415	32k Wds.	900 cpm	100 cpm	1200 lpm	8	--
5.	Honeywell 120 IBM 360/25	16k Bytes 16k Bytes	450 cpm	300 cpm	600 lpm	4	--
6.	H-200	8k Bytes	850 cpm	200 cpm	450 lpm	3	--
7.	H-200	16k Bytes	400 cpm	100 cpm	450 lpm	3	1 @ 8k Bytes
8.	H-120	20k Bytes	300 cpm	400 cpm	450 lpm	-	2 @ 4.6 Mil. Chac.
9.	H 200 Model 120	32k Chac.	400 cpm	100-400 cpm	450 lpm	5	2 (on order)

10/ The order in which the hardware is listed in this Appendix is basically in accordance to an alphabetical listing of the manufacturers. An attempt to list the hardware according to its respective computer generation would be a moot strategy since there are no clear-cut guidelines separating generations. Consequently, such a course of action would be subject to semantic differences. The composition of the electrical circuitry is generally the criterion utilized for the determination of generation differences; however, this information was not readily available.

APPENDIX TABLE A (CONT.)

Firm	Make & Model No.	Memory Capacity	Card Reader No. & cpm	Card Punches No. & cpm	Printer # & lpm	Magnetic Tapes No. of Tape Drives	Magnetic Disks No. & Capacity
10.	H 2200	64k Bytes	1000 cpm	400 cpm	110 lpm	6	1 @ 2.5k Bytes
11.	H 4200	262k Bytes	800 cpm	250 cpm	1100 lpm	9	4
12.	IBM 1130	16k Bytes	400 cpm		100 lpm		
13.	IBM 1410 (2)	20k (1) 40k (1)	800 cpm	250 cpm	600 lpm	729 IV	--
14.	IBM 1440	8k Bytes	400 cpm	91-365 cpm	240 lpm	-	21 packs @ 2 Mil. Bytes/Pk.
15.	IBM 1440	8k Bytes	150 cpm	50 cpm	240 lpm	-	2 @ 2 Mil. Chac. ea.
16.	IBM 6420	1k Bytes	50 cpm	25 cpm	6 lpm		
17.	IBM 360/20	4k Bytes	not specified	not specified	not specified	-	--
18.	IBM 360/20	8k Bytes	500 cpm	100 cpm	600 lpm	-	--
19.	IBM 360/20	8k Bytes	500 cpm	92 cpm	600 lpm	-	--
20.	IBM 360/20 sub 5 disk	16k Bytes	1000 cpm	300 cpm	600 lpm	-	16 disk packs @ 5.4 mil/pk
21.	IBM 360/20	16k Bytes	1000 cpm	200 cpm	600 lpm	4	--
22.	IBM 360/20-sub-model 5	24k Bytes	300 cpm	100 cpm	600 lpm	-	2 (2311)

APPENDIX TABLE A (CONT.)

Firm	Make & Model No.	Memory Capacity	Card Reader No. & cpm	Card Punches No. & cpm	Printer # & lpm	Magnetic Tapes No. of Tape Drives	Magnetic Disks No. & Capacity
23.	IBM 360/20- sub-model 5	32k Bytes	500 cpm	--	600 lpm	--	2 @ 5 Mil. Bytes ea.
24. a.	IBM 360/30	32k Bytes	600 cpm	600 cpm	600 lpm	--	4 @ 4 Mil. Bytes ea.
b.	IBM 360/30	32k Bytes					
c.	IBM 360/25	16k Bytes					
d.	IBM 6400						
25.	IBM 360/25	16k Bytes	240 cpm	240 cpm	600 lpm	--	2 (2311)
26.	IBM 360/30	24k Bytes	1000 cpm	300 cpm	1100 lpm	--	1 (2311) @ 7.5 Mil.
27.	IBM 360/30	32k Bytes	1000 cpm	300 cpm	1100 lpm	4	2 (2311)
28.	IBM 360/30	32k Bytes	1000 cpm	500 cpm	600 lpm	--	5 (2311)
29.	IBM 360/30	32k Bytes	400 max.	250 max.	600 lpm	2	4 @ $7\frac{1}{2}$ Mil. ea.
	IBM 360/20	12k Bytes					
30.	IBM 360/30	32k Bytes	1000 cpm	300 cpm	600 lpm	4	3 @ $7\frac{1}{2}$ Mil. Bytes ea.
31.	IBM 360/30	65k Bytes	1000 cpm	300 cpm	600 lpm	4	4
32.	IBM 360/30	65k	1000 cpm	350 cpm	1100 lpm		
33.	IBM 360/30	65k Bytes	1000 cpm	250 cpm	1100 lpm	2	3(2311)
34.	IBM 360/30	65k Bytes	1000 cpm	300 cpm	600 lpm	2	4 @ 7.25 Mil. Bytes ea
35.	IBM 360/30	65k Bytes	1000 cpm	350 cpm	1100 lpm	2	8 (2314)
	IBM 1401 H	8k Bytes					

