A COMPETITIVE ANALYSIS

OF THE

PERSONAL COMPUTER INDUSTRY

by

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ABSTRACT

This thesis investigates how the evolution of the personal computer industry and the performance of its participants are shaped by the personal computer market structure. The thesis utilizes an extended version of Michael Porter's model for competitive analysis, describing the role of six major competitive forces impacting the structure and evolution of the personal computer industry: power of the buyers, power of the suppliers, threat of substitute products, development of complementary products, threat of potential entrants, and competitive rivalry among current participants.

The strategies of seven major personal computer participants are discussed in detail: Apple, Radio Shack, Commodore, IBM, NEC, Xerox and Atari.

The importance of complementary products in our increasingly integrated information industry is emphasized. The development of two complementary products, software and networks, are shown to be of extreme importance to the structure of the personal computer industry.

By making comparisons to the light bulb, telephone, automobile and television industries, this thesis notes the necessity of standardization, networking and user friendly interfaces for the mass acceptance of the personal computer.

Thesis Supervisor: Mel Horwitch

Title: Professor of Management

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This thesis is dedicated to Sloan Professor Hoo-Min Toong, who provided an incredible source of knowledge, patience, dedication and friendship.

I would also like to express my appreciation to my advisor Mel Horwitch and to Earl Lipson and Timothy Sutton, fellow colleagues at the Sloan School. Mel played a crucial role in shaping the direction and theme of this thesis. Earl provided a sometimes otherworldly perspective on the personal computer industry, and his insights into technology and industry structure proved helpful, novel and illuminating. Tim helped clarify the importance of complementary products to industry structure, and demonstrated a very interesting psychological approach to one's thesis endeavors.

Gary Farner
May 20, 1982

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CHAPTER ONE

INTRODUCTION

Market structure is the economic and environmental features of a market which affect the behavior of firms in the industry supplying that market.(1) This thesis investigates how the evolution of an industry and the performance of its firms are determined by its market structure. In particular, the purpose of this thesis is to present a competitive analysis of the personal computer (PC) industry, and determine how its evolution and performance will be shaped by its market structure.

In presenting this analysis, I have drawn upon the works of Richard Caves, Joe Bain and Michael Porter. In his book American Industry: Structure, Conduct, Performance (1964), Richard Caves clearly describes the effect of six major elements of market structure:

1. Concentration
2. Product differentiation
3. Barriers to the entry of new firms
4. Growth rate of market demand
5. Price elasticity of market demand
6. Ratio of fixed to variable costs in the short run.

Joe Bains's Barriers to New Competition (1965) investigates how the "condition of entry", or the relative ease or difficulty of entry of new competitors to an industry, influences the market performance of established firms. In particular, Bain describes the effect on market structure of three primary barriers to entry:

1. Economies of large scale
2. Product of differentiation
3. Absolute cost barriers, including capital barriers

In his book Competitive Strategy (1980), Michael Porter discusses five competitive forces which shape the structure of an industry, its evolution and ultimate profit potential.

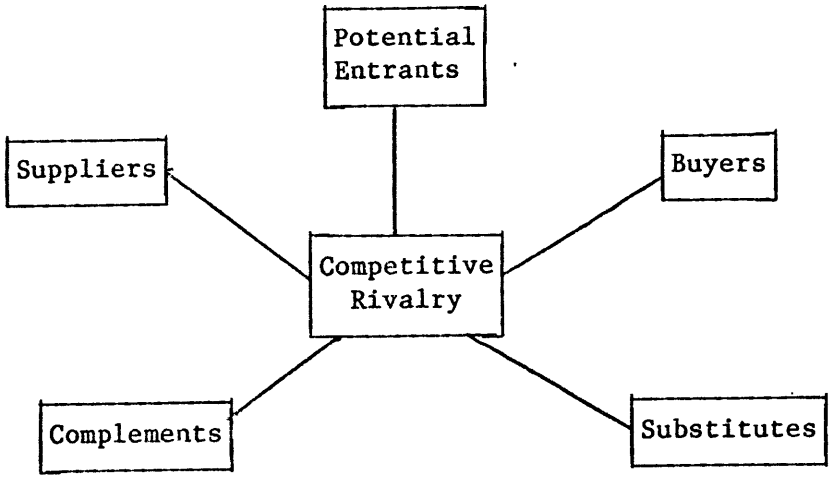
1. Power of the buyers
2. Power of the suppliers
3. Threat of substitute products
4. Threat of potential entrants
5. Competitive rivalry (jockeying) among the current contestants

The underlying theme in all these works is that an awareness of an industry's structure and competitive forces enables a company to find a position in the industry where it can best defend itself against these forces or influence these forces in its favor.

This thesis uses a slightly modified version of Michael Porter's industry competitive analysis model. The personal computer industry highlights the importance of a previously unstated force which shapes an industry structure: the availability of complementary products. My thesis therefore incorporates this competitive force into the expanded model depicted below.

FIGURE 1.1

Competitive Forces Influencing Industry Structure



This thesis provides an overview of the personal computer industry and describes the six major forces shaping this industry, including an in-depth analysis of the positions and strategies of seven major PC competitors. The thesis is hopefully of interest to two major groups of readers. For the computer enthusiast, I intend to provide an in-depth knowledge of the personal computer industry. For the corporate strategist, I intend to demonstrate how the concepts of industry analysis can be utilized to determine the structure of an industry and the future evolution of the industry and its participants. To structure the analysis, this thesis is divided into the following chapters:

1. Chapter Two provides a definition of the personal computer.
2. Chapter Three describes the historical development of the personal computer industry.
3. Chapter Four describes the major personal computer buyers. The demographics, needs, usage and growth of four separate buyer segments are discussed: The current and future products addressed toward these buyer segments are discussed, as are the distribution channels and marketing efforts needed to serve these segments.
4. Chapter Five describes the major personal computer suppliers. This chapter focuses on microprocessor, memory and peripheral products. It discusses the practice of bundling system components in order to reduce supplier power and differentiate one's product. The value added cost stream from the component level to the personal computer system level is described. The positions of the major suppliers and the issues of integration are also considered.
5. Chapter Six describes the important complements to the personal computer. The development of the software, communications and information industries will have an enormous impact on the personal computer.
6. Chapter Seven describes substitutes for the personal computer.

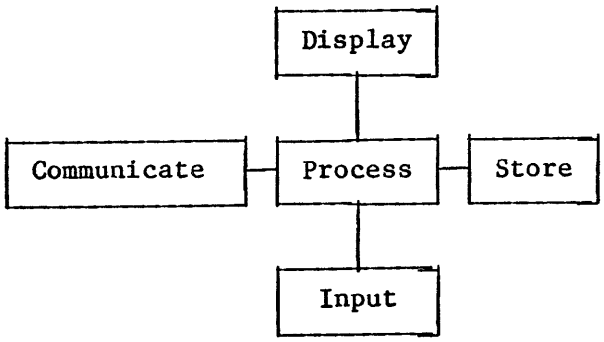
Since needs, usage, preference and elasticities vary drastically across the four buyer segments, substitute products will be discussed separately for each buyer segment.

7. Chapter Eight describes threats of potential entrants into the personal computer industry. New entrants will significantly alter the market structure of the PC industry, and the development of entry barriers and defendible strategic positions is becoming increasingly important as the PC industry matures.
8. Chapter Nine describes the position and strategy of seven major competitors in the personal computer industry: Apple, Radio Shack, Commodore, IBM, Nippon Electric, Xerox, and Atari. These firms will be positioned on two strategic maps, and the comparative strengths of each position will be described.
9. Chapter Ten provides the main conclusions of this thesis. It summarizes the important features of the personal computer industry, expands upon the importance of complements to the personal computer, and compares the PC industry development to that of other industries.

CHAPTER TWO
DEFINITION OF THE PERSONAL COMPUTER

The personal computer is an adaptation of microprocessor technology to personal (single) users. For our purposes the personal computer must be capable of performing five essential functions. As Figure 2.1 depicts, these functions are to (1) process data, (2) input data locally, (3) display data, (4) store data permanently and (5) transmit/receive data.

FIGURE 2.1
Functions of the Personal Computer



I will define the personal computer to include the following components and capabilities

1) To process data
   a) A multiprocessor, and a microprocessor operating system.
   b) Local (generally semiconductor) memory. Although this thesis is not restricted to systems expandable to 64K of memory, this capacity is necessary to utilize three input/output channels and allow room for sophisticated software applications.
   c) A capability to support graphics.
   d) A capability for programming in at least one higher level language.

2) To input data

A keypad input device. Most personal computers have an alphanumeric keyboard unit which encases a power pack and one or more circuit boards. The circuit boards house the microprocessor, semiconductor chips and other electronic components.

3) To display data

A full screen display device such as a cathode ray tube (CRT). Some personal computers attach to a television for displaying purposes.

4) To store data permanently

The capability for permanent mass memory storage. The most commonly used mass storage devices are tape cassettes and floppy disks.

5) To communicate

Input/output ports are necessary to communicate with any functional device which is not directly integrated (encased) with the processing unit. I/O ports enable attachment to transmit/receive devices (modems), display devices (TV, printers), input devices (light pen, etc.), and mass storage devices (floppy disk drives, etc.).

I will further restrict my definition to computers whose standard configurations cost $5,000 or less and are mass marketed to the computer neophyte or preprogrammed applications user.

Appendix A provides examples of several PC systems which are currently available.

CHAPTER THREE

DEVELOPMENT OF THE PERSONAL COMPUTER INDUSTRY

The personal computer industry has capitalized upon technological innovation and consumer awareness to instigate and satisfy an undeveloped consumer need. The unsatisfied need was for a low-cost personal machine for the unsophisticated computer user. The technological innovation making this possible was the development of compact, powerful and inexpensive semiconductor technology, particularly the microprocessor. The success of the PC manufacturers has been their ability to make this technology useful and to develop a mass-market infrastructure to support the continued proliferation of the personal computer.

The PC industry is in an early stage of evolution and its industry structure is still loosely defined. This chapter will describe the historic development of this industry.

The personal computer did not exist in the early 1970's. Digital Equipment's first minicomputer, the PDP-5, had been introduced in 1963 for $30,000. By 1970, DEC's basic PDP-8 minicomputer with 4K words of core was priced at $10,000 (1). These machines were much too bulky and expensive for the personal user, and time sharing was the only real alternative for "personal" computer use.

The development of the microprocessor was the driving force which led to the personal computer industry. In 1971, Intel successfuly packaged a complete "microprocessor" in one integrated circuit. This initial microprocessor, the Intel 4004, had only a 4-bit word size and was therefore limited in its processing capability. However one could envision the use of future microprocessors in compact, inexpensive computers.

By 1972 Intel had produced an 8-bit microprocessor, the 8008, which could perform many low level tasks previously delegated to

minicomputers. In 1973 Intel announced a much more powerful 8-bit microprocessor, to be available in early 1974, the Intel 8080. Although the initial price of the 8080 was several hundred dollars, the price of the 8080 and other microprocessors was falling rapidly. Microcomputer kits building upon these microprocessors were available as early as 1974 (1).

A cover article in the January 1975 issue of Popular Electronics helped make the Altair 8800 the first successful personal computer product. The Altair 8800 was designed around the Intel 8080 by Micro Instrumentation and Telemetry Systems (MITS). It was sold for $395 in kit form or $621 assembled. The typical kit consisted of a front panel, microprocessor unit (MPU) board, memory board and power supply. Assembly occurred at the component level, individual boards would be soldered and it was often necessary to hand wire interboard connections. These kits did not include keyboards or video monitors, and were used by flicking on/off toggle switches and watching flashing red lights. Additional features, such as a serial interface, terminal, line printer, disk controller and disk drives, disk operating system and basic software were quickly available. The Altair 8800 "Advanced Accounting/Engineering System" included all these features and sold commercially for $10,500 (1A).

In 1975 there were 10,000 personal computers sold at a retail value of $5.5 million (2). The majority of these early sales were to the computer hobbyist. The Altair 8800 and the bus- and card-compatible IMSAI 8080 were the market leaders in 1975-1977.

By 1978 Radio Shack, Commodore and Apple Computer had entered and overwhelmed the market with fully assembled turn-key systems. Radio Shack's substantial production and distribution facilities accounted for 100,000 shipments of TRS-80 computers in 1978. About 25,000 Commodore PET computers and 20,000 Apple II computers were also shipped in 1978 (3). These three innovators developed the market, and by 1981 more established firms such as IBM, Hewlett-Packard, Xerox and NEC had entered the industry in hopes of using their resources and reputation to restructure the PC industry.

Personal computer sales have continued at 50%-100% annual growth rates. Dataquest estimated 1980 worldwide sales of 500,000 units with a total revenue value of $730 million.(4) Future computing estimated 1981 worldwide sales at 755,000 units (Appendix C). These estimates are very unexact and differ dramatically amongst market research firms.

Table 3.1 briefly estimates historic PC industry sales and concentration. Appendix B breaks down 1977-1980 personal computer sales by user segment, supplier and geographic region. Appendix C details the installed base of individual computer models as of January 1, 1981. Appendix D details the 1981 sales and installed base (January 1, 1982) of the major personal computer suppliers.

TABLE 3.1

PC Industry Unit Sales and Concentration

Company	1976	1978	1980	1982E
MITS	25%			
IMSAI	17%			
Processor Technology	8%			
Radio Shack		50%	26%	18%
Commodore		12%	20%	16%
Apple		10%	19%	23%
IBM				14%
NEC				7%
Osborne				7%
Other	50%	28%	35%	15%
Total	100%	100%	100%	100%
Total Units	15,000	200,000	500,000	1,500,000

Sources: For 1976, Personal Computing, Daniel McGlynn, pg. 29.
For 1978, Personal Computing, Daniel McGlynn, pg. 30.
For 1980, Appendix B.
For 1982, Author's estimates based on various sources.

From these statistics, one can discern that PC market leaders have changed dramatically yet the industry has remained reasonably concentrated over time. The majority of worldwide PC sales have occurred in the United States, and these sales have shifted from an initial hobbyist orientation to an emphasis on business applications.

Apple has recently surpassed Radio Shack as the domestic (and worldwide) market share leader, with expected 1982 sales of 350,000 units.(5) Commodore has established itself as the foreign (non-U.S.) market share leader and IBM has stormed into the market with expected first year sales (since August 1981) of 200,000 units.(5) These four competitors have currently established themselves as the major players in the personal computer industry, yet the industry is growing rapidly and remains in a state of continual change.

In order to understand the future development of the PC industry, it is necessary to examine the six competitive forces which will shape its evolution and market structure. The first of these forces, the power of the PC buyers, is discussed in Chapter Four.

CHAPTER FOUR
PERSONAL COMPUTER BUYERS

The bargaining power of PC buyers is the first competitive force shaping the PC industry structure. These buyers influence the optimal development of products, the price these products can bear, the viability of individual firms, and the long term industry profit potential. Understanding one's buyers and targeting attractive buyer segments is essential to corporate strategy development.

This chapter describes the demographics, needs, usage and growth of four personal computer buyer segments:

1. business users
2. home/hobby users
3. educational users
4. technical users.

The current and future products addressed toward these buyer segments are discussed, as are the distribution and marketing efforts needed to serve these segments. Stanford Research Institute's future forecasts for these four market segments are provided in Appendix E. (These forecasts are not completely consistent with Dataquest's historic statistics provided in Appendix B). Appendix F lists the most frequent applications in each buyer segment. Appendix G lists the comparative strengths of the major competitors in each buyer segment.

4.1 The Business User.

The business segment accounted for 385,000 personal sales for a retail value of $1.7 million dollars in 1981 (Appendix E). This accounts for 55% of 1981 unit sales and 64% of 1981 dollar sales. Businesses are undoubtedly the dominant current purchaser of personal computers.

There are over 14 million businesses within the United States alone. There are 36 million white collar workers within the 88 million total domestic workforce. Businesses can be broken down by revenues into four arbitrarily defined segments, as depicted in Figure 4.1.

Figure 4.1
Breakdown of United States Business Segments

Business Segment	Annual Sales	% of Businesses	# of Businesses
Very Small	<$100K	85	11.9M
Small	$100K-$1M	13	1.8M
Medium	$1M-$150M	2	.3M
Large (Fortune 1,000)	>$150M	-	1,000

Source: Statistical Abstract of United States, 1979.

A. Very Small Businesses (Sales less than $100K)

A very small business is typically run by a repairman, tradesman or craftsman. The profits from the these businesses are barely sufficient to support one or two employees, and these businesses often have very limited cash flow.

These businessmen are very unsophisticated in the use of computers and the cost benefits of a personal computer are not yet sufficient to induce purchase.

B. Small Businesses ($100K - $1M Sales)

Small businesses are normally run by professionals (doctors, lawyers, accountants, consultants) or sole proprietors. These businesses can afford a personal computer if its applications are deemed important. For a $100,000 business, a $5,000 personal computer amortized over a 5 year life can be expensed at 1% of yearly sales. Large corporations spend an average of 2% of their revenues on data processing, and a personal computer purchase could be less than half of this guideline data processing expense.

Personal computers serve as stand-alone mainframes for the small business users. The most common small business applications include word processing, accounting, and data management. Common applications for small businesses with under 50 employees are listed in Figure 4.2.

Figure 4.2
Common Business Applications of Personal Computers

	Company Size		
	Under 50	50-100	Over 500
Word Processing	61%	54%	47%
Data Base Terminal	55%	37%	50%
Accounting	58%	31%	22%
Inventory	42%	29%	22%
Taxes	32%	11%	13%
Payroll	34%	17%	5%
Investment Mgt.	18%	17%	13%
*Teaching Aid	8%	34%	10%
*Educational Purposes	5%	23%	13%
*Software Development	14%	0%	7%
*List/Client List	10%	0%	5%
*Scientific Calculations	4%	6%	15%
*Research	1%	6%	10%

Source: ARBOR, Inc

*Write Ins (Not specified on questionnaire).

