7-1980

Developing System Specification for Selection a Business Minicomputer

William Bobertz

DEVELOPING SYSTEM SPECIFICATIONS FOR SELECTION OF A BUSINESS MINICOMPUTER

by

William H. Bobertz

Bachelor of Science

Northern State College 1976

An Independent Study

Submitted to the Faculty

of the

Department of Accounting and Business Law

of the

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Master of Science

Grand Forks, North Dakota

July
1980

TABLE OF CONTENTS

LIST OF TABLES

Table

CHAPTER I

INTRODUCTION

The advanced technology of today's space age is bringing the speed and storage capacity of the computer to all reaches of society. This technology has spawned a multitude of minicomputers and a new marketplace that is highly competitive and diversified.[1]

Prospective buyers of small business systems include growing businesses which never before needed to automate inventory control, accounting, or manufacturing. Others may have received computing services from a service bureau or a time-sharing terminal.

Too many prospective users of small systems develop a rough plan of their application, and begin immediately talking to vendors to solicit ideas, suggestions, and proposals.[2]

If the prospective user was going to spend tens of thousands of dollars on a new machine for the factory, or was going to hire another secretary, he/she would know exactly what the machine or secretary would do, how they would do it, and in what ways the company would benefit. Unfortunately, this seldom is true with computers.

Most managers of small- or medium-sized organizations depend on computer salespeople to tell them what is best for

their businesses.[3] They become snowed by technical jargon and end up buying a system using as criteria only the price of the system and the proficiency of the salesperson.

This yields a working system because vendors generally are competent and capable of making a system work. However, it often yields a system with too much capability (and too high a price) for the user's needs; or not enough capability because the vendor cut the price to get the order. The result is renegotiation of the contract halfway through implementation when user and vendor discover they did not understand each other.

These problems are avoidable if the user adopts an organized, intelligent approach to the procurement of a business minicomputer system. The user must recognize that some effort and cost must be spent to ensure that the final product will be the most appropriate for the needs of the enterprise, at the best price.

As will be discussed in more detail later, the prospective user must, on his/her own, or with the assistance of outsiders experienced in small business computer systems, define the operation and the flow of information and material throughout the business. When making this analysis, the user should consider the operation both as it currently exists and as he/she would like to have it to make the business more efficient and more profitable.

The user should identify those improvements which are essential and those which are only desirable, and put a

price tag on each so he/she can determine which improvements are economical. The user should then add to this the anticipated growth and changes in the business over the next five years.[4]

The primary goal of this applications study is to produce a set of specifications which represent an itemized description of the data processing objective and requirements of the organization.

The sections of this study which follow will seek, first, to put the term "minicomputer" into perspective by examining its development, characteristics, and classifications.

The second portion of the study will focus on the information required to develop the processing objectives and requirements of the system and various methods available for assembling that information.

The last part of the study will examine the process of translating system requirements into system specifications.

ENDNOTES FOR CHAPTER I

1. Thomas F. Tapper, "The Installation," Michigan CPA 30 (November-December 1978): 45.

2. Dan M. Bowers, "Implementing a Small Computer System," The Office 88 (July 1978): 48.

3. Robert S. Kintisch, "It's Still a Big Step To Install A Small Computer," Administrative Management 39 (November 1978): 26.

4. Bowers, "Implementing a Small Computer System," p. 48.

CHAPTER II

MINICOMPUTERS: IN PERSPECTIVE

Starting in the mid-1940's with the programmable vacuum-tube computer that was developed to compute ballistic firing tables, the growth of computers has been extremely rapid both in capability and quantity. Early vacuum tube technology limited computer memories to thousands of words and memory access time to hundreds of microseconds.

The vacuum-tube type of machine was made obsolete in the late 1950's by the transistorized computer. A transistorized computer could be made more powerful, less expensive, smaller in size, more reliable, and with less power dissipation than its earlier counterpart. An upper limit of tens of thousands of instructions per second was now expanded to hundreds of thousands of instructions per second.

The second generation computer shared many of the earlier first-generation peripherals such as magnetic tape drives and magnetic drums with more cost-effective storage devices such as fixed- and moving-head disks.

The next quantum jump was also made possible by advancements in solid-state technology. Space-age requirements for highly reliable, compact navigational and guidance

computers for the Minuteman missle, as well as various manned and unmanned spacecraft, accelerated the development of integrated circuit technology,[1] so that by the mid-1960's, the third-generation computer had found its way into the commercial computer market. The change from second- to third-generation peripherals was related to throughput and capacity rather than new types.

Sometime in the early 1960's, the rapidly declining cost of integrated circuits, coupled with the demand for low-cost, limited-capability data processors, brought about the minicomputer.

It is difficult to pinpoint the exact year that the minicomputer originated. Small airborne computers using a 16- or 18-bit word format had been developed by the early 1960's, and a transistorized 12-bit, low-cost machine was introduced on the commercial market a few years later. It was not until integrated circuits had become commercially available that the minicomputer market exploded.

The transition from third to fourth generation is hard to pinpoint. It may have started with the introduction of militarized computers using medium-scale integrated (MSI) circuits in the late 1960's or with the advent of large-scale integrated (LSI) circuits in microminiaturized

---

[1]Integrated circuit technology started in the early 1960's with the development of a complete logic function such as a single gate or flip-flop on a single chip. Later developments included the medium-scale integrated circuit with more than twelve functions per chip and the large-scale integrated circuit with more than 100 functions per chip.

aerospace computers in the early 1970's. The fourth generation incorporated changes in storage technology, with solid-state memory replacing or complementing the earlier core technology, in addition to microminiaturized logic technology.[2]

The preceding paragraphs discussed the early development of computers, but what exactly is meant by the term "minicomputer?"

Minicomputer Characteristics

Most computers are categorized in terms of central processing unit (CPU) capability, word length, memory capacity, speed, input/output (I/O) capability, complexity of the interface, reliability, maintainability, and supplied software.[3]

Minicomputers differ in their architecture, data formats, peripheral equipment, and software; there are, however, several characteristics that distinguish commercially oriented minicomputers from larger general-purpose computers. These characteristics will be discussed in the paragraphs which follow.[4]

As a general rule, the central processor is a single-address, binary machine where negative numbers are expressed in two's complement, word size ranges between eight and sixteen bits, and the number of general-purpose hardware registers ranges from one to eight.[5]

Hardware multiply/divide facilities are standard in some minicomputers and optional in others. When no hardware facilities are present, multiplication and division must be performed by means of programmed subroutines at a significant reduction in execution speeds.[6]

Floating-point arithmetic, decimal arithmetic, and searches, which are found on larger machines, are seldom available in the miniprocessor.[7]

Hardware byte manipulation is the ability to conveniently process information expressed in the 8-bit character codes which are rapidly becoming an industry standard. Most of the 8-bit minicomputers are effective byte manipulators, and many 16-bit machines offer special instructions that permit either half of a word to be addressed and processed as an 8-bit byte.[8]

The memory increments for the majority of minis are either 1024, 4096, or 8192 words, and the maximum memory size for most minis is 32,000 words, although some minicomputer memories can be expanded to 128,000 or even 256,000 words. Many minicomputer memories feature both parity check and memory protect, although these may be optional features.

The input/output section is an integral part of most minicomputers.[9] A direct memory access channel (DMA) permits direct transfer of I/O data between main storage and a peripheral controller. When a DMA channel is used, the

I/O data bypasses the computer's main hardware registers, and the I/O operation proceeds independently of program control once it has been initiated by the program.

In minicomputers that lack a DMA channel, I/O data transfers are generally carried out under direct program control, with each word being transferred by way of the processor's registers.