APPENDIX TABLE A (CONT.)

Firm	Make & Model No.	Memory Capacity	Card Reader No. & cpm	Card Punches No. & cpm	Printer # & lpm	Magnetic Tapes No. of Tape Drives	Magnetic Disks No. & Capacity
36.	IBM 360/30 IBM 1440	32k Bytes 4k Bytes	1000 cpm	250 cpm	1100 lpm	4	3 @ 7.5 Mil. Bytes ea
37.	IBM 360/30 IBM 360/40	65k Bytes 128k Bytes	1000 cpm	250-300 cpm	1000 lpm	2	4 (2311)
38.	IBM 360/40 NCR 315	128k Bytes 40k Bytes	2 @ 1000 ea 1 @ 400	250 cpm --	2 @ 1100 lpm 1 @ 600 lpm		1 (2314) --
39.	IBM 360/40 IBM 1401	128k Bytes 12k Bytes	1000 cpm 800 cpm	250 cpm 250 cpm	1100 lpm 600 lpm	2 2	1 (2314) 1 (1405)
40.	IBM 360/40	196k Bytes	1000 cpm	250 cpm	1100 lpm	10	233 Mil.
41.	IBM 360/50	256k Bytes	1000 cpm 500 cpm	300 cpm	1000 lpm	8	9 @ 28 Mil. Bytes ea
42.	NCR 500	4.8k Chac. or 4800 Chac.	300 cpm	100 cpm	125 N 62 A/N		
43.	NCR 315 RMC	40k Bytes	--	--	1000 lpm	7	--
44.	NCR Century-200	65k Bytes	750 cpm & 300 cpm	84 to 240	1500 lpm A/N 3000 lpm N	4	4 @ 4.1 Mil. Bytes
45.	NCR 315-100 NCR Century - 200 (ordered)	20k Bytes	--	--	800 lpm	5	--
46.	Univac 418	40k Wds.	600 cpm	250 cpm	600 lpm	4	Fastrand II Drum
47.	Univac 9200	8k Bytes	2 @ 1000 cpm 1 @ 400 cpm	75-200 cpm	250 lpm	--	--

APPENDIX B

Hypothesis #1

Regression analysis was used to determine the relationship between annual sales (X) and annual computer expenditures (Y). The following linear estimation was obtained:

$$\hat{Y} = b_o + b_1 X'$$

where: $b_o = 87.27$ = (expenditures in $ thousands)

and, $b_1 = 2.35$

hence: $\hat{Y} = 87.27 + 2.35X$

Specifically it was hypothesized that there was no relationship between annual sales and computer expenditures (i.e., $H{:}\beta_1 = 0$). This hypothesis was rejected at the 95% significance level; thus indicating a linear relationship between X and Y. The correlation coefficient, r, was .54; meaning that 54% of the total variation about the mean $\overline{Y}$ was explained by the regression. (The correlation coefficient is a measure of the association between the random variables X and Y. For example, if r = 1, X and Y are perfectly positively correlated and the possible values of X and Y all lie on a straight line. If r = 0, the variables are said to be uncorrelated.)