A typical doctor would use his personal computer system to keep his patient's records and to perform billing, scheduling and word processing. Assuming 150 characters of information (name, address, amount owed, etc.)

for each of 1,000 patients, the personal computer would need 150K bytes for patient data storage alone, and additional memory capacity would be needed for associated software. A fairly expensive personal computer would be necessary for these applications, such as a fully-loaded IBM Personal Computer. An IBM Personal Computer with a keyboard, 64K internal memory, 2 floppy diskettes (each with 160K external storage), a monochrome display and dot matrix printer would cost approximately $4,500 without software. An Easy Writer Word Processing program costs $200 and an Accounts Receivable Program $600. (I doubt if a specialized patient maintenance and billing program has been written yet for the recently introduced IBM). Not every small business needs the full capability I have described, so this system overstates the investment of the average small business user.

The small business market will become applications dependent with buyers purchasing whatever hardware is available (necessary) for the desired package. Small businessmen do not want to program their computer and will only purchase a system with appropriate, user-friendly software. The major personal computer software efforts have historically addressed standard (mass) small business applications such as budgeting, accounting and word processing. The lack of software tailored to the specific functional or industry needs of small businessmen is the major deterrant to personal computer purchase and a major growth area in the coming years. In essence, the software will sell the hardware.

C. Medium and Large Businesses (Sales over $1M)

Medium and large businesses are too large to use personal computers as their mainframe machines. The large scale accounting, control (inventory, etc.) and reporting functions of these businesses are performed in-house by minicomputers and mainframes and out-of-house by remote computer service or timesharing bureaus.

Small scale user (or department) specific tasks (processing and reporting) have historically been performed in a batch (delayed) mode

through programs on a central computer or interactively through the use of a local "dumb" terminal hooked up to the businesses' central computers or a timesharing service.

However, the personal computer has enabled a substantial change in the information systems policies of medium and large corporations. Since the changes in large corporations encompass those in medium corporations, I will focus my discussions on personal computer use in large corporations. In particular, I will divide this analysis into seven sections.

1) PC applications in large organizations.
2) The organizational effect of the PC.
3) Factors influencing corporate IS departments.
4) Factors influencing corporate users.
5) Centralized vs. decentralized computer usage.
6) How corporate users want PCs handled.
7) How corporations should handle PC use.

1. Personal Computer Applications

Personal computer applications can be divided into common applications which all departments can use and user-specific applications.

A. Common Applications
   1. Flexible utility programs such as VISICALC are necessary to create Decision Support Systems and allow "What If" analysis. These utility systems allow one to model different scenarios and forecast budgets, balance sheets, sales, inventory and production.
   2. Word Processing.
   3. Graphical analysis and hard slide reproduction.
   4. Data Base management to store corporate or department

specific data.

5. Communications
   a) Within the corporation, access to corporate data files and programs is often useful. Electronic messaging (mail) is also highly desired.
   b) It is also useful to retrieve external data which is not company specific, such as DRI economic data or SAMI marketing data.
   c) Dumb terminals have histoically been used for these communications tasks, but personal computers allow the downloading of software and data for extended user-specific local processing.

B. User-Specific Applications
   1. Although the majority of existing software addresses common applications due to their larger market appeal, user specific packaged software (such as order inventory and accounts receivable) is becoming increasingly available, and users can also program the personal computer to handle more specific needs. An eight person marketing group could use the personal computer to keep track of their schedules, their competitors products and prices, and all information pertaining to their customers.

2. The Organizational Effect of Personal Computers

The personal computer will affect a corporations organizational structure, personnel, office environment, decision making process and the role of the central information services (IS) department.

The low cost of the personal computer allows middle managers to purchase a computer on their own signature. This will greatly increase the power of the middle manager, provide him the capability for quick and drastic change, and will profoundly impact the organizational

control structure whose goal is often to oversee and authorize any substantial change from standard operating procedures.

The personal computer will impact how corporate personnel view themselves. Using the increased processing capabilities of their personal computers, secretaries at Apple have now been redefined as managerial assistants, with substantially increased task variability and responsibility.

The office environoment will change as people will be able to work at home more often. Computer networks will allow synergies between home and office workers. The usefulness of part time cottage workers (eg. mothers) will impact hiring and office space decisions.

The easier accessibility of data, and the use of decision support systems and graphical analysis will greatly alter the manager's decision making process.

The role of the central information services department will move from a processing orientation toward a more user-supportive role. Mainframes will still be used, but the IS department will concentrate more on networking.

3. Factors Influencing the IS Department

IS departments are becoming increasingly exposed to and supportive of personal computers. The major PC manufacturers have established sales forces which directly market to the IS departments of large corporations. Personal computers can substantially reduce the processing and programming backlog of central IS departments, and are therefore viewed favorably.

The problem confronting the IS department is an uncontrolled migration of personal computer power. IS departments want to maintain some central control and prevent the purchase of incompatible systems which could make future corporate networking attempts unreasonably expensive.

4. Factors Affecting Corporate Computer Users

Corporate computer users are becoming frustrated with the typical 18 month backlog one encounters when IS departments are assigned major user projects. The dissatisfaction with corporate IS, emphasis on increased office productivity, demand for computer versatility (local data processing, word processing and program development), hardware price reductions, increased availability of software applications packages and increased remote computer service costs have all lead to an increasing user demand for personal computers.

5. Centralized vs. Decentralized Computer Use

The personal computer is causing a very significant revaluation of the role of centralized computer processing in large corporations. Figure 4.3 pictorially contrasts centralized power of shared logic with localized distributed intelligence. Table 4.4 highlights more general arguments for centralized versus decentralized processing.

Figure 4.3

Centralized Power vs. Distributed Intelligence

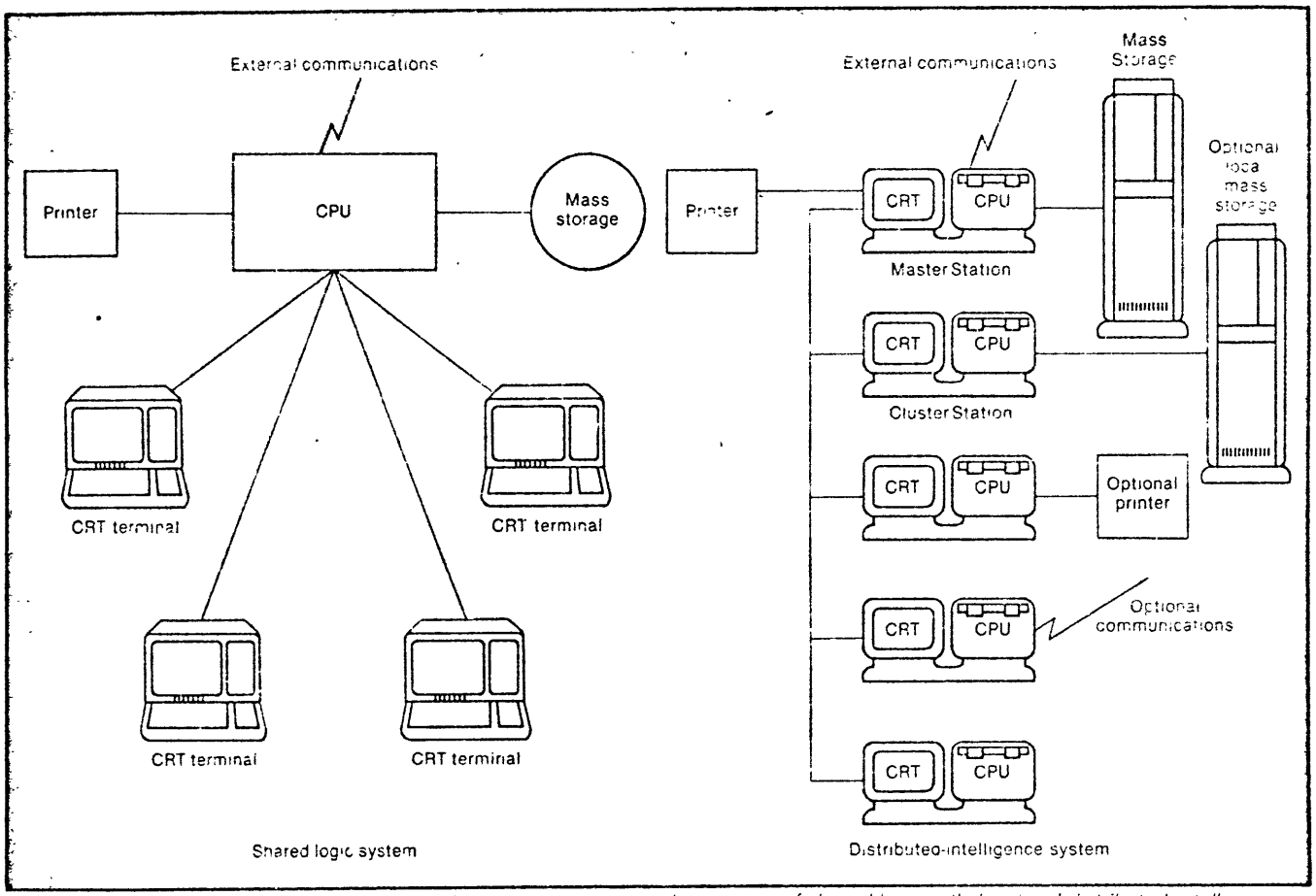


Fig. 2. Two approaches to distributed processing, *contrasting centralized power of shared logic with localized distributed intelligence.*

Source: Mini-Micro Systems; 5/81, pg. 106.

TABLE 4.4
Advantages of Centralized vs. Decentralized Processing

Centralized Processing Advantages	Decentralized Processing Advantages
1. Economies of scale. Cost/computation drops with size. These economies are becoming less significant over time.	1. Reduce telecommunications costs.
2. Ability to share large scale capacity among multiple users who have defined but limited need for it.	2. Potentially faster, more stable response time. Centralized computer systems become back-logged during "peak" utilization periods. EDP department program development backlogs average 18 months.
3. Potential to enforce better security and operating procedure control.	3. Potentially better fit with organizational structure.
4. Ability to manage multiple user access to common data and programs	4. More responsive to user needs and priorities, especially with individualized systems.

Source: Professor Warren McFarlan (HBS)

The objective is to capture the advantages of centralized and decentralized structures. A well managed (controlled and coordinated) migration of computing power can create a distributed network which accomplishes this goal.

6. How Corporate Users Want Personal Computers Handled

Despite frequent dissatisfaction with in-house computer processing support, a recent INPUT survey (Personal Computer Use in Large Companies--October 1981) indicates that users want the centralized IS department to act as a personal computer purchasing and service agent. Users want the IS department to:

A) Evaluate and supply competitive systems and applications programs.

B) Take care of maintenance.

C) Provide a spare system in case of major failure.

D) Provide user training.

7. How Corporations Should Handle Personal Computer Use

Some centralized control of corporate personal computer purchase and usage is essential. Personal computers are not compatible with each other and programs developed for one computer will not run on a differently designed machine. Standards will be set to restrict purchases to a limited number of acceptable vendors. This will reduce the threat of uniformed users purchasing computers soon to be obsolete, and will help compatibility and transferability (as opposed to proliferation) of programs and data. Data dictionary standards (definitions of data formats and file structures) will be espoused in order to facilitate access of "useful" data and programs across multiple computer networks.

The potential benefits of passing data and programs throughout a business will lead to the development of personal computer standards. Large businesses should evolve to an enviornment where the following occurs.

A) Centralized bulk purchases of personal computers are made directly from the manufacturer. National sales accounts will prove very important in reaching large corporations, and mass purchases will enable price discounts and bundled support. In order to aid standardization, guarantee support and reduce the threat of obsolescence, purchases should be limited to a few name brands such as Apple, IBM and Xerox. One large corporation recently purchased 1,100 Apples in order to induce increased usage of a standardized system.

B) IS departments provide training in the use of personal computers, either directly or by hiring computer service

firms expert in this area. Programs such as McGraw-Hill's Microcomputer Resource Center (HBS Case #0-182-017) should develop. This center of Apple II hardware and software provides convenient access, assistance and education for potential (and current) users so that training and application feasibility analysis can be done before department purchase and development decisions are made.

C) Corporations should provide (financial) incentives for the purchase of home systems compatible with those used in one's work environment. Boeing currently provides these incentives to prevent the dislocation of potential home buyers from the computer environment (interfaces, languages, applications programs) at Boeing. In addition, these incentives induce increased computer literacy and familiarity with the computer environment at Boeing.

D) The objective should be to induce the <u>controlled</u> proliferation of personal computers throughout the corporation.

In this section I have not explicitly differentiated between medium and large businesses. These businesses are similar in that personal computers will not serve as the business "mainframe" but rather will be appropriate for user-specific applications. As a business's size increases, the existence and power of a centralized IS department will increase. The capability and inclination to set personal computer standards will increase with the power of the IS department and the company's emphasis on shared data, programs and communication. The size of the business will determine how vendors market to the business and how purchase decisions are made.

4.2 Home/Hobby Users

The home/hobby segment accounted for 175,000 personal computer sales for a retail value of $437,000 in 1981 (Appendix E). Although the home market has been unprofitable and home sales are much lower than business sales, SRI predicts that the home market will grow at a faster rate than the business market, with a peak growth rate of 60% around 1985. Assuming 80 million U.S. households and 60% of worldwide home sales occuring in the United States, SRI's forecasts indicate a .4% U.S. market penetration in 1982, 1.5% penetration by 1985 and 12.7% penetration by 1990. The cost of the average home system is predicted to drop from $2,000 in 1982 to $750 in 1985 to $450 in 1990.

According to Future Computing, the major home computer manufacturers are Radio Shack (25%), Apple (20%), Commodore (20%), Texas Instruments (15%) and Atari (10%). This market is very price competitive on the low end. Texas Instruments and Atari have dropped the prices on their keyboard computers 40% in the past year to $369 and $399, and Commodore has come out with a $299 VIC-20 which is occasionally advertised for $249. Attempts to open up the home market have been unsuccessful to date. Texas Instruments was still in the red two years after its introduction. Atari sold $20 million of personal computers in 1980 and probably lost $10 million in the process.(6) Atari's home computer division is just starting (1982) to become profitable.

Home computer use is currently centered on entertainment, education and electronic messaging. The development of home computer software and communications networks will enable the sophisticated user to perform financial management, bill paying, teleshopping and information retrieval at a reasonable price by 1985-1990. By 1990 home computer systems may be hooked up to video discs, security monitors, etc.

4.3 Education Users.

There are 64,000 public elementary schools, 24,000 public secondary schools and 3,000 institutes of higher education in the United States alone.(7) Including private schools, the U.S. has approximately 77,000 elementary schools and 29,000 secondary schools. There are approximately 90 million students within the United States. Projecting elementary school PC unit potential as 5, secondary school PC unit potential as 20 and higher education PC unit potential as 150, the U.S. educational market alone has a purchase potential of 1.4 million units. According to SRI, the worldwide educational segment accounted for 35,000 unit sales for a retail value of $122,500 in 1981 (Appendix E). SRI predicts that PC unit volume will increase by 15% and sales revenues will decrease (due to lower unit costs). This author believes that annual purchases are much higher than 35,000 units and will increase by more than 15%.

The problems with the educational sector are their tight budgets and seasonal purchase patterns. However, if a variety of students are trained on one vendor's machine, this will establish individual transfer costs which may induce later purchase of the same machine. To build up their installed base, Commodore is offering 3 computers for the price of 2 to the the educational sector. Apple is pushing the "Technology Act of 1982" to provide Apple a substantial tax break if it gives one Apple II system to each public school in the United States.(43)

Computer-assisted instruction could provide interactive textual, graphic and audio instruction for any subject from mathematics to drama to auto mechanics. One could design homework assignments and interactively test students on their comprehension. The key advantage to computer-aided instruction is that the material is designed to move with the individual learner's speed and capability.

Control Data Corporation's timeshared PLATO system is probably the most sophisticated computer-aided instruction package currently available. Plato offers more than 7,000 hours of coursework. In addition to typical elementary high school or college coursework, Plato is used for personnel

training by airlines, utilities, automakers and other businesses. The system provides a menu of different subjects to choose from, presents the subject matter chosen, and drills you on your comprehension. PLATO is effective, but is basically a drill and practice tool. More conceptually oriented systems are needed which assume the role of a tutor. These systems will attempt to teach you conceptual problem solving techniques by walking you through a sequence of decision steps. Faced with a calculus equation to integrate, you will be asked if you would like to integrate by parts, perform a variable substitution, etc. The tutor can occasionally inform you, "It seems like you are getting off-track, why don't we check your assumption in step 3."

Software is the current bottleneck in computer-aided instruction. The development costs for PLATO have been on the order of $750 million (Source: Joel Moses, MIT). Sophisticated software also requires substantial memory capacity, which many inexpensive education systems don't possess. In addition, still frame picture and full motion video systems (video discs which will enable a student to interactively choose to observe a molecule or cell, or take a trip to Paris or the moon) are still in the distant future. However, less extensive computer-aided instruction packages can be very effectively developed if one understands how a student thinks, what s/he is interested in, and how he or she is motivated.

In addition to providing preprogrammed learning packages, personal computer usage will help acclimate the user (often a child) to the computer as a valuable tool. Since programming and sophisticated computer usage skills are becoming more important and useful in our society the educational system is a logical place to develop these skills.

4.4 Technical Users.

The science segment accounted for 105,000 unit sales for a retail sales value of $420,000 in 1981 (These 1981 projects by SRI in Appendix E substantially exceed Dataquest's 1980 figures in Appendix B).

Scientists use personal computers for CAD/CAM, sophisticated calculations, self-programming or to aid in experimentation analysis. The software for these systems must provide extensive calculation capability and be programmable in higher level languages such as PASCAL. These systems should also have hardware and software capabilities enabling them to hook up and utilize other scientific instruments.

Hewlett-Packard is focusing its HP-85 personal computer sales on its traditional market of science and engineers. This bundled machine has a built in printer, tape memory and 5" video monitor. The HP-85 is very compact and fits conveniently on a small surface.