Regardless of the type of I/O control they employ, most minicomputers can accomodate multiple I/O devices and include appropriate facilities for addressing the desired device.[10]

Minicomputer systems can support a full range of peripheral devices. Minicomputer systems support the use of card readers, hardcopy and visual display terminals, magnetic tape and disk devices, and printers. However, the advent of minicomputer systems has given rise to many new types of peripheral devices.

Minicomputer systems effectively employ magnetic tape as a secondary storage medium. However, the use of tape cassettes, similar to those used for home tape recordings, is possible with minicomputers. This unit both reads and writes data on cassette. A tape cassette is a portable means of storing approximately 250,000 characters of data.[11]

Magnetic tape cassettes offer increased convenience in that they can be transported and stored with little fear of damaging the data that has been recorded.[12]

Manufacturers have developed smaller disk drives for use with minicomputer systems. The compact disk drive utilizes a removable disk capable of storing up to 80 million characters of data.

A more specialized means of disk storage is the disk drive unit that contains a small magnetic disk called a diskette. The diskette is enclosed in a plastic envelope and is manually inserted into the small disk drive. The storage capacity of a diskette is approximately 1 million characters.

In many minicomputer systems, the diskette is employed as a backup storage medium, in much the same way that a magnetic tape might be used. However, it also provides a limited, low cost means of random access storage.

Another means of magnetic storage similar to the "hard" diskette is the "floppy" diskette.[13] The diskette itself consists of a flexible Mylar disk, about eight inches in diameter, that is permanently housed in a plastic envelope. It can serve as an input/output and/or random-access storage medium that is considerably smaller in capability and slower in performance than conventional disk units, but also far lower in cost. The storage capacity of a "floppy" diskette is approximately 250,000 characters.

Recent enhancements to the floppy disk concept include more concentrated data storage and "flippies" (floppy disks that utilize both sides of the diskette), allowing more data to be stored on-line.[14]

These newer peripheral devices broaden the operational capabilities of minicomputer systems. They offer users great flexibility in satisfying their data processing needs.

The software used in minicomputer systems can be divided into the broad areas of systems software and applications software.

Systems software are manufacturer-supplied programs which are used to control the operational activities of the system. This software includes any of the supervisor control programs, operating systems software, utility programs, and language compilers.

Applications software are user-written programs which are applied to specific data processing tasks, such as processing a payroll, updating an inventory, or preparing customer monthly statements. The languages BASIC, FORTRAN, COBOL, and RPG are employed in minicomputer systems, depending on the manufacturer.[15]

Classifications

Minicomputer systems are divided into three operational classes: mini-, midi-, and maxi-minicomputers. Each classification is defined by a set of operational limits, as shown in Table 1. Entries in the table are representative of each category; however, actual amounts will vary between manufacturers and available models.

Mini-minicomputer

The mini-minicomputer is the smallest type of mini-

TABLE 1

CLASSES OF MINICOMPUTER SYSTEMS

	Mini-	Midi-	Maxi-
Capacity:			
CPU storage, in bytes	4K - 16K	16K - 64K	64K - 256K
Online disk storage, in millions of bytes	1 - 10	10 - 80	40 - 512
Peripherals:			
Printer speed	30-165 CPS	200-600 LPM	600-1200 LPM
Magnetic tape	Not normally used	Limited use	Limited use
Card reader	Not normally used	Used	Used regularly
Number of CRT's system can support	1 - 2	3 - 16	4 - 33
Price range, in $1,000's	8 - 50	50 - 100	100 - 300

NOTE: Abbreviations:

K - 1024 bytes of storage
CPS - characters per second
LPM - lines per minute
CRT - cathode ray tube (television-like video display terminal)

SOURCE: Lawrence S. Orilia, Introduction to Business Data Processing (New York: McGraw-Hill, Inc., 1979): p. 424, table 11.2.

computer system and possesses a limited set of operational features. It has the smallest CPU capacity, supports one to two visual display terminals, and has the lowest average cost range.

Mini-minicomputers are successfully used in financial planning, processing accounts receivable or accounts payable data, and in auditing and engineering applications. Despite their effectiveness, however, mini-minicomputer systems are restricted in the scope of their activities. They are normally applied to one type of problem and do not possess the operational capabilities of the larger systems.

An example of a mini-minicomputer system is the Wang WCS/20 minicomputer. The WCS/20 incorporates a CPU of 8K, a CRT with a keyboard, and a thermal printer to provide hardcopy outputs.

Midi-minicomputer

Midi-minicomputers can be applied to a wider range of data processing activities. They offer larger CPU's and permit more terminals and other peripheral devices to be attached to the system. Midi-systems also incorporate online disk storage which approaches 80 million characters in some models. These additional features expand the usefulness of midi-minicomputers.

One of the primary objectives of minicomputer systems is to provide a teleprocessing capability in a small computer system. This is a feature in almost all minicomputers.

However, it is also necessary to provide minicomputer systems with the ability to batch-process data. The midi-system handles both tasks extremely well. This system can handle one large problem or several smaller concurrent activities.

Examples of midi-minicomputer systems are the NCR 8250 and UNIVAC BC/7 systems.

The basic NCR 8250 has a CPU size of 48K, which can be increased by increments of 16K until a maximum size of approximately 128,000 bytes of storage is attained. Similarly, the online storage capacity of the 8250 begins at 10 million bytes and can be increased to 80 million bytes. The 8250 system can support a maximum of seven terminals. This system can be used to teleprocess data and to batch-process data; however, it cannot perform both tasks simultaneously since only one CPU is available. The 8250 system is supported by a full complement of peripheral devices.

The UNIVAC BC/7 is a midi-minicomputer with a CPU size of 48 or 64K. The peripheral devices available with the BC/7 include terminals, printers, and magnetic disk and tape devices. It has an online disk storage capacity of 40 million bytes. The BC/7 can support the online and batch processing of data related to all types of business applications. This system has been sucessfully applied to inventory control, accounts payable or receivable, payroll, and the projection of future sales.

Maxi-minicomputer

Maxi-minicomputers have even greater operational capabilities. They employ larger CPU's, support the use of more terminals, and possess greater online storage than the midi-minicomputer systems. Maxi-systems fully support online

and batch processing, and can perform both concurrently. The capability to concurrently support batch and online processing adds a significant dimension to maxi-minicomputer systems.

It should be noted that minicomputers are not the only systems capable of this type of concurrent processing. Although the cost of a minicomputer that performs this type of processing may exceed $100,000, a comparable conventional system may cost three to four times that amount.

Two systems that are classified as maxi-minicomputers are the BASIC-Four and Burroughs B 800 systems.

The BASIC-Four system possesses a CPU of 64K (which can be built up to 128K) and an online disk storage capacity of 300 million characters. It can support the use of 16 terminal devices. The BASIC-Four system can perform batch processing, online processing, or a combination of both. This system permits the online access of separate files and the concurrent batch processing of other data.

The B 800 system possesses similar operational capabilities. It may possess a CPU of 64K or larger, maintain an online storage of 512 million characters on magnetic disk units, and support teleprocessing via 33 terminals.[16]

The preceding sections dealt with minicomputer characteristics and classifications, but what exactly is a small business computer and who makes up the small business computer industry?

Small Business Computer and the Small Business Computer Industry

Small business computers are a subset of minicomputers; the distinction rests on a strong orientation, in both equipment and software, toward conventional business data processing applications.

The small-business computer market is served by four distinct types of vendors.

The first is large, established companies such as Burroughs, NCR, and IBM, all of which market large computers and have long-established product lines and large marketing resources.