Therefore, we can conclude that there is a significant positive relationship between annual sales and annual computer expenditures. However, sales alone is not an exact predictor; as aforementioned, other factors have a significant effect on computer expenditures such as the type of product marketed, processed, supplied, the maturity of the computer installation, management's attitude towards computer utilization, etc.

Hypothesis #2

Regression analysis was used to determine the relationship between years of computer experience (X) and the percent of total computer usage allocated to the bookkeeping-financial reporting applications.

Specifically, it was hypothesized that there was no linear relationship between the length of computer experience and the percent of total computer time allocated to the bookkeeping applications (i.e., $\beta_1 = 0$). This hypothesis was not rejected at the 95% significance level. Thus, we can conclude there was no statistically significant linear relationship between X and Y at the 95% significance level. The slope of the regression equation was, however, slightly negatively sloping, suggesting that as the years of computer experience increased a smaller percent of total computer time was allocated to the bookkeeping-financial reporting applications.

Hypothesis #3

Regression analysis was used to determine the relationship between years of computer experience (X) and annual computer expenditures (Y).

Specifically, it was hypothesized that there was no linear relationship between X and Y (i.e., $\beta_1 = 0$). By rejecting this hypothesis it could be concluded that as cooperatives gain more experience with their computer installations their computer expenditures would increase (if a positive relationship). However, this hypothesis was not rejected and we conclude that there is no statistical relationship between X and Y.

Hypothesis #4

Regression analysis was used to determine the relationship between annual cooperative sales (X) and the percent of total computer usage allocated to the bookkeeping-financial reporting applications.

Specifically it was hypothesized that there was no linear relationship between variables X and Y. By rejecting this hypothesis it could be concluded that as cooperatives increase their sales volume, the proportion of total computer time allocated to the bookkeeping-financial reporting activities should decrease (if a negative relationship) as a result of increased allocation to other application areas. However, this hypothesis was not rejected despite a slight negatively sloping equation. Therefore, we conclude that there is no statistical relationship between X and Y.

Hypothesis #5

Regression analysis was used to determine the relationship between cooperative annual sales (X) and the percent of total computer usage allocated to the marketing and sales applications.

Specifically, it was hypothesized that there was no relationship between X and Y. By rejecting this hypothesis it could be concluded that as sales increased the percent of total computer time allocated to the marketing-sales applications would increase (indicating a positive relationship). This increase would primarily be at the expense of a decrease in the bookkeeping-financial reporting area. However, the hypothesis was not rejected at the 95% significance level and we can conclude that there is no statistical relationship between X and Y.

Hypothesis #6

Specifically, it was hypothesized that there was a positive relationship between annual cooperative sales and the percent of total computer usage allocated to the financial analysis applications. However, no significant positive relationship was found.

Hypothesis #7

Specifically, it was hypothesized that there was a positive relationship between the amount of computer experience of a cooperative and the amount spent for systems and programs planning. There was a slight positive relationship but not statistically significant.

Hypothesis #8

Specifically, it was hypothesized that there was a relationship between annual sales and whether the cooperative either owned its own computer, leased from manufacturers, or leased from a non-manufacturer. However, no significant relationship was discovered.

Hypothesis #9

Regression analysis was used to determine the relationship between the total number of computer employees (X) and annual computer expenditures (Y). The following linear estimation was obtained:

$$Y = b_o + b_1 X$$

where: $b_o = 16.78$

and, $b_1 = 13.97$

hence: $Y = 16.78 + 13.97\ X$

Specifically, it was hypothesized that there was no relationship between the total number of computer employees and computer expenditures (i.e., H: $\beta = 0$). This hypothesis was rejected at the 95% significance level; thus indicating a linear relationship between X and Y. The correlation coefficient, r, was 92; meaning that 92% of the total variation about the mean Y was explained by the regression. Therefore, the conclusion is that there is a significant positive relationship between the total number of computer employees and annual computer expenditures.