The scientific market will be best served by a series of highly differentiated hardware and software products. The marketing and distribution channels for this market will be different from the other market segments. The copy will be more technically oriented, trade journals will be utilized more, and distribution will tend more toward direct sales and trade shows.

4.5 Marketing and Distribution.

As hardware costs decline and software standardization increases, marketing and distribution become increasingly important. One's marketing and distribution strategies will very depending upon which buyer segments are being targeted.

A. Marketing.

The prices (and margins) on personal computers are so low that mass media marketing will become the rule. In addition to utilizing the standard computer trade magazines (such as Byte, Datamation and Computer World) competitors are advertising heavily through such mass media business and financial publications as Business Week, Fortune and the New York Times. These advertisements are non-technical in nature and are attempting to promote awareness and purchases from the computer neophyte.

The major competitors are blitzing the television advertising channels. Atari is trying to focus the consumer on the inexpensive game-playing capabilities of the home computer. IBM, Apple, Hewlett-Packard and Xerox are maintaining a more sophisticated profile addressed primarily at the business or professional market.

IBM reportedly spent almost $1 million during the September 1981 U.S. Open tennis tournament, competing directly with Radio Shack for the commercial attention of these sports enthusiasts. Hewlett-Packard spent $1 million last autumn for spots on such shows as Monday Night Football and ABC's Nightline. Apple Computer spent more than $2 million on network programs such as CBS's Universe and 60 Minutes and on local programming in 14 major markets.(8) Commodore has undertaken a six month $6 million advertising blitz on such shows as 20/20 and Hill Street Blues. Nineteen out of twenty homes are targeted to receive 8 exposures to William Shatner selling Commodore products.

IBM's total advertising budget for its personal computer's first year of introduction will total $12 million to $15 million. Hewlett-Packard

will spend more than $10 million on promotional advertising. Texas Instruments tripled its advertising campaign to $3 million in the Christmas quarter of 1981. Apple will spend 4% of its revenues, or $12 million to $15 million, on advertising from mid 1981 to mid 1982.(8) These heavy advertising expenditures appear to be aimed at developing the market, establishing brand recognition, and increasing the costs of competition.

B. Distribution.

Unlike large computer system sales, personal computer margins are generally not large enough to warrant an internal sales force selling directly to end users. During this early period of dramatic growth, competitors are experimenting with a wide range of channels to determine what distribution strategy is optimal for their particularly competitive position. These competitors are faced with the following distribution options.

1) Independent Retailers
2) Computer Store Retail Chains
3) Office Equipment Dealers
4) Manufacturer Owned Retail Stores
5) Value Added Houses
6) Direct Sales Forces
7) Mass Merchandisers
8) Consumers Electronics Stores
9) Catalog Showrooms
10) Mail Order Houses

I will describe these ten distribution channels, specify which channels are most appropriate for the major buyer segments, and conclude that a multi-channel approach is the best distribution strategy.

1) Independent Retailers.

Single store retailers order in limited quantities and can be poor credit risks. These vendors are often too thinly capitalized to compete vigorously and are therefore dwindling in numbers and importance.

2) Computer Store Retail Chains.

Computer Store chains are the dominant distribution channel in the personal computer industry. These franchised chains provide the classic distributor functions of warehousing and individual account service. The major chains are well financed, and serve as a more reliable customer that purchases in less eratic patterns. The problem with utilizing these chains is that the quality of sales and service can vary from store to store.

Four well known computer store chains are Computerland, MicroAge (22 stores), CompuShop (18 stores) and Computer Store (16 stores). Computerland (based in San Leandro, CA) opened its doors in 1976 and had 200 franchised units by October 1981. The Computerland chain sold almost $200 million worth of computers and accessories (peripherals, video games, calculators, etc.) for an average single store volume of $1 million. Each franchised store pays Computerland 8% of their sales revenues. In exchange, Computerland provides national and local advertising, training programs, and price discounts due to Computerland's large volume purchasing.(8)

Most computer retail stores carry a wide cross-section of computers, peripherals and software products. These stores succeed due to the variety of their product offerings and the expertise of their sales personnel. Since the majority of current personal computer sales are to the business segment, these stores are concentrating their efforts toward business products. The different purchase needs of business and home buyers may lead to the development of two types of franchised chains and/or stores. In fact, some highly focused business chains could evolve providing specialized systems for scientists, manufacturers (CAD/CAM) or professionals.

Best Products, the nation's largest catalog-showroom merchandiser, is diversifying into computer store distribution. Its first personal computer outlet, called Data Base, opened in Richmond, Virginia on March 26, 1982. The store will offer computers made by Hewlett-Packard,

Commodore, NEC, Apple and Panasonic. Instead of the discount pricing offered at Best's catalog showrooms, Data Base will emphasize full-service programs.(9)

Since computer chains have undoubtedly been the most successful distribution channel, the competition for shelf space here is intense. Computerland buys the Apple III for $2,300. The $3,500 list price allows a 33% margin from the list price, i.e. a 50% markup.(10) Hewlett-Packard allows a 30% margin. Osborn provides a 41% discount for its recently introduced $1,795 portable computer.(8) Commodore has been giving between 30% - 50% margins in order to establish its domestic distribution channels. It is very expensive for a new entrant to provide the necessary margins to entice a successful computer store to sacrifice the throughput of the established brands such as Apple and IBM.

3) Office Equipment Dealers.

Office equipment dealers sell copiers, typewriters, word processors and other office equipment to the small and medium business markets. There are two major (perhaps overlapping) office equipment dealers associations in the United States. NOMDA (National Office Machines Dealers Association) has 5,200 members and NOPA (National Office Products Association has 4,200 members. These dealers provide an in-place nationwide selling and service channel with established contacts in the small business market. These dealers are better known and respected in many parts of the country than the personal computer manufacturers.

Sears joined this distribution channel in 1981 with the opening of five Business Service Centers in Boston, Chicago and Dallas. These centers handle personal computers (IBM, NEC and Vector Graphic), word processors (Wang, Exxon, etc.) and other office equipment. Sears views service as the key to merchandising a computer and "intends to be premier in servicing this type of product."(11) Sears' competitive advantage will be its large service network for its retail store products along with its existing technician training and inventory control procedures. Sears

recently announced plans to expand this network by 45 stores in 1982.(12)

4) Manufacturer Owned Retail Store.

There are many pros and cons of establishing a network of company owned retail stores. Manufacturer owned outlets provide higher potential profits, but a retail network takes time and money to establish, detracts from a market share strategy and does not provide a quick payback. A manufacturer can avoid having one's reputation tarnished by association with marginal dealers but independent dealers provide more credibility for being impartial. However, having one's own dealership can alleviate the problem of shelf availability within other channels.

Radio Shack "attacked" the personal computer market in 1977 via its own vast network of retail stores. Radio Shack has expanded this exclusive worldwide distribution channel to over 8,000 full line electronics stores (which offer all "popular" models) and 200 Computer Centers which offer a comprehensive product line, service, leasing and training. This distribution channel has been Radio Shack's major competitive advantage.

IBM has been developing a channel of company owned stores for several years. In 1978 IBM's General Systems Division opened a series of nationwide Business Computer Centers within IBM's branch offices. These 80 centers sell IBM's small business computer products to groups of customers rather than directly selling one customer at a time. IBM launched a retail sales program in April 1979 by opening stores in London and Buenos Aires. The apparent success of these stores encouraged IBM to establish 3 domestic retail outlets (Philadelphia, Baltimore and San Francisco) by year-end 1981. These outlets sell IBM equipment only (such as the Personal Computer, Selectric typewriters and $13,500 Displaywriter word processor), act as an IBM Service Center and offer typewriters for rent.(13)

In June 1980, thirteen months before Xerox introduced its personal computer, Xerox joined Radio Shack, DEC, and IBM in the retail computer

business. With the opening of the first "Xerox" store in Dallas. Xerox initiated a chain of "office equipment supermarkets for the small businessman." While the Xerox stores is primarily a showcase for Xerox equipment (office copiers, word processors, facsimile machines and small business computers), the stores also handle a variety of non-Xerox printers and initially stocked the Apple II in order to provide a low-end business system. By October 1981, Xerox had established 16 Xerox stores nationwide.(14) The verdict is still out as to how successful these stores will be.

5) Value Added Houses

The three major types of value added houses are Original Equipment Manufacturers (OEMS), Systems Houses, and Remote Computer Service (RCS) Companies. Although these channels are not currently of major import, this may change as the need for more focused and differentiated personal computer products develops.

OEM's incorporate the microcomputer into their product and specialize it for a particular application.

Systems Houses develop turn-key software and hardware packages for specific applications in the professional, small business and large business arenas.

RCS companies (such as ADP or Tymeshare) have historically provided computer training and access to data, software libraries and processing power (timesharing) through "dumb" terminals. These RCS companies will probably utilize the following strategies to adapt to expanding personal computer usage.(15)

1. Capitalize on applications knowledge and established relationships with the end users.
2. Convert selected application programs to personal systems. Many of the application programs can probably be

split so that one part is done on the personal system while another part requires the larger system.

3. Consider buying personal computer systems in bulk at good discounts and selling a turn-key package to people who were using the application package previously.
   -Consider leasing these turn-key systems to make it easier for the users to justify or substitute as an expense item.
4. Create a variety of data bases that can be accessed or downloaded to the corporate end users employing the personal computers as an intelligent terminal.
5. Provide detailed training in the use of personal computers.

6) Direct Sales Forces.

Direct sales forces are used by some manufacturers to serve major corporate accounts (Fortune 1000). Corporations which make bulk purchases would rather deal directly with the manufacturer even if they are approached by an enterprising retail dealer. The national account salesmen will focus on the Information Services unit of a large corporation or on specific functional (or industry) units if the corporate purchase decision is decentralized. These sales forces also target state purchasing units when educational or government purchases have been legally mandated to a centralized unit.

Radio Shack has established a national accounts sales force which can discount up to 18% on agreements to purchase $75,000 of equipment in one year. To avoid rivalry with the company and to maintain the incentive to provide appropriate service, Radio Shack credits these sales to the computer center nearest the location where the machines will be placed.(8) The fact that Radio Shack owns its retail outlets makes this strategy viable.

IBM has established a direct sales force which can sell only in quantities of 20 units or more. On sales of over 150 units, they can

offer a 15% discount. The fact that IBM has historically had a very strong direct sales force should provide it a competitive advantage in reaching the large corporate user.

IBM, Apple and Xerox must resolve a difficult conflict in establishing direct sales forces. These manufacturers do not want to antagoinze their very important retail chain dealer bases. However, the margins on these direct sales are substantial and it is important to lock the large corporate user into your system early on. The development of corporate PC advocacy programs provides the opportunity to capture a significant number of multiple system sales to important current and future corporate buyers.

7) Mass Manufacturers.

Sears, Montgomery Ward and J.C. Penny are among the mass merchandisers attempting to distribute personal computers. Sears started selling Atari computers in 1979 through the Sears' catalog and 80 Sears stores, but results were disappointing. A Montgomery Ward 8-store experiment with Ohio Scientific Computers has not been successful.(8)

There are many current problems with the mass merchandising channel. Mass merchandisers sell low cost, simple, commodity products. Any usable computer "system" still costs over $500, computers are not yet user friendly and simple to use, and current non-commodity computer products are substantially different from each other. Personal computer reliability (analogous to Japanese stereo reliability) has not yet been established, so the questionable service capabilities of mass merchandisers adds another purchase deterrent.

Selling personal computers takes time. It is estimated that customers need 4 visits totalling up to seven hours before they will buy a personal computer. Department stores are not accustomed to (and probably can't economically justify) providing the time and the expertise necessary to sell a personal computer. This problem will be partly alleviated as manufacturers develop interesting audio/visual software which can describe

and sell the system by itself.

The home market demand has not taken off due to a lack of perceived cost/benefit. As personal computers familiarity (penetration) increases, software and hardware standardization occurs, reliability improves and costs decline, mass merchandising channels will become more viable. At this point there will be an aggressive merchandising of personal computers by the major retailers, including a surge of private label offerings.

8) Consumer Electronics Stores.

With the exception of Radio Shack's private outlets, consumers stores have not become a major distribution channel. For example, Tech Hi-Fi has had only moderate success in moving Commodore's VIC-20 computer. The consumer electronics store has many of the problems currently facing the mass merchandiser. The Japanese have very strong established ties in these channels and already hold a substantial hardware cost advantage. If reasonable software standardization occurs, the Japanese will play a significant role in selling home computers through these channels.

9) Catalog Showroom.

Catalog showrooms sell calculators, typewriters, watches, radios and inexpensive stereos. To my knowledge Texas Instruments is the only major competitor currently using this channel. This channel suffers the same problems as the mass merchandiser, accentuated by its further lack of personal sales support and service.

10) Mail Order House.

Mail order houses may induce sales to price sensitive customers, but their lack of continuing service could disenchant the manufacturer's end users. The use of this channel can also upset one's dealers who take the time to educate a consumer, only to lose the sale due to "overly

competitive" mail order prices.

The largest U.S. mail order house is probably Olympia Sales in Los Angeles (Call 800-421-8045 for a free catalog). Olympic sells the major personal computers, peripherals, calculators, televisions, watches, typewriters, word processors, etc. at an average 20% discount off list prices. For example, Olympic sells the Apple III (which Computerland buys for $2,300 and resells for #3,500) for $2,800.(10)

Apple is currently involved in a major dispute with its mail order dealers. The December 4, 1981 Wall Street Journal described Apple's recent attempt to stop its 75-150 mail order retailers from selling its personal computers. In order to emphasize personal service, and perhaps to protect the $1,200 margins ($3,500 list price minus $2,300 dealer price) of its full-service dealers, Apple asked its 1,100 retail dealers in the U.S. and Canada to sign amended contracts not to engage in mail-order sales. The mail-order houses are currently challenging this policy change in court on anti-trust grounds. Apple's move could increase its quality image and help stabilize prices, but the loss of extensive mail-order sales could deter Apple purchases by price sensitive buyers.

Of the 10 distribution channels described above, the independent retail store and company owned retail store have been the most important channels to date. Appendix H gives Dataquests estimates of 1980 and 1985 worldwide computer market consumption broken down by four major distribution channels: independent retail stores, company owned retail stores, direct sales and mail order.

The choice of an optimal distribution strategy will depend upon the buyer segment(s) to be served. Technical users are best served through business computer stores, scientific equipment suppliers, and direct sales. Hewlett-Packard's experience in providing and selling solutions to engineering and science problems will help it dominate in this market. Educational users are best served through direct sales in states with centralized purchasing, office equipment dealers who have established credit and service relationships with the schools (e.g. Bell Howell),

retail computer chains and company owned stores. Home users are best served through computer chains, Radio Shack, and eventually mass merchandisers and consumer electronic stores. IBM's choice of Sears may legitimized the mass distribution channel in the eyes of the consumers. This would substantially reduce the entry barriers to low cost producers such as NEC. Business users are best served through computer chains, office equipment dealers, manufacturer owned stores and direct sales.

Most new manufacturers are wisely experimenting with a wide range of channels during this period of high growth, and are trying to avoid being locked out of important channels, IBM is distributing through Sears, Computerland, its own retail stores and its direct sales force. Xerox is using retail computer chains, its own Xerox stores and its direct sales force.

Manufacturers must be aware of four major issues in determining their distribution strategy.

1) Determine which buyer segment(s) are being targeted and prioritize your distribution efforts accordingly.

2) Use multiple distribution channels initially to serve your segment(s).

3) Train your distributors on what your product does, who it best serves and how it should be sold. For example, IBM requires a 3 day training session in Boca Raton for all of its dealers.

4) Develop interesting, user friendly audio/visual software which can describe and sell your product independent of a sales representative.

4.6 PC Buyers Conclusion

This chapter described the demographics, needs, usage and growth of four end-user buyer segments: business, home, education and technical users. The business sector is currently the largest, fastest growing and most attractive segment. However the purchase potential of the home market (80 million domestic households alone) may make it a very lucrative, long-term target.

The fact that the personal computer is not standardized reduces the power of all buyers. Since sales are generally made individually in small volumes, these buyers have even more limited bargaining power. However, large corporations have substantial bargaining power, based on their ability to control volume purchases. One large corporation recently made a bulk purchase of 1,100 Apples. Due to the high productivity gains facilitated by the personal computer, these corporations are not overly price sensitive. However these corporations will demand increased service, word processing, graphics, software friendliness and networking capabilities. Due to problems of making incompatible machines talk to each other, large corporations will restrict purchases to a few established vendors, causing increased concentration within the business sector.

Home buyers have completely different purchasing needs. They are less concerned with productivity, less sophisticated with computers, more price sensitive, and have yet to find a compelling need to purchase a personal computer. A different set of entertainment and service oriented, low cost competitors will serve this market, perhaps with standardized products.

There are a variety of different distribution channels available to reach these consumers, including computer store chains, company owned stores, office equipment dealers, direct sales, consumer electronics stores, mass merchandisers and mail-order stores. Although Radio Shack made an early entrant into the PC industry, the technological expertise currently necessary for PC manufacturing makes the threat of backward

integration untenable. However, the importance of consumer contact and expertise may lead these distributors into private label arrangements.

Computer store chains have been the superior distribution channel to date. These chains provide service, offer a variety of products, have qualified salesmen, and will take the time to fully explain their products. These chains have significant power to demand high margins and have very little available shelf space for new entrants. This condition provides a substantial barrier for potential entrants and will cause an increased emphasis on other distribution channels with products appropriate for these channels.

CHAPTER FIVE
PERSONAL COMPUTER SUPPLIERS

The price and quality of products supplied to an industry impacts its growth and profitability. As Michael Porter describes in his book Competitive Strategy, supplier power is determined by the following factors:(10A)

1) concentration of suppliers
2) lack of dependence on the customer for a substantial fraction of sales
3) switching costs facing the customer
4) a unique or differentiated product (few alternative sourcer)
5) threat of forward integration.