A second group consists of "traditional" minicomputer manufacturers such as Hewlett-Packard, Data General, and Digital Equipment Corporation. This group was active in the 1960's serving primarily a scientific market. As the small-business market has grown, this group of manufacturers has repackaged its equipment with new software aimed at the small-business market.

A third group of "turnkey" vendors purchases minicomputers and/or peripherals from manufacturers, supplies software packages, and markets the resulting configuration.[17] These third parties are often referred to as original equipment manufacturers, or OEM's.

A subset of this group consists of software suppliers who do not buy and sell hardware. These application software suppliers are usually referred to as software houses or system houses.[18]

These "turnkey" vendors tend to offer more software support and/or customized software than minicomputer manufacturers, although the gap is being closed by the larger manufacturers.

A fourth group consists of semiconductor and microcomputer companies that have begun to offer small-business systems aimed primarily at the lower end of the small-business market. Complete microcomputer-based business systems may be purchased from a new breed of consumer-oriented "computer stores" for less than $5,000.

The bulk of the minicomputer business is captured by the first group of established computer companies who are also leading suppliers of office equipment and business paper.[19]

The preceding portions of this study have focused on clarifying the term "minicomputer" by discussing typical minicomputer specifications, characteristics, and classifications.

The remaining portions of the study will deal with the information necessary to develop system requirements, methods of obtaining this information, and the translation of system requirements into system specifications.

ENDNOTES FOR CHAPTER II

2. Cay Weitzman, Minicomputer Systems: Structure, Implementation, and Application (Englewood Cliffs: Prentice Hall, Inc., 1974), pp. 1-4.

3. Ibid., p. 4.

4. George H. Bodner, Accounting Information Systems (Boston: Allyn and Bacon, Inc., 1980), p. 394.

5. Weitzman, Minicomputer Systems: Structure, Implementation, and Application, p. 9.

6. Datapro Research Corporation, Minicomputer Specifications (Delran: Datapro Research Corporation, 1976), p. 5.

7. Weitzman, Minicomputer Systems: Structure, Implementation, and Application, p. 9.

8. Datapro Research Corporation, Minicomputer Specifications, p. 5.

9. Weitzman, Minicomputer Systems: Structure, Implementation, and Application, p. 9.

10. Datapro Research Corporation, Minicomputer Specifications, p. 5.

11. Lawrence S. Orilia, Introduction to Business Data Processing (New York: McGraw-Hill, Inc., 1979), p. 431.

12. Datapro Research Corporation, Minicomputer Specifications, p. 7.

13. Orilia, Introduction to Business Data Processing, pp. 432-434.

14. Datapro Research Corporation, Minicomputer Specifications, p. 7.

15. Orilia, Introduction to Business Data Processing, pp. 434-435.

16. Ibid., pp. 423-428.

17. Bodner, Accounting Information Systems, p. 395.

18. J. Richard Dowell, "So, You Want to Buy a Minicomputer?" Price Waterhouse Review 22 (#3 1977): 21.

19. Bodner, Accounting Information Systems, p. 395.

CHAPTER III

DETERMINING SYSTEM REQUIREMENTS

On his own, or with the assistance of outsiders experienced in small business computer systems, the prospective user should define his operation and the flow of information and material through the business, as it currently exists and as the user would like to have it to make the business more efficient and profitable.

The user should identify those improvements which are essential and those which are only desirable, and put a price tag on each so he can determine which improvements are economical. The user should then add to this the anticipated growth and changes in the business over the next five years.

From a description of the business to be automated, a description of the specifications for equipment necessary to perform the work can be written.[1]

Analysis of the Present System

Any effort to develop the management information needs of an enterprise should begin with a study of the present management information system.

Such a study allows management and/or the systems analyst to look into the way things are presently being done,

look for trouble points or bottlenecks, determine what else has to be done and the impact of various changes, and then develop a better system.[2]

The business objectives of management are of fundamental importance in this analysis since their views should set the direction in a variety of areas including the firm's projected growth, new or better information needs, desire to implement cost controls or savings, improvement in competitive services, and other possibilities.[3]

Understanding company objectives should clarify what each of the systems or subsystems within the enterprise is intended to accomplish.

The study of the company should produce valuable information concerning:

a) Organizational Data. Who's who in the company, the company's organization chart, the true relationships between departments (the informal organizations), the staffs of each department, personnel and equipment of each department, etc.

b) Historical and Industrial Background. The variations in business conditions and products; past economic conditions; the number of existing customers, potential customers, employees, vendors, etc.

c) Policies, Practices, and Regulations. The policies and practices of the company regarding employees, products and service; governmental regulations affecting the company, etc.[4]

In general, the data to be collected will answer general questions such as the following: (1) What output results are currently being achieved? (2) What processing is needed? (3) What input data are processed to produce the output results?[5]

Table 2 contains a detailed list of questions which should be answered during the course of the analysis.

TABLE 2

DATA GATHERING QUESTIONS

System Output Questions

What output reports are prepared? What other output is received?

What is the purpose of the output information?

Who uses the output information? How is the output information actually being used?

How accurate is the output? Do controls exist to ensure accuracy?

How timely is the output? How is output stored and retrieved?

Have controls been established to maintain the security of output information?

Processing Questions

What records and files are being kept to support the operation?

How frequently--daily, weekly, monthly--is processing being performed? What is the volume or magnitude of work in each phase of the operation? What volume fluctuations occur in the operation?

What is the cause of these fluctuations?

What is the flow of work? What sequence of steps is followed to perform the processing?

What controls have beeen incorporated to maintain data integrity and prevent processing errors? What security controls are there?

Have processing standards been established? Are they followed?

What departments are involved in the processing? What place in the organization do they occupy? What is the primary function of these departments?

How many people are involved in the processing? What are their skill levels?

How much time is required for processing?

What materials and supplies are being used? In what volumes?

TABLE 2--Continued

System Input Questions

How are data introduced into the system? What source documents are received? How are they stored and retrieved? What source documents are actually used?

Where does input originate? In what form? Who originates the input?

What is the frequency of input--daily, weekly, or monthly?

What is the maximum volume received? The minimum? The average?

When do the peak periods occur? The slack periods?

Do procedure manuals and standards exist in the input departments? How reliable is this documentation?

What controls are there on accuracy, integrity, and security of input data and source documents?

SOURCE: Donald H. Sanders, Computers in Business 4th ed. (New York: McGraw-Hill, Inc., 1979): 219, figure 8-6.

The data gathered during this study of the company reveals the essential nature of the current system's information flows, thereby underscoring the degree of change that will be necessary. Further, the investigation reveals problems with the current system which must be resolved before computerization. Otherwise, they may be amplified thereafter.

An analysis of this data includes evaluation of the current system in terms of efficiency and effectiveness. Each aspect of the system should be questioned as to its purpose.

Sometimes because a system has evolved piecemeal over an extended period of time, the usefulness of certain parts of the system may be difficult to discern. Personnel conducting the analysis should look for opportunities to eliminate, to simplify, or to combine operations. The overall emphasis

should be on identifying problems which should be solved before computerization.[6]

The major ways in which work simplification can be accomplished is through the use of the following processes:

1) Try to eliminate unnecessary forms. A copy of a report which is merely filed can perhaps be eliminated.

2) Eliminate those steps which perhaps represent a duplication of effort. A report which recaps orders may be eliminated because the basic information is available from a report which recaps shipments.

3) Combine steps. Instead of having data go to the same work station at two different times, have everything completed the first time it arrives at that station.

4) Rearrange steps so that they may have a more logical flow.

5) Instill in others a plain method of simplifying things and making them easier to perform. Car manufacturers have made all car prices in whole dollars, and airlines have made all fares in whole dollars. This has made tax calculation easier and has reduced errors.[7]

In conducting the study of existing methods and procedures, the study personnel should be seeking to identify areas of potential automation.

Identification of Potential Automated Applications

Classical indicators of application feasibility are "yes" answers to any of the following questions:

1) Do the applications involve high direct and indirect clerical cost?

2) Are any of the major competitors presently running these applications on computer systems?

3) Is improved customer service required?

4) Is a high degree of accuracy required?

5) Are complex mathematical or logical techniques and formulae used?

6) Is there a need for summary information that is drawn from various files?

7) Is there an urgent requirement for more timely and accurate reports?

8) Are there many time-consuming, high-volume operations requiring many repetitive tasks?

9) Are the actions taken within the application fairly straight forward?

10) Is there a requirement for high volumes of data to be manipulated, received or transmitted?

11) Is there a relatively small amount of subjective judgment involved?

12) Is there a requirement for short response time for action?

Applications meeting one or more of the above criteria are good candidates for automation.[8]

As a result of the system review and analysis, a detailed list, by application, of the potential capabilities of an automated system should be developed.

The list of potential capabilities for each application should not be oriented toward how the system will produce the desired information but rather toward what end-product information is needed.[9]

Methods of Obtaining Required Information

As noted earlier, the process of determining the management information needs begins with a review and

analysis of the present system: the inputs, the outputs, and the required processing.

Existing management reports should be studied to determine the basic characteristics of the output. The characteristics of interest are purpose, form, responsiveness, frequency of occurrence, number of copies, volume, and distribution.

Each of the inputs studied will have, like the outputs, certain recognizable and definable characteristics. Some of the characteristics of interest are purpose, form, methods and media, format and message length, frequency of occurrence, volume (daily, weekly, monthly, and peaks), and the source of the inputs.

Processing should be described in terms of the function performed. Enough detail should be given about the operation of a processing function, but not so much about it as to impose preconceived limitations on the process.[10]

Study personnel have various techniques available to them in assembling the necessary factual information for development of system requirements.

The paragraphs which follow will discuss some of the techniques which are available.

Interview

Interviewing has two main objectives: to enable the

interviewer to discover and verify facts, and to provide an opportunity to meet and overcome resistance.[11]

The interview provides the opportunity for face-to-fact contact and for exploration in depth of any key segment of data. The interviewer should have a prepared list of key questions. Without such a predetermination of subject matter, there is a danger that important aspects may be overlooked.[12]

Questionnaire

The questionnaire is most valuable when a small amount of information is required from a larger number of persons or when a systematic study of one unit's activities is made.[13]

It has the advantage of unlimited range of what can be covered and is more economical than a personal interview. However, there are also disadvantages.

It is difficult to secure replies from everyone and/or the replies may be inadequate. People may also be willing to talk about controversial results, but unwilling to put them in writing. Then there is the matter of different interpretations of the questions and/or the answers.[14]

Certain areas of systems analysis lend themselves to the use of a questionnaire or survey, for example, form and/or report distribution and usage, task lists, and activity lists.

A questionnaire on form or report distribution might

contain such questions as:

1) Do you still require this report?

2) If you do, what information do you use?

3) How do you use it?

4) What additional information should be in the report?

5) How would you use the additional information?[15]

The task list is made up by each person in the unit or area being studied. It is a detailed record of the regular daily jobs performed by the individual.

An activity list is prepared by the head of a unit or section and consolidates the task lists made out by each individual.[16]

Observation and Record Inspection

The purpose of observation is multifold. Its use allows study personnel to determine what is being done, how it is being done, who does it, when it is done, how long it takes, where it is done, and why it is done.

Observation can be used to verify what was revealed in an interview or as a preliminary to interviewing. Observation is also a valuable technique for gathering facts representing relationships.

Observation tends to be more meaningful at the technical level of data processing where tasks can be more easily quantified. Technical activities include tasks related to data collection, accumulation, and transformation.

Decision making activities do not lend themselves to observation as easily. Decision making activities can best be understood through the process of interviewing and other fact finding techniques.

Study personnel can observe in any of three basic ways. First, study personnel may observe a person or activity without awareness by the observee and without any interaction between observer and observee.

Secondly, study personnel can observe an operation without any interactions but with the party being observed fully aware of the observation.

Lastly, study personnel can observe and interact with the persons being observed. This interaction can be simply questioning a specific task, asking for an explanation, and so forth.[17]

Record inspection involves inspecting the actual results and records of the system. It requires detailed counting of entries, numbers of documents, timing of throughput, and so on, usually to quantify facts obtained through questionnaires or interviews.[18]

Distribution Charts

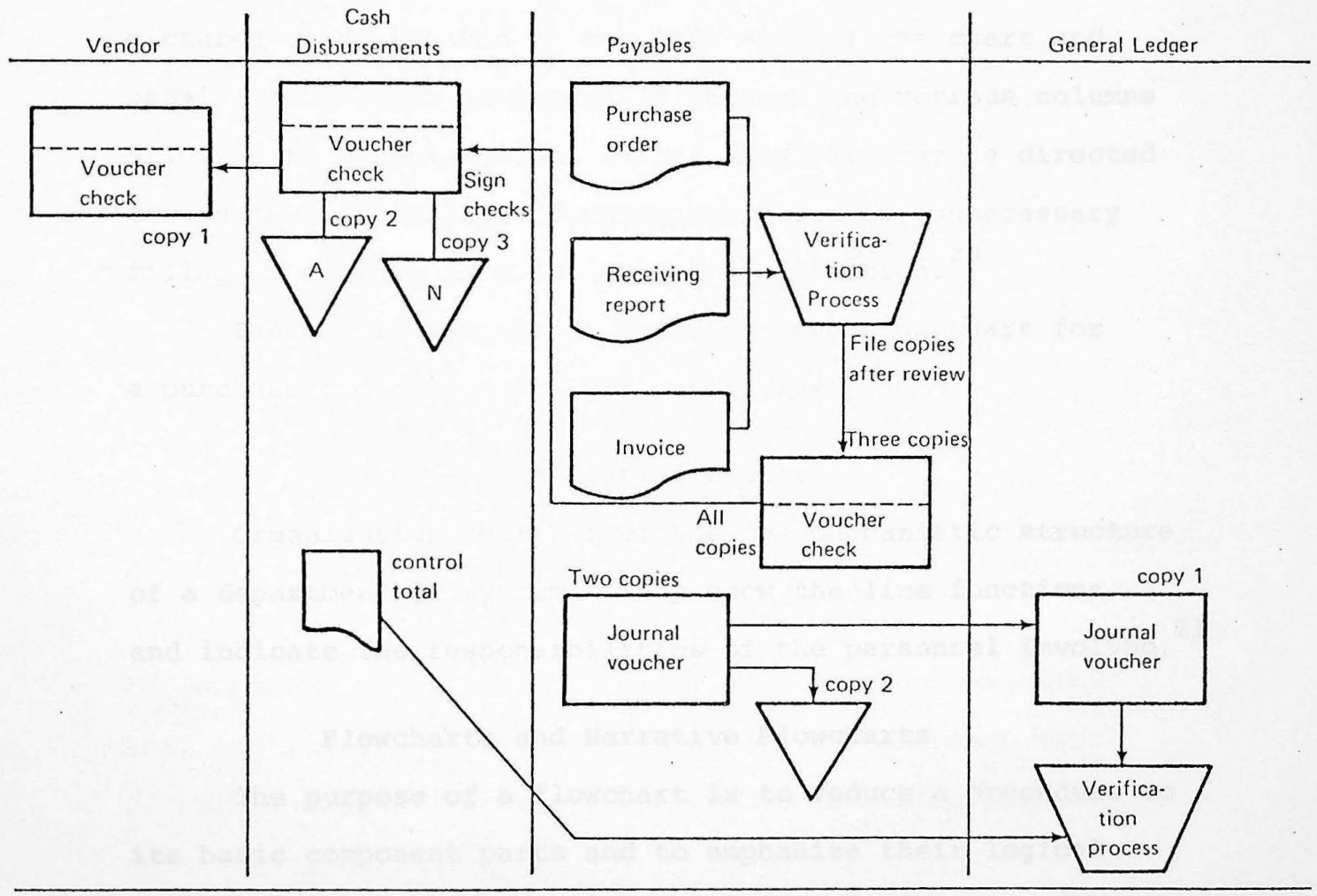
A document flowchart may be used to illustrate the flow of documents within a procedure. The intent is to take each document used in a procedure, identify its point of origination, distribution, and ultimate disposition with

respect to the various organizational entities (departments or persons) that are affected by the procedure.[19]

Table 3 illustrates a document flowchart for a voucher in a typical enterprise.