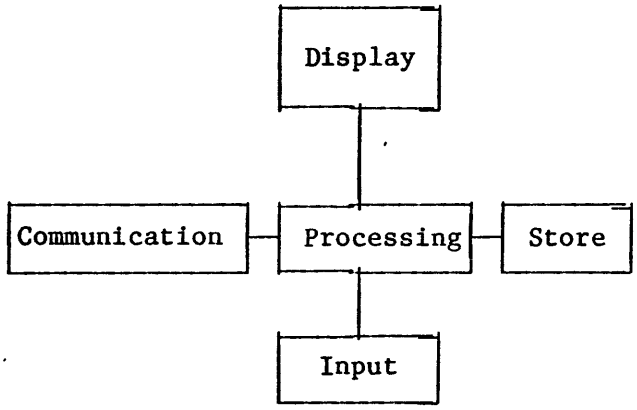
A purchaser must carefully select "good" suppliers and attempt to offset or surmount these sources of supplier power through the following strategies:(10A)

1) spread purchases
2) avoid switching costs
3) help qualify (encourage) alternate sources
4) promote standardization
5) create a threat of backward integration
6) use tapered integration.

As mentioned in Chapter Two, the personal computer can be broken down into five functional components: processing, display, input, storage and communication. PC competitors can either produce these functional components internally or purchase them externally from PC suppliers.

Figure 5.1

Functions of the Personal Computer



PC competitors initially assumed the role of assemblers. They would buy the microprocessors, semiconductor memory, peripherals and (sometimes) the software which comprise the personal computer, and then assemble these parts for resale. The evolving group of PC competitors have become increasingly integrated over time.

This chapter examines the technologies, costs and trends of the five functional hardware components supplied to the personal computer manufacturer. Since the PC industry has an important technological orientation, the price/performance of these components is an essential determinant of industry growth and structure. The issue of bundling components to reduce supplier power is discussed, as is the value added cost stream from the component level to the personal computer system level. The position of major microprocessor suppliers and the issues of integration are discussed.

5.1 Components to Process Information.

The major processing components of the personal computer are (A) the microprocessor and (B) semiconductor memory to allow local storage of data and programs.

(A) The Microprocessor.

The microprocessor is a central processing unit (CPU) which has been placed on a single integrated circuit (chip). "The task of the microprocessor is to receive data in the form of strings of binary digits (0's and 1's), to store the data for later processing, to perform arithmetic and logic operations on the data in accordance with previously stored instructions and to deliver the results through an output mechanism such as a cathode ray tube (CRT)."(16) The power of the CPU depends upon its word size(number of bits in its instruction set), internal cycle speed, and the sophistication of its instruction set and operating system. A larger word size allows a more sophisticated instruction set which can process more data (a larger word) in one instruction. Table 5.2 illustrates typical applications for microprocessors of different word sizes, and Table 5.3 illustrates typical microprocessor prices.

Table 5.2
Microprocessor Applications

Type	Applications	Languages	Models
2-4 bit controllers	Control Instrumentation	Binary Cross- Assemblers	Motorola 14500
4-8 bit functional devices	Instrumentation Games Controllers	Binary Assmember	Intel 4004/4040
8-bit systems	Personal Computer General Purpose	Assembler Basic Fortran etc.	Mostek 6502 Intel 8080 Zilog 80 Motorola 680
16-bit systems	Personal Computer Advanced Business Science File handling	Assembler Basic Fortran etc.	Intel 8086 Motorola 68000 Zilog 8000

Source: Stanford Research Institute, 1981.

Table 5.3
Typical Microprocessor Prices

4-bit	$ 1
8-bit	$ 4
16-bit	$15

Source: Hoo-Min Toong, Sloan School

Microprocessors are the fastest growing segment (25% - 30%) of the semiconductor market, accounting for 6% of last year's worldwide sales of $14 billion.(17) The Japanese have found this more software oriented portion of the semiconductor market difficult to crack, and American firms such as Intel and Motorola currently dominate this market. Microprocessor standards for personal computers have been the Zilog Z80 8-bit microprocessor and Mostek (owned by Commodore) 6502 8-bit microprocessor.

Recent usage of more advanced microprocessors has concentrated on the Intel 8088 and Motorola 68000. The Intel 8088 has been incorporated into the IBM PC. It has a 16-bit internal word size and 8-bit external word size (interface to the curcuit board "bus" for data and instructions). Some recent personal computers are upgrading to the Motorola 68000. This popular microprocessor has a 32/16-bit architecture and its multiprocessing capabilities allow several terminals to utilize this CPU without slowing down the main unit.

Other major microprocessor suppliers are Texas Instruments and National Semiconductor. Characteristics of the major microprocessors are provided in Table 5.4.

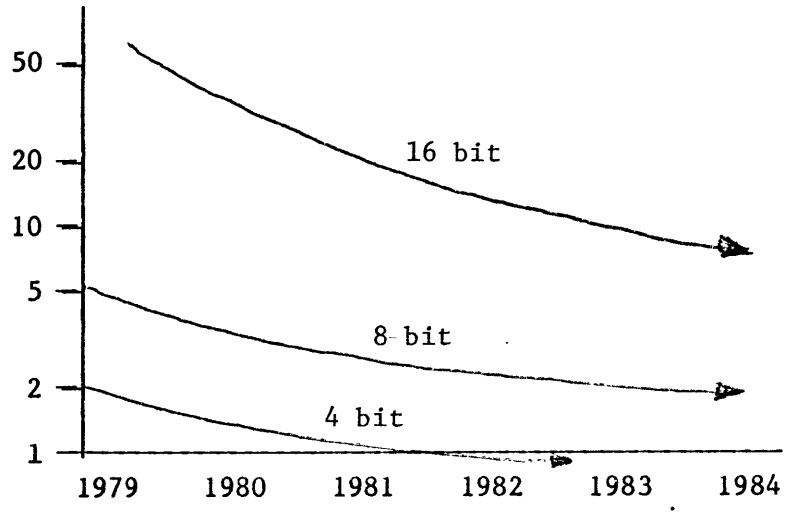
Microprocessor price/performance is dropping at an exponential rate. The historical 28% annual price decrease for a comparable processing function is expected to continue. (Table 5.5 provides more specific price forecasts). These drastic reductions will allow incredible processing powers to be available at low prices.

Table 5.4
Microprocessor Characteristics

Supplier	Processor	Word Size	Addressable Memory[1]	Cycle Speed(MHZ)	Users
Commodore	6502	8-bit	64K	4	Apple Commodore Atari
Intel	8080	8-bit	64K	2.6	
Zilog	80	8-bit	64K	6	Radio Shack Xerox Osborne
Intel	8086	16-bit	1M	10	IBM
Motorola	68000	16-bit	16M	12	Radio Shack Fortune Systems

[1]The amount of (local) memory the microprocessor can directly address.
[2]16-bit internal word size, 8-bit external word size.
[3]32-bit internal word size, 16-bit external word size.

Figure 5.5
Microprocessor Cost Forecasts



Source: Mini-Micro Systems, 5/81, pg. 103

Technological microprocessor advances will significantly affect the future capabilities of the personal computer. Microprocessors will be capable of supporting much larger address spaces (memory). Sophisticated operating system implementations will support multiuser/multitask environments. System architectures will use multiple processors. For example, shared microprocessors could divide general purpose tasks between them. Special purpose microprocessors could perform input/output or graphics tasks, or different coprocessors could be used to run software previously designed for these different microprocessors. Microprocessors will have more direct high level language support so that these languages can be more efficiently used for software development.(17A)

The problem will be developing the operating systems and applications programs which can utilize the ever increasing capabilities of the microprocessor. Within five years the 32-bit CPU of an IBM/370 mainframe will be commercially available on a single microprocessor chip. This will enable the utilization of a wealth of business software written for the IBM. Admitedly some of this software will not be appropriate for personal computers due to the program size, resource allocation needs, business application being addressed, and lack of user-friendliness.

When considering upgrading one's microprocessing unit, the strategic considerations facing the personal computer manufacturers are

1) Is the development of sophisticated operating systems and applications programs to utilize this new processing power worth the increased processing capabilities that can be gained?

2) Will programs designed for my existing computers be transferable to my upgraded machine?

B. Local Memory

Local memory is located on the microprocessor curcuit board, where it is "directly" connected to the microprocessor via an 8-bit or 16-bit data bus. Due to this direct electronic connection, local memory is very rapidly accessible to the microprocessor. The most common types of local memory are semiconductor ROM (Read Only Memory), semiconductor RAM (Random Access Memory) and magnetic bubble memory.

ROM is nonvolatile, cannot be written to (updated) by the CPU, and is therefore used for permanent "predefined" local storage of data or programs (such as the operating system). RAM is read/write memory and is used for temporary local storage. Since RAM is volatile memory, its contents are "forgotten" once power is turned off. If one wishes to utilize three input/output channels (CRT, disk, printer) and allow room to process sophisticated applications software, one's system should be expandable to at least 64K bytes of RAM. The IBM Personal Computer uses 40K bytes of ROM and up to 256K of RAM.

The Japanese are rapidly becoming the worldwide leaders in the semiconductory memory market. They recently gained 40% of the worldwide 16K bit chip market (semiconductor capacity is expressed in bits, where 8 bits = 1 byte), capitalizing on the inability of American firms to meet surging demands. The Japanese currently hold 70% of the worldwide sales of the embryonic 64K market (Hitachi 40%, Fugitsu 20%, NEC 6%, Motorola 20%, Texas Instruments 7%, Other 7%). The prices of these semiconductor chips have historically declined at an average 40% annual rate, with more rapid

declines occuring during the early stages of the chip's life cycle. 16K semiconductor memory chips sold for .90¢ or .005¢/bit in late 1981 (18). The more recent 64K chips dropped in price from $28 in March 1981 to $8 or .01¢/bit in November 1981. (19)

Magnetic bubble memory produces nonvolatile read/write capability at the more expensive cost of .10¢/bit. Bubble memory is slower than semiconductor memory, with transfer spreads comparable to those of hard disks. The recently announced $8,000 portable Grid computer (targeted at mobile businessmen) uses bubble memory to avoid an external storage device, but it is questionable whether bubble memory can drop enough in price to be competitive with semiconductor memory.(20)

The important point to observe is that integrated curcuits (microprocessors and memory) will become a less important part of overall system cost. This will provide a motivation for substantial increases in processing and memory capabilities.

The semiconductor suppliers have limited power in the personal computer industry. The intense rivalry here will continue to lower prices and keep margins very competitive. The important historic power of buyers to force semiconductor firms to license their designs and assure second sourcing will probably continue. The major threat to personal computer manufacturers is that the intense rivalry in the semiconductor industry and enormous profit in the personal computer industry will motivate the forward integration of these suppliers.

5.2 Components to Display Information

The major display devices for the personal computer are the television, cathode ray tube and printer.

A. Television

The television can "display" text, graphics, voice, still-frame and full-motion video. Its graphics resolution (300 pixels on each of 525 scanning lines) is sufficient for most usage. The display versatility (and the fact that 99% of U.S. households already own televisions and over 10% of all households purchase a new color set annually) make the television an outstanding display device, especially for the home user.

Color television sets are expected to remain in the $500 average price range, while black and white sets will remain near $150. However, television manufacturers will expand the current display function of the television set by including processing and communications functionality (videotex decoders, phones and modems) into future televisions. International Resource Development Inc. of Norwalk, Connecticut projects that 12 million TV sets with videotext/teletext decoders (see Chapter 6) will be installed by 1990. This compares with 9 million color TV sets purchased domestically in 1980.

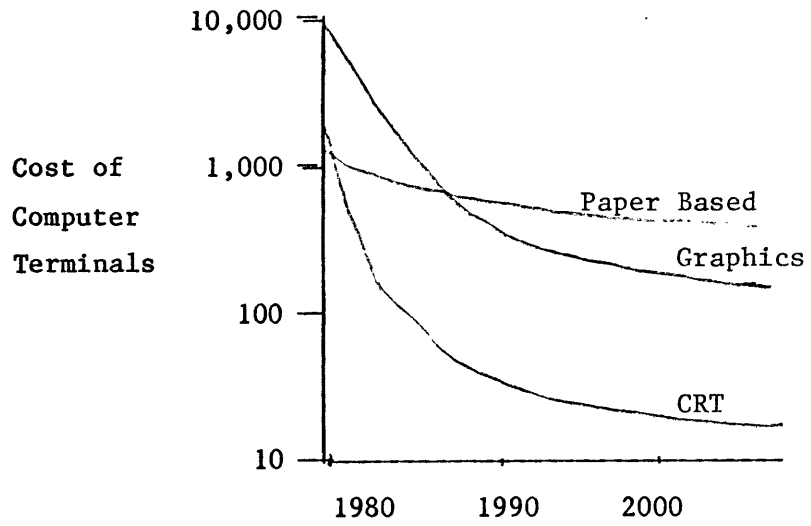
B. Cathode Ray Tube (CRT)

The CRT monitor is an alternative display device which keeps the television set free for normal TV program viewing. Typical CRTs for the personal computer market range from $150-$1000. For example, the Apple II includes a 12 inch black and white 24 row x 40 column CRT for $320. The IBM Personal Computer includes a black and white 25 row x 80 column CRT for $680. The TRS-80 Color Computer includes a 13 inch color 16 row x 32 column CRT for $399. NEC produces a $459 color monitor and $199 black and white monitor which are mass marketed for use with any personal computer

system. Although Stanford Research Institute claims that CRT prices are decreasing by only 5-10% a year, the Institute for the Future projects that CRT prices will drop substantially in the coming years (see Figure 5.6). Flat screens such as that used by the portable Grid computer will remain much higher priced than CRTs, and will not gain the mass market appeal of the CRT.

Figure 5.6

Projected CRT Prices ($1980)



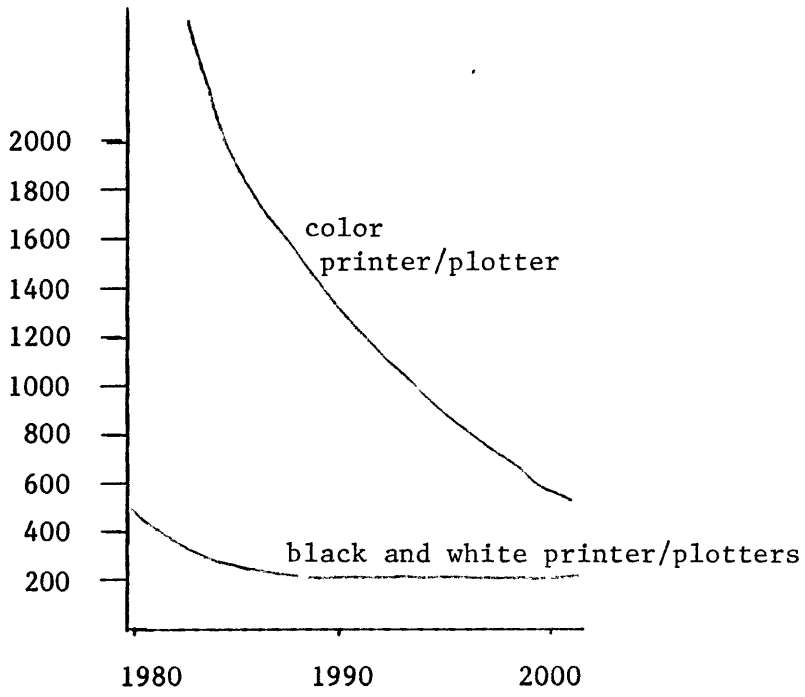
Source: Institute for the Future, 1982

C. Printers

Printers vary along a continuous price/performance spectrum. The most popular "personal computer" printers are the black and white serial dot matrix printers. They print between 60-400 characters per second, cost between $300-$1800, but are not quite letter quality. The Japanese company Epson is starting to dominate market for dot matrix printers. Letter quality printers will be offered at prices less than $1000 within the next few years. Figure 5.7 shows 20 year forecasts of low cost printer/plotters.

Figure 5.7

Projected Printer/Plotter Prices ($1980)



Source: Institute for the Future, 1982.

5.3 Components to Input Data

Input devices can take the form of

a) Textural Input (Numeric/Alphanumeric)
b) Graphics Input (Painting/Drawing)
c) Voice Input
d) Video Input (Still frame/full motion)
e) Sensory Input (Fire/home security monitoring.

Source: Institute for the Future, 1982.

In the near future the major input mode will remain the alphanumeric keyboard. These keyboards often house the microprocessor circuit boards and power packs in personal computers. These devices currently cost $30-$300 and are not expected to drop substantially in price.

The touch-tone telephone, which allows voice and numeric input, may also be incorporated into communications oriented personal computers. The $30 installation charges and additional $15-$20 annual costs of touch-tone (vs. standard dial) services are often justified by increased convenience of normal phone usage. The cost and increasing penetration of the touch-tone telephone make it viable input device. AT&T may substantially upgrade the telephone to include processing, alphanumeric input and display capabilities if they choose to automate the yellow/white pages and/or move into the home terminal market.

5.4 Components to Store Data

The actual processing of data and programs is done through the microprocessor and the rapidly accessable local memory. External memory is much slower to access than local memory because it requires the mechanical positioning of a read/write mechanism. External storage is used to retrieve and permanently store data and programs which are either (1) suspect to update or (2) not of enough importance to permanently reside in ROM memory. External storage can take the form of (A) tape casettes, (B) floppy disks, (C) hard disks, (D) videodiscs and (E) video cassette tapes. For the purposes of comparison, remember that a 24 row x 80 column typewritten page holds 2,000 (2K) characters.

(A) Tape Cassettes are acceptable for loading programs to and from local memory, but are limited by their speed and reliability, and by the fact that direct access is impossible on this sequential storage medium. The typically low cassette drive cost (e.g., Radio Shack's $60 cassette player) is their strongest feature.