TABLE 3

DOCUMENT FLOWCHART OF A VOUCHER PROCEDURE



SOURCE: George H. Bodner, Accounting Information Systems (Boston: Allyn and Bacon, Inc., 1980): p. 45, figure 2.8.

Closely related to the document flowchart is the forms distribution chart. A forms distribution chart illustrates the distribution of multiple-copy forms within an organization. The emphasis is on who gets what forms, rather than on how these forms are prepared.

Forms may be represented by symbols, reduced photos of the form itself, or simply word descriptions. The form is pictured or designated on the left side of the chart and usually progresses horizontally through the various columns allotted to organizational units. Analysis may be directed toward the elimination of unnecessary copies, unnecessary filing of copies, or unauthorized distribution.[20]

Table 4 illustrates a forms distribution chart for a purchase order in a typical enterprise.

Organization Charts

Organization charts indicate the mechanistic structure of a department or system. They show the line functions and indicate the responsibilities of the personnel involved.[21]

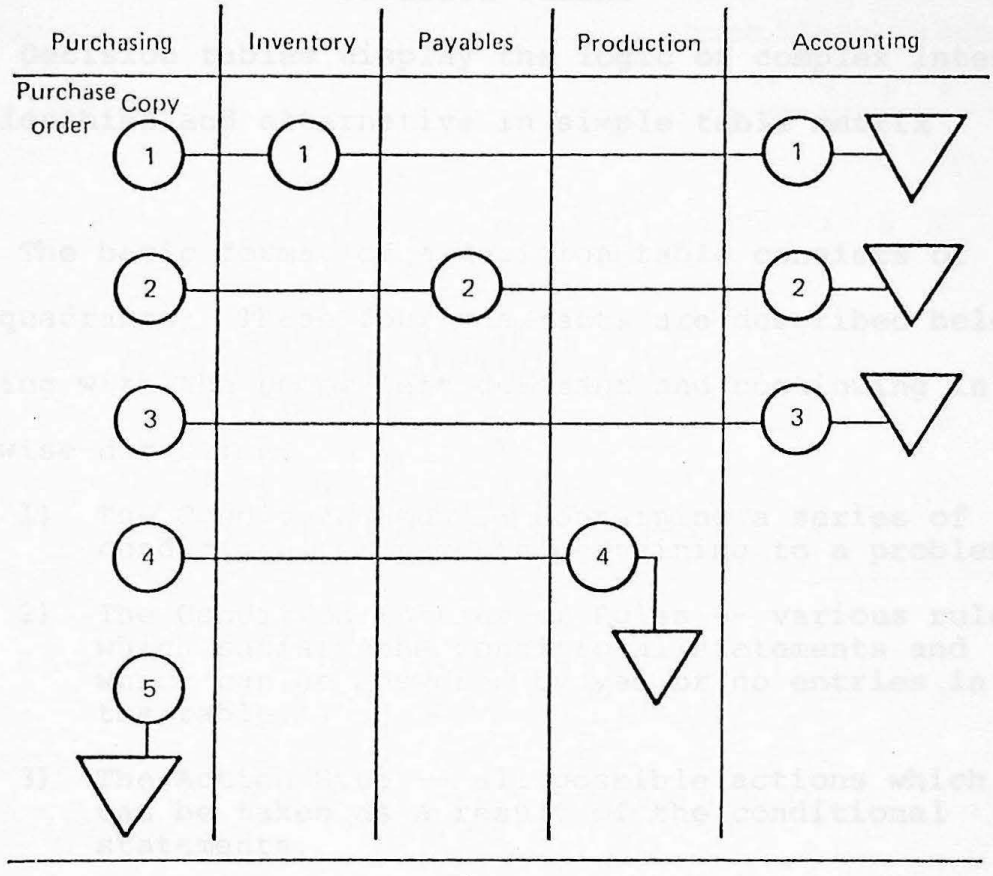
Flowcharts and Narrative Flowcharts

The purpose of a flowchart is to reduce a procedure to its basic component parts and to emphasize their logical relationships. A connected pattern of activity can thus be traced and will highlight duplications and repetitive activities.[22]

In a step-by-step graphic representation, it can help

TABLE 4

FORMS DISTRIBUTION CHART FOR A PURCHASE ORDER



SOURCE: George H. Bodner, Accounting Information Systems (Boston: Allyn and Bacon, Inc., 1980): p. 46, figure 2.9.

to determine whether all steps of a system are accounted for, and its use of symbols and flow-lines reduces the volume of written descriptive material and cross-reference notations required.[23]

A narrative flowchart extends the concept of a graphic representation. The narrative that accompanies the flowchart describes not only the events or happenings, but also the volumes, rates, frequencies, and peak workloads for the 'exceptions' as well as the 'normal'

processes during the course of these events.[24]

Decision Tables

Decision tables display the logic of complex interrelationships and alternative in simple table matrix form.

The basic format of a decision table consists of four quadrants. These four quadrants are described below starting with the upper left quadrant and continuing in a clockwise direction:

1) The Condition Stub -- containing a series of conditional statements pertaining to a problem.

2) The Condition Entries or Rules -- various rules which satisfy the conditional statements and which can be answered by yes or no entries in the table.

3) The Action Stub -- all possible actions which can be taken as a result of the conditional statements.

4) The Action Entries -- all the action or actions that can be taken for each specific condition entry or rule.[25]

Table 5 illustrates the use of a decision table in analyzing a typical purchasing department.

The preceding section focused on the information necessary to develop the requirements of the system and various methods for obtaining that information. The next section will deal with the process of translating system requirements into system specifications.

TABLE 5

DECISION TABLE SHOWING PURCHASING RULES

	1	2	3	4	5	6	All Other
Is order up to $500?	Y	N	N	N	N	N	
Is order $501 - $20,000?	-	Y	Y	Y	N	N	
Is order to a subsidiary?	-	Y	Y	N	-	-	
Is order for capital equipment?	-	Y	N	N	-	-	
Is order $20,001 - $50,000?	-	-	-	-	Y	N	
Is order over $50,000?	-	-	-	-	-	Y	
Approval by:							
Buyer	X	X	X	X	X	X	
Manager, Purchasing Department				X			
General Manager		X					
V. P., Operations					X		
President						X	
See Supervisor							X

NOTE: A dash (-) indicates not applicable.

SOURCE: Richard W. Lott, Basic Systems Analysis (San Francisco: Canfield Press, 1971): p. 93, figure 6-2.

ENDNOTES FOR CHAPTER III

1. Bowers, "Implementing a Small Computer System," p. 48.

2. Edward O. Joslin, comp., Analysis, Design and Selection of Computer Systems, 2nd ed. (Arlington: College Readings, Inc., 1974), p. 67.