(B) Floppy Diskettes are very popular external storage devices for personal computers because of their ability to allow quick random access of data or programs. The 5 1/4" IBM diskette drive unit holds 160K bytes of data, and the diskette drive and required interface unit costs $790. Typical 5 1/4" floppy disks hold 40-200K bytes of data and cost $300-$800. Typical 8" floppies hold 150K-3M bytes and cost $500-$1500. Floppy diskettes are faster than tape cassettes but much slower than hard disks. Shugart Associates (purchased by Xerox in 1980) has annual revenues of $200 million and is probably the largest supplier of floppy disk drives.(20A)

(C) The most inexpensive hard disks are the recently developed 5 1/4" and 8" Winchester disks. The essence of Winchester technology is

that the head-to-disk assembly of Winchester disks is sealed from the outside air and is non-removable. Because the drive is impervious to external air contaminants (dust) and pressure fluctuation, reliability is substantially improved and read/write heads can be designed for faster access than floppy disks. Since Winchesters cannot be removed, all information must permanently reside on the disk or be "backed-up" on removable tapes or floppy disks.

Winchester disks typically store 1M-6M bytes of data and cost $1000-$6000. Since hard disk drives (like floppy disk drives) are mechanical in nature, costs/byte will decrease more substantially than the total device costs. These devices will become increasingly popular for applications with large database requirements that need the capacity of these disks to store data and the database management systems needed to manage sophisticated access to this data.

Dataquest estimated that 59,000 micro Winchesters were sold in 1981, their first full year on the market. By 1985, annual sales could reach 770,000. In addition, computer makers will manufacture close to 500,000 for use in their own products.(20B) The Winchester industry is now very concentrated, with Seagate Technology and Tandom Corp. respectively accounting for 65% and 15% market share.(20C)

(D) Videodisc devices play prerecorded audio/visual material on a television set. For the foreseeable future videodiscs will be technologically limited to read only usage. Although random access capability can be designed into these systems (with direct random access to any frame in 2.5 seconds) current videodiscs do not have sophisticated addressing and random access capabilities.(21) Current videodiscs have also not advanced beyond the stand-alone phase to enable easy integration with other devices. North American Phillip's LaserVision and RCA's Selectivision are examples of the two types of videodiscs (optical versus capacitive) currently available.

LaserVision has an optical-reflective pickup method which uses a

mirror and reflected laser beam to read the "contours" of the videodisc. The laserdisc can hold an incredible 2,500M bytes of information (100,000 video frames of 25K bytes each). The entire Encyclopedia Brittanica can be fit on a few laserdiscs. The M.I.T. Department of Architecture recently drove a car through Aspen, Colorado (with cameras pointing straight ahead and to both sides) and recorded the entire town on a single videodisc. A computerized system has been developed to teach a user about Aspen. The user simulates a drive through Aspen, choosing directionality at each intersection, and zooming in on interesting sights.

RCA's Selectivision has a capacitive pickup method similar to a record player. A capacitive electronic disc (CED) has grooves which are read by a diamond stylus. The Selectivision player sold only 50,000 units in 1981 (RCA's sales goal was 200,000 units and RCA had planned to be able to produce 500,000 units by yearend 1981). Selectivision prices were dropped from $500 to $350 in February 1982.(22) In contrast, individual disc sales were outstanding. RCA had produced and sold 2.85 million discs by year end 1981.(23) RCA's new strategy can be described with the following analogy, "If you can sell enough blades, you can give away the razors".

It is likely that the optical disc technology will prevail. RCA's technology appears limited to analog recording, while the Phillip's technology appears likely to develop digital capability as well. This capability would allow one to store programs (digital), still-frame pictures, and full motion video on the same disk. Combined with random access capability, these videodisc players would allow incredible educational and information retrieval capability.

More than 200,000 videodisc players were sold in the United States in 1981. About 160,000 of these were capacitive disk players and 60,000 to 80,000 were optical types. (23) Videodiscs will most commonly be used for preprogrammed entertainment and education, and for information retrieval of a fairly static nature (Sears catalog).

(E) Videocassette recorders such as Sony's $900 Betamax allow audio/visual reading and writing (recording). However, because tapes are a sequential storage medium, videocassette access time is extremely slow. Videocassette recorder sales jumped 70% in 1980 to 800,000 units.(24) Assuming that videocassette penetration outpaces videodisc penetration, this may eventually be the preferred medium for mass delivery of audio/visual information.

Table 5.8 compares attributes of the different storage media we've discussed and Table 5.9 presents 20 year forecasts for storage and media prices.

Table 5.8

Attributes of Storage Media

Technology	Cassette	Floppy Disk	Hard Disk	Laser Disk	Video Cassette
Digital Storage*	20-200K	100K-1M	3M-20M	----	----
Video Storage (25K byte video frame)	----	----	----	108K	216K
Access Time	10"/sec	200-800 ms	20-80 ms	2.5 sec	
Transfer Rate (Kbytes/sec)	.5-5	60	500	30**	30*
Drive Unit Cost ($1982)	$50-$80	$500-$2500	$1000-$6000	$400-$750	$700-$4200
Media Cost ($1982)	$.50	$5-$10	N/A	$15-$25	$10-$15

* One typewritten 24 row by 80 column page contains 2,000 (2K) characters.
** Frames/sec.

Source: Institute for the Future (revised by author)

Table 5.9

Forecast of Storage Device Prices($1982)

	1980	1990	2000
Audio Cassette Players	50-80	50-80	50-80
Floppy Disk Drives	500-2500	500-2500	500-2500
Hard Disk Drives	1000-6000	500-5000	500-5000
Video Disk Players	400-750	250-500	100-3000
Video Cassette Recorders	700-1200	350-800	200-600

Source: Institute for the Future, 1982.

5.5 Components to Transmit/Receive Data

The telephone system is the most popular system for two way communication of information. This sytem has virtually 100% penetration, but has relatively slow transmission capabilities. Most home and commercial lines use transmission speeds of 300 or 1200 baud (one baud is roughly equivalent to one bit/second, so a 300 baud line transmits roughly 37 characters/sec). Telephone lines can be updated fairly easily to 9600 baud.

Modems convert the analog signal our home phone lines receive into a digital format for the computer, and visa versa for transmission. Modems vary in complexity and price with the baud rate to be converted. Standard 300 baud modems cost $150-$200. The TRS-80 direct connect modems (which plug directly into a phone socket) cost $149 and their telephone interface modems cost $199. Projected telephone modem costs are provided in Table 5.10.

Slightly more than one third of today's personal computer systems use modems, and by 1985 over 70% of all personal computer systems will include a modem. This change will be due to a substantial increase in networking and data base access opportunities evolving over the next several years.

Table 5.10
Projected Modem Costs ($1982)

	1982	1990	2000
300 baud	150	50	10
1200 baud	700	100	20
2400 baud	1600	250	30
4800 baud	4800	400	50
9600 baud	3000	800	100

Source: Institute for the Future, 1982.

5.6 Bundling

The term bundling applies to the practice of providing a group of products or a physically integrated system at a single price, without individual prices for the elements that make up the system.(23A) For example, any combination of the five functional components described above (processing, display, input, storage and communication) could be offered as a system package. Bundling one's components enables one to increase entry barriers, differentiate one's product, and reduce the power of one's supplies.

Bundling increases entry barriers by foreclosing the opportunity for a potential entrant to specialize. The entrant must amass expertise in a greater multitude of activities and encounters larger absolute cost barriers. The increased expertise and costs required will likewise deter the development of plug-compatible computers.

Bundling allows one to differentiate one's product by tieing particular features such as support, peripheral or networking compatibility into one's product. Differentiation is further increased by the difficulty in making direct price comparisons.

Bundling can reduce supplier power by restricting their ability to reach outside markets. Peripheral suppliers have reasonable power in that some peripherals are becoming standardized and useable for several PC designs. These suppliers (e.g. Epson printers) can sell their products directly to distributors (computer chains, mail-order houses, etc). PC manufacturers can reduce this power by building interfaces into the peripherals, continually changing interfaces or physically bundling their components together.

The trend in the PC industry has been toward increased bundling. The processing unit and keyboard were integrated very early in the industry's development. With the exception of their lowest cost products Commodore and Radio Shack have historically bundled the keyboard unit and CRT together. Osborne has integrated the keyboard, CRT and disk drives into its protable unit. The Apple III differs from the Apple II by its

incorporation of a disk drive and operating system. Hewlett-Packard has bundled the keyboard, CRT, casette drive and printer into one compact unit.

One cost of bundling is lost sales to consumers wanting flexibility in designing and upgrading their systems. IBM is therefore emphasizing its five device independent interface slots which allow one to purchase IBM interface boards and whatever configuration of interface compatible peripherals the user selects.

Bundling can also prevent the development of an infrastructure of peripheral products designed around one's PC. The Apple II was in part successful because Apple encouraged the development of software and peripheral products to support it. IBM is publishing the specifications for its interfaces in hopes of spawning a comparable development of IBM compatible peripherals.

Bundling can also decrease the flexibility of the manufacturer. Management of technological innovation stresses the need to maintain flexibility in designing one's product and reacting to technological change.

One should note that the advantages of bundling are leading the PC industry in a different direction from that of the mature stereo industry. It is interesting to conjecture whether PC "console" units will dominate or whether standard inteface units such as the stereo receiver will become more prevelant.

One should also note that the historic computer industry practice of building software is not present in the personal computer industry. Osborne includes the standard CP/M operating system and applications packages such as word processing and SuperCalc in its $1,795 system price, but other manufacturers offer their systems software (sometimes) and applications software separately from the hardware system. The crucial role of software development and the evolution of an independent software industry has established the practice of unbundling software and hardware.

5.7 Value-Added Chain

We have looked at the five functional components which comprise the personal computer system. In order to determine the relative importance of these components, it is necessary to evaluate the value-added chain from the component level to the retail system sale level.

The rule of thumb for micro/minicomputer systems is to mark up manufacturing costs approximately four times. After including selling, R&D, service, depreciation, and general and administrative expenses, this practice normally allows a 20% before tax profit. The estimates provided in Table 5.11 are based upon financial reports, distribution margins revealed by the press and local distributors, OEM and mail-order price lists, and industry sources (Hoo-Min Toong).

The cost of semiconductor components depends upon their age (learning curve), efficiency and capacity (e.g., 16K RAM vs. 64K RAM chips). IBM's ROM costs are so low because their recent design has placed all ROM instructions on one 40K chip. Power supply costs depend upon the number and complexity of peripherals to control, and the processing power being utilized. The components for IBM's disk drive interface cost approximately $40 and are probably assembled and sold in quantity to IBM for $70. IBM resells this board to a distributor who retails it for a suggested list price of $220. Bare Shuggart disk drive units can be purchased in volume for $140 each. Components (digital logic circuits, disk controller chip, etc.) are added by a third party and resold in volume to IBM for an estimated $210. The drive is then encased in the PC unit (or separate case) and sold to the PC distributor. The final disk drive retail price is $570. When peripherals (such as disk drives) are not bundled into the PC unit, their 30%-34% margins are slightly lower than standard PC margins.

Table 5.11 estimates the value added chain for the IBM PC, Apple II Plus and Commodore VIC-20. The Apple II is an established cash cow, has gone through six cost reductions (Source: Steve Jobs) and is probably funding increased marketing and R&D (including software development) for

the newer Apple III and Lisa systems. Commodore's low semiconductor costs are due to integration and limited memory capacity. IBM's estimated 10% profit margins are much lower than their traditional 20% margins.

These figures are rough estimates and prices will vary over time. In arriving at a make vs. buy decision, the PC manufacturer must consider risk, technology trends, power of the suppliers and the opportunity costs of capital. These estimates dramatize the relatively low percentage of semiconductor costs compared to peripheral costs and distribution markup.

Table 5.11

PC Value Added Chain

	IBM PC		Apple II		VIC-20	
Mainframe						
Motherboard	25		20		10	
CPU	15		5		3	
RAM	45	(48K)	45	(48K)	2	(5K)
ROM	5		20		2	
Power Supply	50		45		20	
Keyboard	60		45		20	
Other (Resistors, etc.)	40		35		8	
Total	240		220		65	
Peripherals						
Diskette Drive Adapter	70		separate		separate	
Floppy Disk Drive	210		unit		unit	
Labor (Assembly, QC, etc.)	50		30		10	
Total Manufactured Cost	570	36%	250	25%	75	36%
Non-Hardware Costs						
Marketing	130	8%	120	12%	12	6%
R&D	90	6%	80	8%	10	5%
Other (Overhead, etc.)	660	41%	360	35%	77	38%
Total Non-Hardware	870	55%	560	55%	99	49%
Full Cost	1,440	90%	810	80%	174	85%
Profit Before Tax	160	10%	200	20%	30	15%
Net Sale	1,600	100%	1,010	100%	204	100%
Distribution Margin	785	35%	520	34%	95	32%
Retail Price	2,385		1,530		299	

5.8 Vertical Integration

Since the major PC cost items are distribution and peripherals, integration into these areas would be most rewarding. We have already seen a number of competitors (IBM, Xerox, Radio Shack) which have established retail distribution channels. Referencing Xerox's 1981 Annual Report, one notes that in the last five years Xerox's has acquired Shugart Associates (the leading supplier of floppy disk control and memory units), Versatec (an established printer/plotter manufacturer), Century Data Systems (a large capacity rigid disk drive producer) and Diablo Systems (a terminal printer manufacturer). Radio Shack has started manufacturing its own printers, and has licensed the technology (from Shugart) to internally manufacture its disk drives.

Due to the incredible competitive rivalry in the semiconductor business and the high relative power of the buyers over the semiconductor suppliers (witness the buyer's ability to force second sourcing), backward integration into semiconductor manufacture is not the most fruitful utilization of resources, unless a company believes it can produce a highly differentiated proprietary microprocessor. However, due to the rivalry and technological importance of semiconductors, semiconductor suppliers pose a serious threat of integrating into the personal computer industry. Commodore (after purchasing Mostek) and Texas Instruments have entered the industry from their semiconductor base. NEC is a fully integrated electronics firm (from semiconductors to computers to peripherals to communication) and their technological and shared cost advantage could be crucial if they again adequate software and distribution or help define the personal computer as a standardized commodity item.

Intel and Motorola are two likely American threats. These firms are currently one and two in worldwide microprocessor sales. Intel has three recently developed "systems" which may lead it into the personal computer industry (25):

1) An incredibly powerful database management system based on the 16-bit Intel 8086 microprocessor. Database management systems and communications capabilities will be the key to the office of the future.

2) A "transaction processor" doing ATM-like computer tasks, which could eventually propel Intel into home banking or teleshopping.

3) A low cost, portable version of Intel's software development system which can run popular software packages such as VisiCalc and serve as a personal computer for engineers or programmers.

Intel's sales force has historically sold only to manufacturers, but they will now sell their new systems to "systems-houses" which put together computer systems on a custom basis. Intel is still very removed from "personal" marketing and distribution and this capability would have to be acquired if Intel chose to move in this direction.

Motorola's December, 1981 acquisition of then troubled Four-Phase Systems gave Motorola a weak product line and strong field-sales and service organization in the computer and terminal business. Teamed with Motorola's very strong semiconductor base, dominant radio communications business and successful Codex subsidiary (a leading supplier of modems, multiplexors and network processors), the Four-Phase acquisition could enable Motorola to make a major thrust into distributed (even mobile) data processing and office automation. (26) This could position Motorola toward large corporate users, in direct competition with Xerox and IBM.

5.9 PC Suppliers Conclusion

This chapter has observed that personal computer competitors initially assumed the role of assemblers, and have become increasingly integrated over time. The five functional units comprising the personal computer have been described along the dimensions of price, performance and expected technological advancement. I have noted the trend toward physical bundling of supplied components to increse entry barriers, differentiate one's product and reduce the power of suppliers. The relatively low price of semiconductor processing power has been emphasized, as has the importance of peripherals and distribution. I have concluded that integration into distribution or peripheral manufacturing is a viable strategy, and the forward integration of semiconductor suppliers is a strong potential threat.

CHAPTER SIX
COMPLEMENTS TO THE PERSONAL COMPUTER

Complementary products are products which are used in conjunction with each other. In more rigorous terms, complementary products have negative cross-price elasticities. When the price/utility of a complement to Product A decreases, demand for Product A increases. Typical complements are bread and butter, razors and blades, cameras and film, or VCR's and VCR cartridges. The price, quality and availability of the complements to a product affect the demand for that product.

The development of complementary products to the personal computer will have a profound impact on the purchase and usage of personal computers. Most personal computer users seek a product which provides a preprogrammed solution for their needs. The rapid development of a microcomputer software industry to complement the personal computer will greatly increase personal computer applicability and sales. The emergence of networks which allow personal computers to share data, programs and processing power with other computers will further increase personal computer utility and usage. This chapter discusses these two critical complements to the personal computer.

6.1 Software

As hardware costs decline, the availability and applicability of software packages becomes an increasingly crucial variable in the personal computer industry. The importance of the software industry is reflected by its size and expected growth. 1981 sales of microsoftware totalled $500 million and sales are expected to reach $6.2 billion by 1987. (27)

This section describes how microcomputer software works, what types of software have been developed and will be developed in the future, and what strategies have been and will be used for the development and distribution of software.

1. How Microcomputer Software Works

The key variables in software development are the microprocessor instruction set, the associated operating system and the programming languages which are supported.

Microprocessors are designed to support (execute) an instruction set of approximately 100 binary instructions. The length and sophistication of these instructions depends upon the word size (8-bit, 16-bit, etc.) of the microprocessor. An instruction such as "10101001" could mean "Add the contents of register 2 to the contents of register 1" or "Store the contents of register 2 in the local memory address contained in register 1". Microprocessor manufacturers provide assemblers which enable software development in less complex mneumonic representations. These mneumonics are assembled almost directly into executable binary code.