3. Stephen A. Levine, "The Requirements Analysis Approach for Selecting a Business Minicomputer," Massachusetts CPA Review 4 (May/June 1977): 18.

4. Joslin, comp., Analysis, Design and Selection of Computer Systems, p. 67.

5. Donald H. Sanders, Computers in Business, 4th ed. (New York: McGraw-Hill, Inc., 1979), p. 218.

6. E. Earl Burch and Carl Gooding, "Planning for Computerization," Managerial Planning 26 (March/April 1978): 29.

7. Richard W. Lott, Basic Systems Analysis (San Francisco: Canfield Press, 1971), p. 204.

8. Joslin, comp., Analysis, Design and Selection of Computer Systems, p. 3.

9. Mark L. Hildebrand and Karl G. King, "How to Help a Client Select a Data Processing System," The Practical Accountant 12 (September 1979): 46-47.

10. Joslin, comp., Analysis, Design and Selection of Computer Systems, pp. 68-69.

11. Alan Daniels and Donald Yeates, ed., Systems Analysis (Palo Alto: Science Research Associates, Inc., 1971), p. 18.

12. Joslin, comp., Analysis, Design and Selection of Computer Systems, p. 60.

13. Daniels and Yeates, ed., Systems Analysis, p. 22.

14. Joslin, comp., Analysis, Design and Selection of Computer Systems, p. 61.

15. Daniels and Yeates, ed., Systems Analysis, p. 23.

16. Association for Systems Management, Auditing for Systems Improvement (Cleveland: Association for Systems Management, 1972), pp. 9-10.

17. John G. Burch and Felix R. Strater, Information Systems: Theory and Practice (Santa Barbara: Hamilton Publishing Company, 1974), p. 461.

18. Daniels and Yeates, ed., Systems Analysis, pp. 25-26.

19. Bodner, Accounting Information Systems, pp. 46-47.

20. Ibid., p. 47.

21. Daniels and Yeates, ed., Systems Analysis, p. 29.

22. Ibid., pp. 30-31.

23. Joslin, comp., Analysis, Design and Selection of Computer Systems, p. 61.

24. Ibid., p. 70.

25. Ibid., pp. 61-62.

CHAPTER IV

TRANSLATING SYSTEM REQUIREMENTS INTO SYSTEM SPECIFICATIONS

The study which has been undertaken to this point should reveal information which must be codified into system specifications.

A set of specifications should first include general background information on the company. A concise outline of the company's facilities, products, financial circumstances, and organization serve as an appropriate introduction.[1]

The remainder of the specifications for the system can be prepared in a number of different ways. Specifications can simply give the system requirements for the various applications, or they can give a detailed description of each step of each application; or a combination of these two approaches can be used. These approaches are described more fully in the following paragraphs.[2]

General Specifications

General specifications are characteristics that are desired for any and all uses of the system.[3] Such specifications consist of a description of the jobs to be done,

the inputs, the desired outputs, and any other pertinent parameters.

General specifications give each vendor a chance to build a system which makes maximum and optimum use of the features of his system. General specifications thus make maximum use of the vendor's system analyst and permits the vendor to produce the best possible system for the user.

The result may be innovations in the system, or a system which is much smaller and less expensive than was thought possible or necessary, or the vendor may be able to propose package-application programs which satisfy many of the system requirements.

There are, however, several problems with this approach. First, the prospective user must spend many hours reviewing the vendor's system approach, and then verify that the system, as proposed, will work. Second, it is often more difficult to compare competitive proposals, since methods of application and timing will be different for each proposal.

When there are general specifications, then, the rewards can be great in terms of improvements to the computer system, but the difficulties of evaluation can also be great.[4]

Detailed or Application Specifications

Applications specifications are the characteristics that are desirable for a particular use of the system, such as the processing of accounts receivable.[5]

Detailed specifications spell out each step to be taken in each application. These specifications require vendors to configure their systems to the specifications.

Detailed specifications do offer a definite advantage to the user in that they describe the situtation completely and they define each application fully and uniformly to all vendors. The user has to waste little time in talking to vendors. When the proposals are submitted, the user can more easily verify, compare, and evaluate them, since the systems proposed must all be identical to steps set forth in the specifications. Thus, a system which does not meet the system demanded by the specifications will seldom be proposed, but, on the other hand, a system which exceeds the specifications required will almost never be proposed.[6]

The list of potential capabilities developed when defining management's information needs is the starting point for determining the application specifications.

From the list of potential capabilities, the potential user must determine the following:

1. the potential capabilities desired;
2. the relative importance or priority of each application; and
3. the relative importance or priority of each capability within each application.[7]

Table 6 contains an example of a checklist which might be used to evaluate the capabilities within a payroll application.

TABLE 6

A CHECKLIST FOR RANKING THE IMPORTANCE
OF PAYROLL SYSTEM FEATURES

Payroll System	Priority Scale				
	Very Important	Important	Useful	Nice to Have	Not Needed
1) Calculation of pay amounts using multiple pay rates for both salaried and hourly employees	___	___	___	___	___
2) Calculation of payroll on a weekly, bi-monthly, semi-monthly, or monthly basis	___	___	___	___	___
3) Preparation of employee paychecks and statements with related earnings and deduction information	___	___	___	___	___
4) Preparation of a payroll register which would report on a yearly, quarterly, and current basis earnings and deduction information for each employee	___	___	___	___	___
5) Preparation of a Deduction Register after each payroll run which would indicate on a cumulative basis the total deductions for each employee	___	___	___	___	___
6) Preparation of a Check Reconciliation List after each payroll run which would serve as a listing of all issued payroll checks to facilitate check reconciliation	___	___	___	___	___

TABLE 6--Continued

Payroll System	Priority Scale: Very Important	Important	Useful	Nice to Have	Not Needed
7) Preparation of quarterly and annual tax reports such as Form 941 and Form W-2	___	___	___	___	___
8) Preparation of a Cost Distribution Report which would accumulate and allocate wages by department and by functions or objective classes, and which would have the capability of reporting one employee in several departments or classes	___	___	___	___	___
9) Preparation of a Rate Change Report which would indicate all employees that had a rate change during the period	___	___	___	___	___
10) Preparation of a Scheduled Rate Review Report which would indicate all employees that are due for a pay rate review	___	___	___	___	___
11) Preparation of a Termination Report which would list on either a current or total basis those employees that have terminated employment	___	___	___	___	___
12) Preparation of Reports required by various unions	___	___	___	___	___

SOURCE: Mark L. Hildebrand and Karl G. King, "How to Help a Client Select a Data Processing System," The Practical Accountant 12 (September 1979): 49, exhibit D.

The application specifications must deal with at least three areas: content of files, volume and frequency estimates, and report layouts.[8]

Files

Five major categories of files are the master file, the transaction file, the table file, the archival file, and the backup file.

Master file

Master files are permanent in that they exist indefinitely, even though individual records may be frequently inserted, deleted, or changed.[9]

This category of file contains data records for basic identification as well as an accumulation of certain statistical data. Examples of master files are customer file, employee file, vendor file, and product file.

Descriptive data contained in these files might include, for example, the name, address, credit rating, account number, and billing and shipping instructions in a customer record, or the product code, styles, components, packaging, and weight in a product record.

Statistical data contained in master files is generally of the current status type, such as outstanding balance owed, quantity on hand, purchases to date, or shares owned.[10]

Transaction file

A transaction file is a file of records reflecting

current activity in an organization which is used to update a master file. Examples would include a file of employee timekeeping records, a file of inventory issue and receipt transactions, or a file of sales transaction data. A transaction file may or may not be permanent, depending on whether it is to be discarded once the updating process is complete.

Transactions may be classified into four general types according to their impact upon the master file. These are record additions, record deletions, updates, and changes.

Additions refer to insertions of entire new records into the file, while deletions refer to extracting entire records from the file. Updates involve revising a current master file balance, generally by adding or subtracting an amount from a transaction record. Changes involve such things as corrections of balances, revisions to credit ratings, or changes of address.

The periodic updating of master files by processing transaction files against the master files is referred to as file maintenance.

File maintenance is the most common processing task performed in accounting information systems. The posting of accounting journal entries from journals to the general ledger is a classic example. Others include maintenance of the accounts receivable file for cash receipts, credit sales, returns and allowances, and bad debt write-off transactions; the maintenance of inventory files for purchases, receipts,

issues or sales, spoilage and scrap transactions; and the maintenance of accounts payable records for payment authorization and cash payment transactions.

Table file

A table file is a master file of reference data, generally numeric, which is retrieved during data processing to facilitate calculations or other tasks. An example would be a payroll tax withholding table, which is entered according to marital status, number of deductions, and gross pay, and provides the correct amount of income tax withholdings. Other examples include sales tax tables, freight rate tables, and statistical tables.[11]

Archival file

Archival or history files are also often termed master files. They contain statistical data for noncurrent periods and are used to create comparative reports, plot trends, pay commission, and so forth. Archival files are normally updated periodically and involve large volumes of data.

Backup file

Backup files are simply noncurrent files of any type which are stored in a file library and are used as a link in a file creation process if a current master file is destroyed.[12]

When designing the above files, several general considerations should be observed.

All master files should be maintained to some level

of up-to-dateness depending on the requirements. Periodically, out-of-date items must be deleted from the file, and restructuring may be necessary to meet changing applications and requirements.

Future needs of present procedures should be anticipated. For example, it may be reasonable and less costly in the long run to include additional fields in a payroll file to handle changes in government requirements. It is more efficient and less costly in many instances to include additional space rather than to restructure a file. Moreover, it avoids reprogramming or a patched-up record layout at a later date.

All applications and processing jobs which utilize the file should be doublechecked to ensure that no necessary data items have been omitted.[13]

Careful consideration should be given to the selection of file codes.[14] The function of a code is twofold. It provides a brief, unambiguous identification for a data item, record, or file; and confers a special meaning to these data structures which will assist in retrieval and manipulation.[15]

The most obvious consideration in the design of a coding system is that the codes be chosen in a manner consistent with their intended usage. The designer should also allow sufficient latitude in the code for likely growth in the number of items to be coded.

Finally, it is important that the coding systems selected in different areas of an organization be consistent in order to facilitate subsequent integration of data pro-

cessing activities across functional lines.[16]

Most business and accounting codes use either alphabetic or numeric symbols, or some combination thereof. Alphabetic symbols have two primary advantages relative to numeric symbols.

First, an alphabetic code can be mnemonic, or suggestive of the name of the item which it represents. For example, in the three-letter code used by airline companies to identify airports, DFW represents Dallas-Fort Worth, and JFK stands for New York's Kennedy airport.

The second advantage is that a single position in an alphabetic code can represent up to twenty-six different possible categories, as opposed to only ten for a numeric code. Thus alphabetical codes are potentially more economical in terms of the number of code positions used.

Despite these factors, numeric codes have long been more common in business and accounting. It has been found that numeric codes are less error prone and more easily remembered when the length of the code is more than just a few positions. Furthermore, number codes are more amenable to machine processing.

Perhaps the most common application of coding in data processing is the assignment of a unique identification number to each data record within the system. This number is referred to as a key, or more specifically, a primary key.[17]

Table 7 lists some of the common types of data records in a business enterprise and identifies the key most commonly used.

TABLE 7

EXAMPLES OF RECORD KEYS FOR TYPICAL BUSINESS RECORDS

Record Type	Primary Key
Payroll	Employee Number
Customer	Account Number
Parts Inventory	Stock Number
Work in Process	Job Number
Finished Goods	Product Code
General Ledger	Account Code
Fixed Assets	Asset Number
Accounts Payable	Vendor Code

SOURCE: Barry E. Cushing, Accounting Information Systems and Business Organizations 2nd ed. (Reading: Addison-Wesley Publishing Company, 1978): p. 50, figure 3.1.

Volume and Frequency Estimates

Volume and frequency estimates are next. What is the expected annual total of each item in the master file? How many characters in each field? How frequently will files be updated?

Original volume estimates tend to be understated. Volumes always take on a life of their own when a system begins to operate. Consider each master file and determine how much historical data will be retained on the computer before the data is erased and the balances brought forward. Before data is erased, it should always be transferred to hard copy, thus remaining accessible.[18]

Other concepts relevant to the design of files and file processing procedures include the activity ratio, volatility, accessibility, and retention policies.

The activity ratio is a measure applied to the file maintenance process to indicate the proportion of master file records referenced by transaction records during the process, that is,

$$\text{activity ratio} = \frac{\text{number of master file records referenced during file maintenance}}{\text{total number of master file records}}.$$

Volatility is a measure of the relative frequency of additions, deletions, and other transactions requiring reference to a particular master file during a specified time period, that is,

$$\text{file volatility} = \frac{\text{total number of transactions relating to the file}}{\text{standard unit of time (day, week)}}.$$

A payroll file is an example of one having a high activity ratio, while an airline reservations file would have high volatility. These measures are useful in establishing file content, selecting file storage media and equipment, designing file processing procedures, and similar decisions.

Accessability refers to the ease with which records can be retrieved, and is a function of the storage medium and equipment used, the coding system used, the availability of indices, and the extent of cross-referencing among records.

Accessability is also related to record retention policies, which, as discussed previously, specify when particular records are to be transferred from active to inactive status, or destroyed altogether. Legal and tax requirements are an important determinant of when such records should be destroyed.[19]

Report Layouts

The fundamental consideration in report design is the user. If the user does not understand the report, or cannot use it, the result is evident.[20]

Keep reports to a minimum. As confidence increases with the use of the system, user criteria change slightly, and the type and number of reports may well change. Therefore do not commit the system to reports that are not initially critical to operations.

Reports should be "exception-oriented." Allow as many options as possible within one report specification. Specific users should receive only data pertinent to their job, no more, no less. Do, however, leave room for notes on the printout; the report will not always accomodate everyone's needs.

Try to design reports that can be used as "turnaround documents," leaving fields on the report vacant so that update information can be entered.[21]

Other basic considerations in report design are the number of times the form will be handled, the storage time or active use, and the quantity that will be used.[22]

At some point the detailed specifications should be frozen. Keep the design simple and practicable. Once the basic processing cycle is running smoothly, it is relatively easy to add more complex routines and reporting mechanisms, as long as care is exercised in designing files.[23]

Combination Specifications

Obviously, specifications can be at any level of a general-detailed category. The benefits to be gained by setting forth specifications which are cast in this general-detailed form depend on the rule: the more general the specifications, the greater the chances of obtaining a superior system. On the other hand, the greater the degree of detail in the specifications, the easier the proposals will be to evaluate.

Another possible solution is to present general specifications as guidelines to be followed in preparing the proposal and detailed specifications as examples of how applications might be handled.

Detailed specifications as examples have the following purposes. First, they indicate which functions are performed in each application and answer many questions a vendor might otherwise need to have answered.

Second, they serve as a common model for all vendors. The examples may be modified in different ways by different vendors, but they still offer a starting point for all vendors. They also indicate the level of sophistication

that the prospective user wishes to see embodied in the proposals.