Operating Systems are sophisticated software systems programmed in the assembly language of the microprocessor. Operating systems are designed on a higher level to allocate and supervise the four main computer system resources - processor time, memory, peripherals and files - on the basis of user needs. Processor management is essential when more than one task is competing for the CPU. (This multiprocessing capability is not available on all personal computers). For example, a user may be

listing something on the printer while he is also playing a game, or multiple users may be utilizing the computer simultaneously. Memory management is necessary to handle data stored in temporary buffers and to insure that certain privileged memory areas are protected from the user. Peripheral management controls tasks like the display of images on a CRT or the transfer of data to and from a disk. File management protects and keeps track of the location of data and program files. In general the microprocessor's operating system oversees (supervises) the computer resources by organizing instructions which the microprocessor executes.

Popular programming languages (such as BASIC and Pascal) are supported to free programmers from writing in the complex instruction set understood by the microprocessor. This is accomplished by developing interpreters and compilers which translate higher level language commands (such as X = Y + Z or READ DATAFILE) into executable binary instructions. By developing or purchasing a BASIC interpreter and including this interpreter with one's personal computer, the manufacturer facilitates the development of software packages for his personal computer.

2. Microcomputer Software Development

When the initial personal computer kits were sold in the mid 1970's, a myriad of microprocessors were being used and there was little or no software to support them. Four crucial developments occured which stimulated the development of an independent software industry. Entrepreneurial success in developing(1) operating systems, (2)higher level languages,(3) applications programs and (4)software publishing houses lead to the evolution of a software industry separate from the personal computer manufacturers.

In 1974 Digital Research designed an operating system called CP/M (Control Program for Microcomputers) which could control an Intel 8080-based microcomputer with floppy disk drives (a new technology at that time) and allow systems programs to be written and compiled on the microcomputer. Many of the early microcomputers (including the Altair 8800)

were based on the Intel 8080 or the Zilog Z80 (which had a "compatible" superset of the Intel 8080 instruction set) and could utilize the mass marketed CP/M operating system. With the availability of a common operating system for a number of machines, standard high level language compliers and applications programs were soon developed. Since CP/M was a mass marketed product (in contrast to the proprietary operating systems of Apple, etc.), new manufacturers could produce a CP/M based product and be assured of an existing library of standardized software. To the extent that the personal computer industry is standardized, it is standardized around CP/M based products which use derivitives of the Zilog Z80. The recent Osborne and Xerox personal computers and the Wangwriter word processor use CP/M, and the IBM includes a modified version of CP/M which allows easy conversion of CP/M based programs to the IBM. To give an idea of its price, Xerox charges $200 for the CP/M software. CP/M helped spawn the independent software industry and there have been thousands of applications developed using the CP/M operating system.

In early 1975, Harvard Business students Bill Gates and Paul Allen bought an Altair 8800 and began developing a higher level BASIC programming language for the 8800. Their "Microsoft BASIC" program converted BASIC instructions into binary code without an operating system to help them. Therefore this interpreter had to perform typical operating system functions such as controlling the transfer of data between the microprocessor and floppy diskette. Microsoft Inc. has since rewritten their BASIC interpreter for use with numerous personal computers, including Apple, Radio Shack, IBM and CP/M based machines. More than 600,000 copies of Microsoft BASIC have been sold (28) and this BASIC interpreter has stimulated a wealth of application packages written in Microsoft BASIC. Although the availability of a common higher level language allows the independent programmer to write one program and revise and recompile this BASIC code for numerous personal computers, most independent programs to date have been designed for exclusive use by one PC system.

The next major software impetus was provided by the October 1979 introduction of VisiCalc. This application program was written initially for the Apple Computer by Software Arts, and then marketed and distributed by Personal Software, Inc. (now VisiCorp). VisiCalc provides a 63 column x 254 row spreadsheet to handle numerical calculations based on user defined variable relationships, and allows one to perform budgeting, forecasting, statement preparation and "what if" analysis. This was the first major application package success which showed people how immediately useful a personal computer could be, and probably directly led to the purchase of thousands of personal computers. VisiCalc is now available on most machines, and has sold over 200,000 copies at approximately $200 each.

To complete the establishment of an independent software industry, publishing and distribution channels have formed independent of the hardware manufacturer. Lifeboat Associates was probably the first publishing house to distribute software not proprietary to the PC manufacturer. Lifeboat Associates was formed for this purpose in 1977, and by 1981 had a catalog of over 200 programs, yearly revenues of $10 million and offices in six countries, including Japan. (28)

The software industry has witnessed the entrepreneurial development of operating systems, programming languages and applications programs. This software development could be divided into three different categories.

The first category consists of computer games software. These programs, such as Microsoft's Adventure, have been very tightly held within the $20-$50 price range. The next category consists of general purpose, mass market programs such as CP/M, VisiCalc, accounting and word processing programs. These programs consistently fall in the $150-$600 range. For example, IBM offers VisiCalc for $200, EasyWriter (word processing) for $175, Accounts Receivable for $595 and a Pascal Compiler for $300. The third category consists of specialized packages which do not have mass market appeal and sell in the $1,000 range.

These software offerings will change over time as technology and software development tools improve and as software suppliers become more atune to the demands of the market. In addition to cost, the most commonly expressed deterrant to personal computer purchase is the lack of user friendly software and the unavailability of software which satisfies specific user needs.

Manufacturers are spending extravagent sums developing user friendly interfaces for their machines so that the computer interface (screen display, etc.) resembles the manner in which a neophyte user visualizes his world (tasks).

The unreleased Xerox Smalltalk interface stimulates a person's experience working with papers and information on his desk. When a user puts aside a computer file (paper) to temporarily work on something else, a visual image of this paper edge appears underneath his current page to remind him of his additional tasks or data.

An IBM File Cabinet option (layman's terms for a database management system) allows a user to move a screen cursor to a visual file cabinet (icon). The file cabinet opens up and presents a number of folders with tabs. After choosing his file, the user actually sees pages turn as he scrolls through the file.

Apple has spent over 200 man years in software development for their upcoming Lisa computer system, as opposed to 25 man years for the Apple III.(49) The Lisa software interface resembles that of the Xerox Star workstation. A mouse is built into the pad on one's terminal to enable one to move a mouse cursor on the screen to familiar visual representations of tasks. Lisa is supposed to allow very sophisticated data management and revrieval and is intended to create an environment which encourages the use and further programming of the Lisa computer. We will probably see a spectrum of novice and expert interfaces which will cure "computer phobia" and allow usage tailored to one's interests and system familiarity.

Specialized program development will also increase in importance.

Experts who understand the needs, environment and problem solving approach of specific industry or functional areas will supervise the development of more useful packages. People will write general programs which can be linked together or user modified for specific needs. Applications generators will allow access to libraries of common functional routines which can be linked together easily to generate specific applications programs. Higher level languages such as microcomputer EXPRESS will be developed to facilitate the development of customized packages.

Other software developments are likely to occur. Sophisticated database management systems (which need lots of storage space) will become more popular as the costs of mass storage Winchester disks decrease. Programs will evolve to satisfy the increasing demand for graphics. The emmergence of popular 16-bit systems, such as those based on the Motorola 6800 microprocessor and Unix operating system, will stimulate a new round of more advanced software development. Significant emphasis will be placed on the multiprocessing (concurrent processing of multiple users or tasks) capabilities of these microprocessors.

This section has described the important types of software that have been developed to date and how this will change in the future. The next section deals with the strategies that hardware and software companies will use to direct the development and distribution of software.

3. Software Strategies

Although entrepreneurs have helped establish an independent software industry, hardware manufacturers still play the dominant role in directing this industry. Although it is hard to predict how hardware manufacturers and independent software companies will split the development, control and distribution of software, I believe that software companies will play an

ever-increasing role. In the minicomputer industry, software is developed either by the hardware manufacturer or by the system user. In the personal computer industry, hardware and software will separate in a manner more analogous to that seen in the stereo equipment and recording industries. This section describes the possible roles and strategies of hardware and software companies, describes the evolution of software distribution channels and comments on how the development of this complementary industry will impact the personal computer industry

A. Hardware Companies

The most crucial software decision made by the manufacturer is the choice of microprocessor(s) and operating system(s). This choice determines whether a company seeks to utilize standardized software, proprietary software or both.

Manufacturers (Xerox) choosing standard CP/M or Unix based systems reduce their entry and mobility barriers through access to predeveloped software libraries and reduced R&D, but make it difficult to differentiate their product based on unique software support.

Manufacturers (such as Apple) which utilize proprietary systems and applications software incur delays and increased costs in establishing software support, but do create high customer transfer costs once a user becomes attached or dependent upon one's differentiated software.

Manufacturers can compromise by utilizing several microprocessors or operating systems within the same machine. IBM's Personal Computer uses three operating systems specifically designed for their 16-bit Intel 8088 based machine. The Microsoft MSDOS operating system will enable the development of proprietary software and the CP/M-86 operating system will allow CP/M-based programs to be "easily" modified for the IBM Personal Computer. Radio Shack's new Model 16 uses the Unix operating system running on the 16-bit Motorola 68000 and their proprietary operating system running on the 8-bit Zilog Z80 coprocessor.

Atari may produce a CP/M based machine with their special graphics and games processors for Atari's more exclusive software.

Commodore has recently announced its intention to pursue a fourth strategy, develop a system to run software developed for the proprietary systems of its competitors. Commodore has announced a personal computer that will accept other microprocessor boards through a slot in its back. It will be able to emulate the Apple Computer, Tandy, IBM and others but sell for a much lower price - less than $1000 (29). How this emulator will work without violating several patents is uncertain.

If a manufacturer chooses to use a proprietary system, it can develop software internally, license development to large software companies, purchase and support independent software through an internal publishing division, or encourage but not directly support independent developments.

Apple has historically developed a substantial portion of its important software internally. Apple also tends to purchase and support the efforts of individual entrepreneurs. Apple's support and its first mover popularity stimuated the development of a wealth of Apple based software products. Apple currently holds a significant competitive advantage in terms of software availability. For example, over 11,000 application programs for the Apple II are listed in the VanLoves Apple Software Directory.

In order to gain quick entry into the personal computer market, IBM broke its historic precedent of never going to outside suppliers for software development. IBM's software development agreements were with established companies such as Microsoft, Personal Software, Digital Research and Peachtree Software. IBM has also established a Personal Computer Software Publishing House, which will pay authors royalty payments on approved programs. These agreements have historically restricted the author from developing similar products for competitive computers.

Atari recently completed a contest rewarding $25,000 and royalty payments for the best software program developed for Atari's computers. This contest enabled Atari to examine thousands of creative ideas and examine the effectiveness of the accompanying software documentation.

Although manufacturers currently have more marketing and distribution capabilities than independent software firms, eventually the returns from developing programs which can run on several (as opposed to one) personal computer will drive software development toward the independent software companies. PC manufacturers will attempt to offset this trend by tieing their (user-friendly) software interfaces directly to their machines.

B. Software Companies

There are five major strategies for independent software companies: software publication, licensed development, independent authorship, software customization and software/hardware systems housing.

1. Software publishers evaluate, publish and market software designed internally or by independent authors. Lifeboat Associates was probably the first publishing house to mass distribute software, and VISICORP is also moving into the role of software publication. The typical author-publisher arrangement proceeds as follows. The author submits his completed program to the publisher on a disk, much like a recording artist submits a tape to a record producer. This program and its accompanying documentation are evaluated based upon sales potential, probable markets and user friendliness. A contract may then be negotiated in which the author receives a flat fee or a royalty of 15%-30% of the packages retail price. The author and publisher work together to improve the package and expose it to communities of in-house (alpha-testers) and external (beta-testers) pre-market test users. Once the product is completed, the program is mass produced on disks or tapes in formats compatible with different microcomputers.(28)

Publishers also design and develop software systems entirely in-house. This allows more predetermined integration of one's product line and user interface. Programs can be developed direclty in microprocessor assembly code to increase efficiency and reduce user response time. These programs could then be revised for the instruction sets of different

machines. Programs can more easily be developed in powerful high level languages such as Pascal, and then run through optimizing compilers to convert the program to executable machine code for each different brand of computer. Microcomputer software development to date has most frequently used Basic, Assembly and Pascal languages (respectively in terms of volume). The sophistication of Pascal is making it the widely preferred development tool.

Software publication and distribution will be the most lucrative portion of this industry, and several major media corporations will bring their resources to bear here. RCA, Time, McGraw-Hill and other record or book publisher/distributors are bound to enter. Addison-Wesley has come out with a financial modeling program, the first of the publishers' Practical Computing Series (28).

2. Licensed software developers are licensed by manufacturers to develop software packages for their specific computer. Digital Research, Microsoft, VisiCorp and Peachtree Software were recently licensed by IBM to develop operating systems, BASIC interpreters, VisiCalc and accounting packages for the IBM Personal Computer. The manufacturer either buys the entire rights to these packages or negotiates a royalty fee for each package. The economics and power position of these players will determine if the manufacturer can restrict the developer from selling similar products to his competitors.

3. Independent authors will have an increasingly difficult time publishing their own programs. The independent entrepreneurs (exemplified by the original founders of Digital Research, Microsoft and Personal Software) will face increasing entry barriers. Following the precedent of independent computer stores, one sees that economies of mass marketing and distribution will not enable independents to compete, and the independent authors will be forced toward the manufacturers and software publishers.

4. Customized software developers will play a minor role in the microcomputer software industry. Nisus Corporation charges $3,000-$10,000 for a custom designed software program and pays their part time undergraduate engineering student staff $4.75/hour.(30) Although customized software developers may flourish in areas such as networking personal computers for large corporations, the high demand for programmers and limited economies of customized development will prevent the evolution of large customized software firms. It is more likely that firms will sell higher level programming languages such as microcomputer EXPRESS and offer additional customization, training or consulting services.

5. Microcomputer systems houses will develop specialized industry or functional packages which they will mass market with a particular hardware configuration as an integrated system solution. As hardware prices decline and the Japanese enter the market, software systems designed around inexpensive (perhaps private-label) hardware will provide substantial value. Buyers are currently clamoring for products which satisfy their specific industry or functional needs.

C. Software Distribution

Personal computer software is currently distributed through computer stores (51%), mail order (41%) and OEM System Houses (8%). The margins in this industry are very high. For a $200 retail package, the computer store may pay the publisher $100, who in turn may pay the author $30. Two major changes are likely to occur in software distribution, as Appendix I indicates.

Firstly, mail-order sales will decline. Buyers currently learn about software through experience, word-of-mouth, or research (sometimes through a computer store). Price sensitive buyers chance ordering through a mail-order retailer in ordr to gain typical 30% cost savings. This tendency will decrease as customers become more sophisticated in the differences in software quality. Customers will want to observe the user interface, look

at documentation and be assured of customer service. These requirements cannot be satisfied through mail order. If one looks at the low percentage of mail order sales in the commodity record industry, one realizes that mail order software sales should play a decreasingly important role.

Secondly, software stores will evolve similar to current record stores. These stores will allow prepurchase evaluation, provide service, and will be closely alligned with the emerging software publishers. There are currently very low barriers to entry in this area, but the evolution toward retail chains of software stores will mirror the evolution of computer stores. The major entrants are likely to be software publishers integrating forward, spinoffs from computer and record stores, and independent entrepreneurs.

In addition to the channels mentioned above, software will also be distributed through the hardware distribution channels described in Chapter 3: mass merchandisers, office equipment dealers, manufacturer owned stores, direct sales, etc. Electronic distribution of software could also develop. This would require sophisticated user programs to allow the downloading of software but could prove extremely successful. The personal computer user could log into a software database over the phone lines, identify his type of computer and request a list of the available word processing packages and their prices. He could observe the user interface directly by testing the program for several minutes before making a purchase decision. This channel has reduced distribution costs and allows prepurchase evaluation, but has a service problem similar to mail order sales. Remote computing service bureaus are the likely participants in this channel due to their existing computer networks.

D. Impact of the Software Industry on Personal Computers

Appendix H provides a summary diagram of the software development and distribution channels I have discussed. The big money will be in the packaging and distribution of software. Companies with substantial resources are entering this industry and substantial conglomeration will

occur. For example, Management Science of America has already acquired Peachtree Software.

Creative authors will have an economic incentive to contract with publishing houses for marketing and distribution, since these firms provide distribution to several brands of personal computers. This trend will lessen the manufacturers ability to differentiate their product based upon software availability and will therefore increase standardization and increase competition on price, marketing and distribution.

In order to maintain their software differentiation, manufacturers will have to maintain high levels of internal development for important projects, and will have to be very competitive in hiring the limited number of available programmers. The Japanese are likely to enter the market this summer with a series of superior performance/price products which will utilize existing standardized software libraries. The entrance of the Japanese and the programmers economic incentive for mass publication will increase software standardization and software publisher power, and will eventually decrease the power of the hardware manufacturer and his ability to differentiate his product based on software availability.

6.2 Networks

The development of networks which allow the personal computer to share data, programs and processing power with other computers will greatly effect the usage and purchase of personal computers. This section addresses four major issues in networking: the protocols necessary to enable computer to computer communication, local area corporate networks, long-haul corporate networks, and third party networks.

1) Protocols

Computers must satisfy several levels of protocols in order to communicate (exchange information) with each other. On a primary level computers must share common physical characteristics such as voltage and baud rate, and agree upon asychronous vs. synchronous transmission and full duplex vs. half duplex transmission. On a secondary level, computers must know how to address each other. There must be signals ("Here come the address") to indicate that an address is forthcoming, and an agreed upon address format (8 bit vs. 12 bit, etc.). Hierarchies of addresses can exist such as the phone system's switching hierarchy of (1) overseas area code, (2) remote area code and (3) local number. On the next level an envelope protocol indicates when the message begins and ends, and whether the information is fixed or variable length. Once this envelope is sent, the computer must know what language the actual message is in. The most common language, or presentation local protocol is the ASCII language (1110 0000 = A, 0100 0000 = carriage return, etc.). Finally, session management protocols must be agreed upon to establish an entire communications session and keep it active, allow computers to interrupt each other and check for errors in transmission ("I didn't hear you completely, please speak again").