Giving detailed specifications along with general specifications is also of considerable value to the user. The prospective user who has to prepare detailed specifications is forced to think through the situation in the same way the vendors will have to think it through.

However, the prospective user will be doing the thinking first. As a result, he should discover any problem areas that exist before he releases the specifications to the vendors.[24]

ENDNOTES FOR CHAPTER IV

1. Barry E. Cushing, Accounting Information Systems and Business Organizations, 2nd ed. (Reading: Addison-Wesley Publishing Company, 1978), p. 313.

2. Edward O. Joslin, Computer Selection, aug. ed. (Fairfax Station: The Technology Press, Inc., 1977), pp. 9-10.

3. Hildebrand and King, "How to Help a Client Select a Data Processing System," p. 48.

4. Joslin, Computer Selection, p. 10.

5. Hildebrand and King, "How to Help a Client Select a Data Processing System," p. 48.

6. Joslin, Computer Selection, p. 11.

7. Hildebrand and King, "How to Help a Client Select a Data Processing System," p. 48.

8. Henry Wertman, "Control Your Minicomputer On Its Way In and Your Problems Will Soon Be On Their Way Out," CAmagazine 109 (August 1976): 38-39.

9. Cushing, Accounting Information Systems and Business Organizations, p. 57

10. Burch and Strater, Information Systems: Theory and Practice, p. 181.

11. Cushing, Accounting Information Systems and Business Organizations, pp. 57-58.

12. Burch and Strater, Information Systems: Theory and Practice, p. 181.

13. Ibid., pp. 188-189.

14. Wertman, "Control Your Minicomputer On Its Way In and Your Problems Will Soon Be On Their Way Out," p. 39.

15. Burch and Strater, Information Systems: Theory and Practice, p. 158.

16. Cushing, Accounting Information Systems and Business Organizations, pp. 55-56.

17. Ibid., p. 49.

18. Wertman, "Control Your Minicomputer On Its Way In and Your Problems Will Soon Be On Their Way Out," p. 39.

19. Cushing, Accounting Information Systems and Business Organizations, pp. 58-59.

20. Bodner, Accounting Information Systems, p. 201.

21. Wertman, "Control Your Minicomputer On Its Way In and Your Problems Will Soon Be On Their Way Out," p. 39.

22. Bodner, Accounting Information Systems, p. 201.

23. Wertman, "Control Your Minicomputer On Its Way In and Your Problems Will Soon Be On Their Way Out," p. 39.

24. Joslin, Computer Selection, pp. 11-12.

CHAPTER V

SUMMARY AND CONCLUSION

Although the definition of a minicomputer is imprecise, a summary definition of a minicomputer might state that a minicomputer is a relatively low-cost, general-purpose computer, small in physical size and environmental requirements, in which the technological features, such as memory, capacity word size, and instruction sets, are either smaller or simpler than in large computers.

Minicomputer manufacturers do not usually provide applications software and other support which large computer manufacturers traditionally provide with their large systems. However, a number of firms known variously as original equipment manufacturers (OEM's), software houses, or turnkey outfits have been developed which supply software, programming services, training, and other support for minicomputer users.

Also, minicomputers, unlike large computers, are usually not rented, but acquired through a purchase or lease purchase.[1]

The process of developing system specifications for selection of a business minicomputer can be summarized as follows:

A) Determine and document information requirements

1) Review management's business objectives

2) Systematize current operations

a) Describe and document current systems in detail

b) Analyze current systems

1) Eliminate unnecessary work

2) Consolidate activities

3) Improve work flow

3) Design an improved system

B) Design systems specifications for proposed automated management information system

1) Identify data requirements

a) Inputs

b) Processing requirements

c) Outputs

2) Determine other parameters

a) Processing frequencies

b) Transaction volumes

c) Time constraints[2]

The limited resources of a small company and its inability to maintain a computer expert on its staff makes the computer selection decision difficult. It is unavoidable that in such a situation, the company will be dependent on the computer vendor.

However, by analyzing the processing needs of the business and developing a set of system specifications, the small businessman can greatly reduce this dependency.[3]

Undertaking such a process will minimize the uncertainty with regard to the selection decision and ensure that the selection clearly reflects the needs of the organization. Failure to do so can result in a long series of frustrating problems.[4]

ENDNOTES FOR CHAPTER V

1. O. Martin Anochie, "Minicomputers," Governmental Finance 6 (August 1977): 27-28.

2. Frank C. Bove and Edward J. Gurry, "Effective Data Processing Planning," CPA Journal 47 (August 1977): 47.

3. Paul H. Laitala and Peter B. Turney, "A Strategy For Computer Selection By Small Companies," Managerial Planning 25 (November/December 1976): 29.

4. Levine, "Requirements Analysis Approach for Selecting a Business Minicomputer," p. 20.

BIBLIOGRAPHY

Books

Association for Systems Management. Auditing for Systems Improvement. Cleveland: Association for Systems Management, 1972.

Bodner, George H. Accounting Information Systems. Boston: Allyn and Bacon, Inc., 1980.

Burch, John G., and Strater, Felix R. Information Systems: Theory and Practice. Santa Barbara: Hamilton Publishing Company, 1974.

Cushing, Barry E. Accounting Information Systems and Business Organizations. 2nd ed. Reading: Addison-Wesley Publishing Company, 1978.

Daniels, Alan, and Yeates, Donald, ed. Systems Analysis. Palo Alto: Science Research Associates, Inc., 1971.

Datapro Research Corporation. Minicomputer Specifications. Delran: Datapro Research Corporation, 1976.

Joslin, Edward O., comp. Analysis, Design and Selection of Computer Systems. 2nd ed. Arlington: College Readings, Inc., 1974.

_____. Computer Selection. Fairfax Station: The Technology Press, Inc., 1977.

Lott, Richard W. Basic Systems Analysis. San Francisco: Canfield Press, 1971.

Orilia, Lawrence S. Introduction to Business Data Processing. New York: McGraw-Hill, Inc., 1979.

Sanders, Donald H. Computers in Business. 4th ed. New York: McGraw-Hill, Inc., 1979.

Weitzman, Cay. Minicomputer Systems: Structure, Implementation, and Application. Englewood Cliffs: Prentice Hall, Inc., 1974.

Articles in Periodicals or Journals

Anochie, O. Martin. "Minicomputers." Governmental Finance 6 (August 1977): 26-33.

Bove, Frank C., and Gurry, Edward J. "Effective Data Processing Planning." CPA Journal 47 (August 1977): 46-47.

Bowers, Dan M. "Implementing a Small Computer System." The Office 88 (July 1978): 44-50.

Dowell, J. Richard. "So, You Want to Buy a Minicomputer?" Price Waterhouse Review 22 (#3 1977): 19-25.

Hildebrand, Mark L., and King, Karl G. "How to Help a Client Select a Data Processing System." The Practical Accountant 12 (September 1979): 44-53

Kintisch, Robert S. "It's Still a Big Step To Install A Small Computer." Administrative Management 39 (November 1978): 26-29.

Laitala, Paul H., and Turney, Peter B. "A Strategy for Computer Selection By Small Companies." Managerial Planning 25 (November/December 1976): 24-29, 33.

Levine, Stephen A. "The Requirements Analysis Approach for Selecting a Business Minicomputer." Massachusetts CPA Review 4 (May/June 1977): 17-20.

Tepper, Thomas F. "The Installation." Michigan CPA 30 (November-December 1978): 45.

Wertman, Henry. "Control Your Minicomputer On Its Way In and Your Problems Will Soon Be On Their Way Out." CAmagazine 109 (August 1976): 37-40.