The problem with networking is that most computer manufacturers and network providers establish their own protocols in order to tie the customer into (encourage) broader use of their own product-lines. This

lack of communications standards (a common networking language) makes it very difficult for different computers to talk to each other.

2) Local Area Corporate Networks

Since sixty percent of business machine communications traffic takes place within building complexes, the development of local area networks (LANs) is of extreme importance to the integrated electronic office. Several incompatible local area networks are currently being offered, including the Xerox Ethernet, Datapoint Archnet and Wang Wangnet. The Yankee Group projects that 140,000 Ethernet nodes will exist by 1983, with 90,000 Datapoint Arc nodes representing the next largest LAN market.(31)

Ethernet is a non-proprietary network design with its full specifications available to all other corporations. The network consists of a broad band coaxial cable and communications transceivers designed to link different kinds of computers, computer peripherals (printers, disks, etc.), data terminals and office equipment located in a building or complex of closely grouped buildings. Each device connected to the cable must contain an interface (control) element allowing it to communicate on the cable through its tranceiver. Other transceivers with associated processors could be implemented as gateways in order to connect multiple networks (long-haul networks, etc) to each other.

Since Ethernet has been jointly developed and promoted by Xerox, DEC and Intel, it stands the greatest chance of becoming a defacto LAN standard. Intel, Advanced Micro Devices and Mostek Corporation are supplying two interface chips that (1) assemble data into Ethernet packets and handle error-dectection and collision management functions and (2) act as a bus transceiver to send or receive data in Manchester code at 10M bits per second, as specified by the Ethernet Standard.(32) Some personal computers (such as the recent Fortune 32:16) have started including these interface chips and a trend toward local networking standardization could occur.

3) Long-Haul Corporate Networks

Corporations needing to pass information amongst their "worldwide" offices either utilize the public telephone network, third party networks or have established their own corporate networks of leased telephone lines, microwave and satellite usage.

Using the public telephone system enables one to establish (dial) a "direct" computer link, but this is expensive and does not make the problem of networking protocols much easier. Third party networks (GTE Telenet and Tymnet have built value-added, packet switching networks that lower the cost of sending data to one-third what it would cost on the public switched telephone network) require that all user computers conform to their third party network protocol standards. Independent corporate networks are economic for large usage, have increased flexibility, but still must deal with the problem of communication between different types of computers. Corporations generally standardize on a particular network architecture such as the IBM System Network Architecture (SNA is the communications architecture to which IBM has committed its new products), the DEC DECNET or AT&T Advanced Communication Syustem (ACS). Interfacing a variety of computers to these network systems can be difficult, and often limits vender selection.

4) Third Party Networks

Since the start of the timesharing industry, on-line information services have developed rapidly. The establishment of packet-switched networks (e.g. GTE Telenet and Tymnet) have provided substantial impetus to this growth by reducing telephone communication costs threefold.(33) Computer timesharing (or remote computing) is a $4 billion a year business, growing at 15%-20% annually.(34) This industry provides time-shared applications programs, data base services, newsletters, electronic mail systems and games. Electronic transaction processing and tele-shopping are already available on a limited scale.

Applications programs constitute the largest portion of this industry, with thousands of users logging on each day. Major timesharing applications include program development, transaction-oriented accounting packages, financial information services (such as portfolio analysis), mathematical modeling, engineering-oriented problem solving services and computer graphics.(33) Control Data Corporation has been extremely successful in designing specific applications such as Cybernet, offering remote scientific and enginering data processing on six continents; Plato, a computer-base educational system used by school children, prison inmates and college students; and Ticketron, a nationwide computer box office.(34)

There are over 700 public data bases offered by approximately 100 vendors (publishers) throughout the world. Link Resources estimate that on-line data base revenues were $1 billion in 1980 and will be $3.4 billion by 1985.(35) On-line services are used almost exclusively by businesses, and on average a user can expect to spend $60 to $70 an hour. Two typical data base products are LEXIS and the Dow Jones News/Retrieval Service. LEXIS provides the full text of state and federal court decisions, statutes and regulations. There is a minimum $500 monthly charge for one terminal and an additional hourly fee (averaging $60 to $90) for computer time.(36) Dow Jones provides complete and abridged articles from the Wall Street Journal, Barrons and the Dow Jones News Service, and price quotations on stocks, bonds, options and mutual funds. Dow Jones charges an initial $50 per user location and typical per minute rates are listed in Table 6.1.

TABLE 6.1

DOW JONES NEWS/RETRIEVAL SERVICE RATES

Database	Non-Prime Rate Per Minute	Prime Rate (Per Minute)
Current Quotes	$ .15	$ .75
Dow Jones News	$ .20	$1.00
Corporate Earnings Estimator	$1.00	$1.00
Free Text Search (of News data base)	$1.33	$1.33

Source: Dow Jones information pamphlet.

A new service called The Source is targeting both business and home users in an attempt to establish itself as the information retailer of the future. Started in 1979, The Source has convinced Telenet and Tymnet to offer low nighttime tariffs and has attracted a wealth of information and service suppliers. A typical list of services available to the Source subscriber appears in Table 6.2.

TABLE 6.2

SERVICES AVAILABLE ON THE SOURCE

1. Information access (news, airline schedules, restaurant reviews, etc.) from UPI, New York Times, and other data bases.

2. Discount catalog teleshopping through Compustar.

3. Electronic mail allowing one to send, read and store mail through Source "mailboxes."

4. Subscriber Bulletin Boards/Classifieds covering such categories as Apple computers, dating, merchandise, houses for rent or sale, software and travel.

5. Creation, storage and editing of files.
6. Appliction program utilization (somewhat limited).
7. Game playing.

Source: Source Digest.

The Source charges a $100 account set-up fee with connect charges of $18/hr during prime time and $5.75/hr during evenings and weekends. Appendix K provides a more detailed listing of Source rates and fees. As of early 1981, the Source had only 7,800 subscribers (as opposed to 12,000 Dow Jones News Service subscribers) and was only moderately successful.(37) Its applications packages are somewhat limited for business users, and home users are very price sensitive due to the wealth of inexpensive substitutes for information access. The Source's communications services (electronic mail and subscriber bulletin boards) have been its most popular offerings to date.

On-line (timesharing) services have historically been hooked up to dumb terminals which use the processing power of the timeshared CPU. Source subscribers type commands to activate centralized programs controlling electronic mail, information access or applications programming. Personal computers can be utilized but only if their architecture (or a local software package) enables them to act as dumb terminals (See Appendix L for Source equipment compatability requirements). To date the Source has not capitalized on the local processing power of the personal computer.

In order to reduce user communication costs and utilize the local processing capability of the personal computer, GE Information Services is developing local software for personal computers which will enable the GE timesharing computers to download data and application programs into the RAM memory of the personal computer. The personal computer will be able to locally utilize a wealth of applications routines and programs previously developed for timesharing but now modified for personal

computer use. The routines downloaded into RAM memory will be "forgotten" once power is turned off.

Another alternative is to sell specific software packages (on discs) which enable the personal computer to communicate as a dumb terminal but store data (such as stock information) for local (portfolio) analysis.

5) Conclusions on Networking

The importance of networking to personal computer use cannot be overstated. Grid Systems is providing a centralized computer network in order to encourage sales of its portable (fits in a briefcase) $8,000 Grid computer for mobile businessmen. The Grid Central network will link each business' portable units to allow electronic mail and central storage of common (or large) data and programs.(20)

Networking services can provide the personal computer user with:

(1) access to increased processing power, software and data (occasionally in a downloaded fashion),
(2) electronic mail and other communications capability,
(3) transaction processing (teleshopping, banking), and
(4) games playing and entertainment.

Networks that are easily accessed, user friendly and provide competitive value/price will greatly stimulate personal computer utility and purchase.

However, computer compatability and networking standardization is unlikely to occur in the near future. These incompatabilities are likely to discourage potential personal computer purchase. In addition to discouraging purchase, the lack of networking standardization is likely to focus purchase on a more limited number of products. Corporations could restrict purchases to Apple, IBM, Xerox or CP/M compatible machines (for example) to decrease the complexity of networking their personal computers.

6.3 PC Complements Conclusion

This chapter has demonstrated the importance of complementary products in determining industry structure. The development of software and networks directly influence the usage and usefulness of the personal computer.

The crucial importance of software has spawned the establishment of an independent software industry to complement the PC industry. The power of the software industry is increasing, and the economics of mass production of software for several computer brands will decrease the manufacturer's ability to differentiate his product on software capability and will lead to increased software standardization. Manufacturers such as Apple will bundle (tie) their software interface directly to their machine in order to maintain product differentiation.

The difficulty in networking personal computers will cause business users, who want personal computers now for productivity improvements, to restrict purchases to a limited number of vendors, thereby increasing the concentration of vendors serving the business sector. The unavailability of widely dispersed, standardized networks to the home user will remain a substantial deterrent to home purchase.

CHAPTER SEVEN
SUBSTITUTE PRODUCTS

The availability of substitute products will effect the price elasticities of PC buyers, shape the optimal functionalities for the personal computer, and determine which market segments can be most profitably addressed. The long term price/performance competitiveness of the personal computer vis-a-vis its substitutes will help shape the structure of the PC industry. Since needs, usage, preferences and elasticities vary across the four PC buyer segments, I will discuss the threat of substitute products within each of these buyer groups.

7.1 Business Users

The major PC substitutes in the business sector are hand-held calculators, large minicomputers, "dumb" terminals attached to larger centralized computers, electronic mail systems, word processors, typewriters, teletext/videotex services and manual operations.

Hand-held calculators are much less expensive, more portable, are often programmable, and are developing attachable printers and attachable preprogrammed software modules. The size, portability and price of the caluclator make it unbeatable for simple, convenient calculations, but calculators lack a user friendly interface, display only one line of information and do not have the storage capability to support an important task.

Larger minicomputers cost more but have substantially increased processing power and memory capabilities. Minicomputers are offered by an established manufacturer, can serve as a networking node for a large business, and can support several "dumb" terminals which utilize the processing capability of the minicomputers. These systems have a competitive advantage as the mainframe for a medium size business.

The use of dumb terminals (typically prices under $1,000) helps distribute input/output capability to more users while sharing the processing power of a central computer (either corporate owned or

timeshared outside). This practice is based on the premise that the cost of terminals is small compared to the cost of computing power. But with the advent of low cost and powerful microprocessors, and with the rising costs of other materials (the "carcass" costs such as glass, plastics and metal), dumb terminals will inevitably be replaced by intelligent personal computers. This substitution will be amplified by the relatively slow decline in communications costs, which increases the incentive for local processing capability. Appendix M provides a good comparison of office automation cost trends.

Word processors are becoming indistinguishable from personal computers as we move towards the office of the future. Xerox, Wang, IBM, Apple and everyone else offers various degrees of sophistication along the spectrum of combined word processing and data processing capabilities. These two capabilities are currently unbundled only by having distinct software packages perform these functions. Personal computers offer less sophisticated word processor systems but at a much lower price than the typical $10,000 Wang Word Processor. The mass market potential for personal computer software will motivate increased development (entrepreneurs, publishers, etc) of word processing software for personal computers, thereby reducing this gap in sophistication and user-friendliness.

The substantial cost advantage of typewriters will enable them to remain a very viable substitute product for word processors and personal computers. Their main disadvantages are their limitations in storing, editing and displaying documents, in addition to their inability to allow graphics and interface with other machines (for mailing, remote printing, etc.).

Teletext and videotext offer information retreival and transaction processing services similar to those provided by the Source, but typically use the television set as the display device, utilize an inexpensive TV decoder for processing and (due to the presention level protocol chosen) provide superior graphics capability. These services will encourage PC substitution in the business sector, but they will be

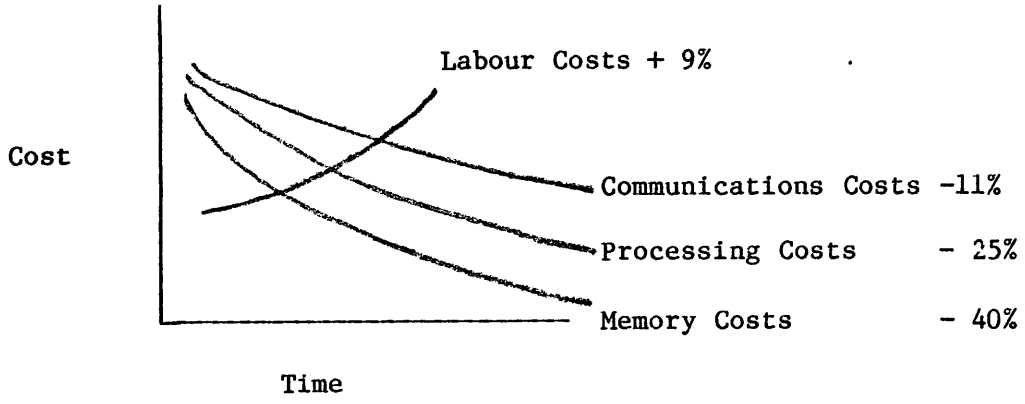
be discussed in greater detail within the home user section.

The economics of personal computer use will encourage continued substitution of personal computers for manual operations (accountant's spreadsheet analysis, filing and retrieving information, etc.).

Figure 7.1 highlights some of the cost trends portrayed in Appen This figure shows that over time the personal computer will most successfully substitute for products requiring substantial communications and manual operations.

Figure 7.1

Office Automation Annual Cost Trends



7.2 Home Users

The average U.S. household spends nearly $1,000 a year for telephone, broadcast and music systems and for printed publication and other information industry output.(38) Households are much more price sensitive than business users and have a different set of needs. Home PC users currently use the personal computer for simple professional tasks or (more often) for entertainment and education. The mass home market requires significant PC price decreases for PC systems before these systems become competitive substitutes. Many people believe that a useful PC system must approach the price of a color TV to achieve mass appeal.

The major PC substitutes for the home user are calculators

video games, videotex/teletext services, hardcopy publications, televisions and VCRs.

Since home users are more price sensitive, have fewer repetitive tasks aided by automation and have fewer storage needs than businesses, the calculator is a much stronger PC substitute for the home user.

Atari's home video games and software accounted for 1981 manufacturer revenues of approximately $500,000 (see 1981 annual report) and the profit margins on these items were substantial. The home user demand for Atari's $150 system and Intellivision's $250 system (and the associated software) has been overwhelming. The attractiveness of these products will continue, but home computers will soon reach these prices, and have the capability for more sophisticated games and additional functions.

Teletext and Videotext services were initially established in Great Britain, and have recently stimulated substantial market testing in the United States. The M.I.T. Research Program on Communications Policy described the British Teletext and Videotext services as follows.(39)

> Teletext refers to a text information service transmitted in the vertical blanking interval of the television signal to specially adapted home TV sets. It is a one way system which continually cycles through a limited data base--300-500 frames per channel. When the user selects a given frame a device in the TV set traps and displays it as it cycles through. The service is offered free to television owners (i.e. covered by license fees in the case of the BBC and advertising revenues for IBA) and renters--their only expense being a specially equipped TV set or an adaptor for the existing set. The specialized adaptor costs $4.50/month to rent or approximately $100 to buy. As of the end of 1981 there were approximately 300,000 in operation in the U.K. (out of a total of 18 million TV set) with about 45,000 additional being installed per month. Nine per cent of all new TVs are teletext equipped.

The information carried in the British teletext system tends to be fast moving and topical, a constantly updated headline service. Financial information on, for example, a Dow Jones-like index is updated frequently throughout the day, as are weather information--both national and local--and sports scores. The medium takes advantages of the ease and speed with which topical information can be entered into the data base and transmitted into the home.

Videotext, of which the UK's Prestel system was the first implementation, was initiated commercially in 1979, and is inherently different from teletext. It is a two-way service which transmits specifically-requested information (typically a simple keypad allows one to select from a hierarchial menu) over telephone lines to a modified TV receiver. A Prestel adaptor to a standard TV set costs approximately $300 to buy and the user pays both for connect time (within the UK $.08 per minute during business hours and $.08/3 minutes during off hours) and for each page of information consumed (many pages are given at no charge). The information on Prestel uses the same kind of graphic presentation as teletext services but has a much larger data base; at present some 210,000 pages or frames as compared to 300-500 on teletext. Much of the information on the videotext system is business-oriented (since 85% of the 15,000 + users are business users) such as international commodity prices (updated every 5 minutes) and various data bases. Flight schedules for 57 airlines are published on Prestel and ten of these provide direct booking on the system (a form of transactional videotext).

One half of all residential interactions are less than three minutes in length although the average length interaction is 8 3/4 minutes. Monthly average bills for domestic (residential) users were $12/month.

Appendix N provides more specific information on the British usage of teletext and videotext. Appendix O lists the historic number of subscribers on various international teletext and videotext systems.

Videotext (like the Source) is interactive and can therefore provide much more user-specific information. However the costs of establishing an interactive computer system, maintaining 200,000 pages of information (or serving as a gateway to third party information or transaction providers), handling customer billing, and establishing reasonably expensive one-to-one communications links, make the videotext system much less attractive to the home user. The price sensitivity of the home user is demonstrated by the fact that their are 300,000 Teletext users, 7,800 Source subscribers and 2,250 (15% of 15,000) home Prestel users.

The personal computer cannot compete on price with a Teletext decoding unit build into a TV, but for those users who want to process the Teletext/Videotext data or interact with the service, it would not be difficult to incorporate this functionality within the personal computer. The development of these networks will therefore encourage substitutes while simultaneously acting as compliments to the personal computer.

Although AT&T estimtates that as many as 7% of all U.S. households--some 8 million homes--will have videotext terminals by 1990, the future of this industry is very uncertain.(40) There is little agreement as to the presentation level protocols to be used for the transmission of textual and graphical information, which will curtail the standardization and mass production of input and receiving units. The major players in the four roles of information and service providers, systems operators, transmitters, and home equipment manufacturers depicted in Appendix P are also very unclear.

In contrast to the national videotext and teletext networks developed in the U.K., it is unlikely that one national network will evolve in the U.S. Teletext will be broadcast over satellite frequencies, TV airwaves, CATV channels or any other broadband medium. Vertical blanking intervals may be used, but "full channel" teletext could provide much greater information capacity. Interactive videotext will probably

use the telephone system since two-way cable has only penetrated 2% of the U.S. homes (compared to 26% one-way cable penetration) and current two-way cable systems are very limited in capability. Hybrid systems are likely to evolve which utilize broadband capacity downstream to the user coupled with telephone based transmission upstream to the videotext system operator.

It is likely that a very fragmented information industry will evolve. It is unclear what types of equipment will be used to receive, transmit, process and display information. As it is depicted in Figure 7.2, it is likely that the television and personal computer will play major roles in this fragmented industry.

Figure 7.2

Structure of the Information Industry

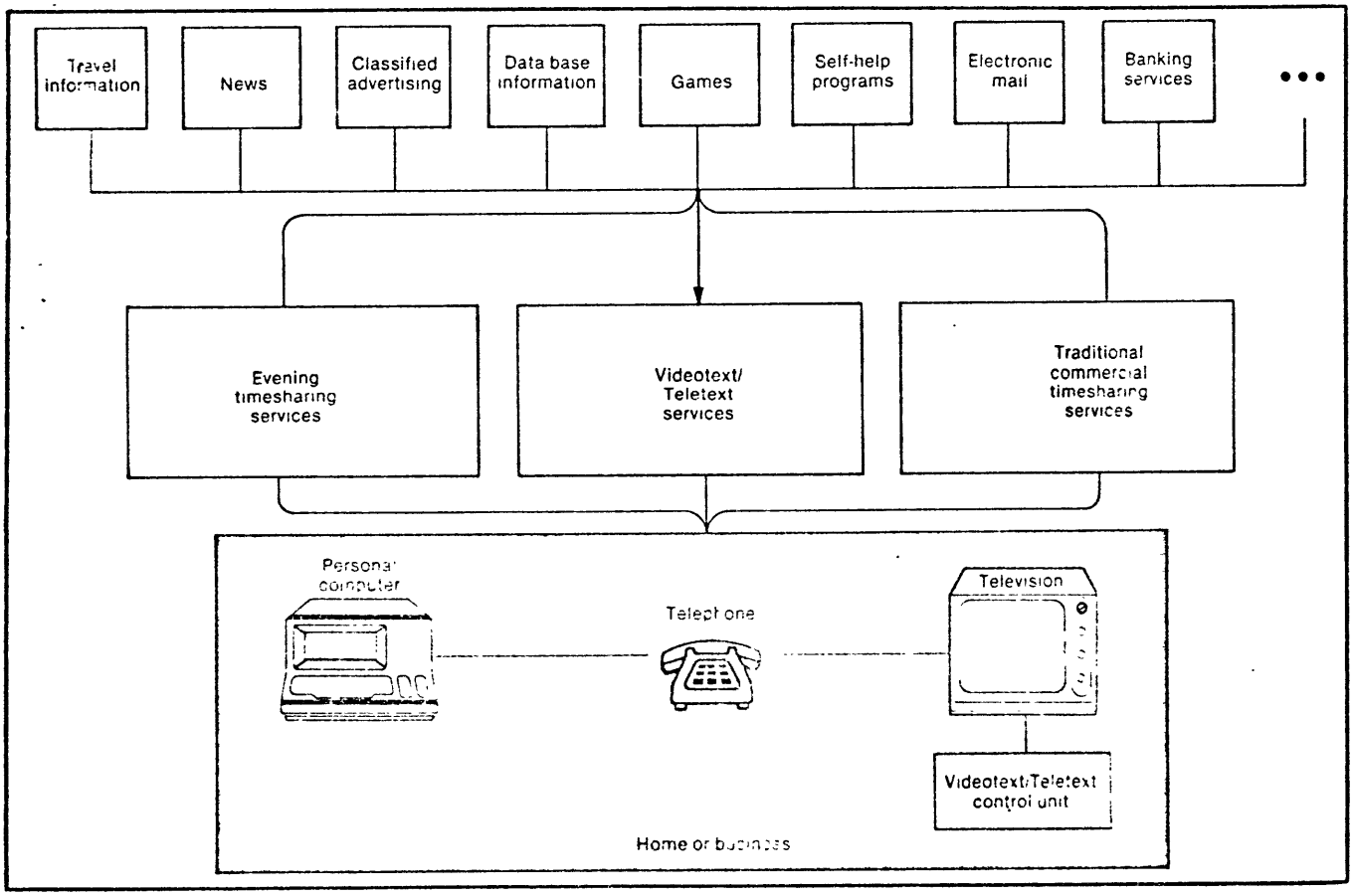


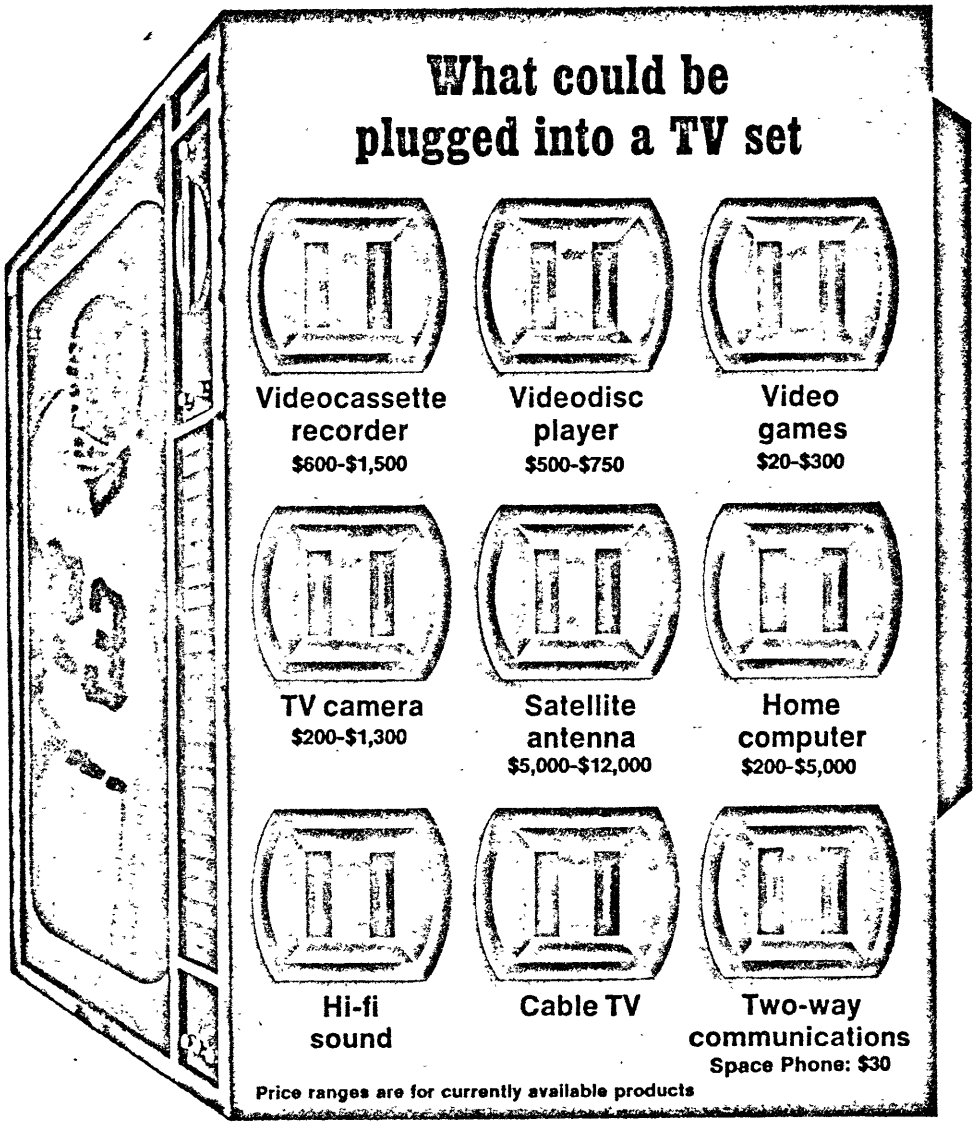
Fig. 1. Structure *of the information industry.*

Leaving the subject of teletext/videotext services, another PC substitute for the home user is hardcopy publications. To the extent that the home user will use the personal computer for information retrieval, the accessibility of alternate sources of user demanded information will impact PC purchase. People enjoy browsing through periodicals and the newspaper is the only "portable, random access, multi-megabyte storage media which allows full graphics and costs 25¢." Personal computer networks must provide value-added information which is either very timely or not readily accesible otherwise in order to substitute for hardcopy publications.

The intelligent (or standard) television is another home user PC substitute. Sony is currently developing a camera which will "expose" or transfer light images onto a diskette within their cameras. The diskette will be placed into a television to project the desired pictures onto the screen. Teletext decoders are already being built into televisions. Once diskettes and intelligent components are placed into the television, it will become much simpler to design the television to include additional microprocessor and peripheral components. Televisions with bundled functionality will substitute for the bundled or unbundled personal computer. The question here is whether the shared cost of bundling a system (camera, diskette, TV, computer processor) will overcome the decreased user flexibility in choosing unbundled components. If one compares hi fi separates with integrated packages, one sees that the home user may prefer a central interface unit (such as the stereo receiver or home computer processor) to a more bundled product.

Although the television will not allow mass storage, its established consumer acceptance and familiarity may make it the preferred interface unit for home entertainment, simple information retrieval and transaction processing. Figure 7.3 shows the wealth of devices (exclusing teletext/videotext decoders) which can be attached to a TV set.

FIGURE 7.3



Video cassette recorders are very hot items for the home user, act as a very strong PC substitute, and indicate the preference of the home user toward audio/visual entertainment. 900,000 VCRs were sold in 1980 in comparison to 100,000-200,000 home computers. These $900 units and the 10 million $500 color TV sets are direct substitutes for the home users

entertainment product budget. Personal computer manufacturers will evolve their products to interface with these products and to provide more audio/visual entertainment.

7.3 Education Users

The major PC substitutes for education users are calculators, dumb terminals, books and teachers.

Calculators are not often bought by educational institutes, but their widespread ownership among students substitutes for the need for a personal computer within this often price sensitive user segment.

Dumb terminals have historically been attached to timesharing networks by educational institutes to provide processing power and training for the students. As discussed previously, the lower marginal cost of adding computer intelligence and memory will lead to the substitution of dumb terminals by personal computers which can act as either a dumb terminal or intelligent processor.

Personal computers can provide textual display and its interactive capability will eventually prove to be very effective in teaching one how to read and in transmitting knowledge, but the portability, underlineability, price and wide availability of books makes them currently irreplaceable.

Teachers are user-friendly, can answer any question and can serve as an invaluable role model. The costs of teachers will increase with labor costs and personal computers will supplement teachers through drill and practice, grading "homework", easy transmission of missed or forgotten "lectures" at low marginal cost, and "individualized" interactive packages which move at student-specific rates or offer instruction in areas unfamiliar to the teacher's main subject matter.

7.4 Technical Users

Technicians are very similar to businessmen in that they use calcula-

tors, dumb terminals, minicomputers and perform manual operations. The major difference is that scientists are technically more advanced and can either use instrument boards as substitutes or else use computer design tools (developed by Intel, etc.) which use substantially different processes than those offered to the neophyte mass market of personal computer users.

7.5 Substitute's Conclusion

The major substitutes for the personal computer are calculators, dumb terminals, minicomputers, word processors, and intelligent televisions. The mass marketability of personal computers will help drive its costs down and stimulate the development of user friendly personal software. These will be the advantages of the personal computer vis-a-vis its substitutes.

CHAPTER EIGHT
THREAT OF POTENTIAL ENTRANTS

Market entry barriers are conditions which allow industry participants to earn sustained noncompetitive profits (also called monopoly profits) without attracting new entry. In Barriers to New Competition, Joe Bain classifies entry barriers into three generic categories: economies of large scale, product differentiation advantages and absolute cost advantages. Bain's "condition to entry" is a structural condition determining intra-industry adjustments which will and will not induce entry.(42A)

The personal computer industry was started by a number of entrepreneurial firms willing to take risks to devcelop a new market. As this industry has evolved and clearly became prosperous, a number of more established corporations have entered, such as IBM, Xerox and Hewlett-Packard. The barriers to enter the personal computer industry have increased, and much greater resources are now required to compete successfully. This chapter discusses the PC entry barriers, the potential entrants which could overcome these barriers, and how the threat of potential entrants will affect the structure and evolution of the PC industry.

8.1 Personal Computer Entry Barriers

The eight major PC entry barriers are (A) access to distribution channels, (B) propietory software, (C) hardware patents, (D) established customer loyalty, (E) brand identification, (F) marketing expenditures, (G) investment startup costs, and (H) economies of scale.

(A) Access to Distribution Channels

Apple experienced substantial first mover advantages in establishing strong ties with the computer store distribution channels. With the more recent efforts of IBM, Xerox, Osborne and Hewlett-Packard, this most popular distribution channel is essentially closed. New entrants must provide very high margins and financial incentives relative to the established market share leaders to induce the dealer to sell their product.

(B) Proprietary Software

New entrants must demonstrate the ability to reach a variety of distribution channels while the industry is still evolving. They also must establish a reliable service network to support their product.

Apple and Radio Shack utilized the first mover advantages to establish a strong base of proprietary software. IBM is attempting to increase entry barriers further by using its power to establish its own proprietary software. The utilization of CP/M (and Unix) operating systems will provide new entrants with an already existing standardized base, but this base is still not competitive with that of Apple or Radio Shack.

(C) Hardware Patents

Software is difficult to copy but it is not patentable. However hardware patents are legal. Apple has patented a ROM chip (contained in an interface unit between a disk drive and Apple Computer) which controls the access of data from the disk. Since Apple's are worthless without disk access, and all Apple software utilizes this disk controller, and Apple won't sell these controllers to plug-compatible competitors, these competitors cannot produce a plug-compatible Apple without infringing upon Apple's copyright. Ace Computers has produced an Apple copy, and is currently being sued for copyright infringement.

(D) Customer Loyalty

Whoever sells the customer first in the computer industry will very often establish customer loyalty. This is often due to the high costs required to gain familiarity with the equipment and software of a new vender. If a company has established (or hopes to establish) networks using personal computers, switching to network-incompatible vendors involves substantial costs.

(E) Brand Recognition

After an industry evolves past its initial introduction, brand recognition starts to set in. Apple has established a very favorable brand image in the eye of the consumer. IBM and Hewlett-Packard had quality reputations which were readily transferable to the PC industry. Radio Shack is attempting to overcome its poor quality Realistic image, Xerox is still stereotyped as a "copier" business and Atari's game identification targets it soley toward the home entertainment market. Companies which do not have a high quality electronics and service image must overcome this important entry barrier.

(F) Marketing Expenditures

Major competitors are spending substantial marketing resources to create customer awareness, differentiate their product, and increase the marketing barriers to entry. Apple spent 14% of 1981 net sales on marketing and initial marketing costs will be higher for new entrants to accomplish the same effect.

In addition to high advertising expenditures, new entrants (such as DEC) may need to develop marketing expertise in dealing with the unusual requirements with this mass marketed, neophyte-based, software-driven, technological product.

(G) Investment Startup Costs

It is difficult to ascertain the costs of an efficient plant, or what initial working capital costs are to establish parts, work-in-process and finished-product inventories, and carry initial accounts receivable. Fortune Systems recent startup required $13 million in venture capital. Steve Jobs estimated investment startup costs for current PC entry to be 3

years and $50 million. This requirement limits potential entrants to large companies or highly respected industry entrepreneurs with substantial venture capital credability.

(H) Economies of Sale

Established market leaders have developed significant economies of scale in purchase, production, distribution, marketing and software development. Apple and Radio Shack are rolling out 30,000 units per month and the experience curve advantages they have developed are probably substantial.

This entry barrier, and the previous seven entry barriers discussed, will become even more important in shaping this industry as the industry matures margins drop and an inevitable shake-out occurs.

8.2 Potential PC Entrants

A number of potential entrants have resources and skills to overcome the current PC entry barriers and have a signficant impact on the structure of the PC industry. The most likely potential entrants are (A) minicomputer firms, (B) Japanese consumer electronics firms, (C) semiconductor manufacturers, (D) AT&T, (E) entertainment/television enterprises and (F) spinoffs and entrepreneurs.

(A) Minicomputer Firms

Minicomputer manufacturers have strong brand identification, customer loyalty in the corporate sector, sufficient startup resources, and transferable experience and economies of scale. As computer costs continue to decline, these firms will continue to gravitate toward the high end (predominantly business) of the personal computer sector. However, firms such as DEC have historically distributed through OEMS and directly to corporations, and must develop new distribution channels, marketing expertise and user-friendly software in order to be major forces in this mass market. Word processor companies such as Wang must overcome similar obstacles to successfully enter the industry.

(B) Japanese Consumer Electronics Firms

Japanese electronics (and computer) firms have been developing their products in Japan while the overseas market has evolved and more clearly defined itself. These firms (such as Casio, Panasonic, Toshiba, Sharp etc.) have products with substantially superior price/performance characteristics which will probably be exported to new markets this summer.

These companies will follow their traditional strategy of producing high volume, low margin products in order to stimulate purchase and move down the experience curve. They have (and will continue) to reduce product/process costs and produce high quality-controlled goods which will overcome service problems with high reliability. These companies have very high quality recognition (everyone knows what "Made in Japan" means), will piggyback off their existing consumer electronics and mass merchandising channels, and offer standardized products to gain access to an established software base.

The entrance of these companies is likely to help force the industry structure toward standardization and cost competition, and will probably force further segmentation of the market into separate home vs. business sectors.

(C) Semiconductor Manufacturers

The semiconductor industry is very competitive and these suppliers would like to integrate forward toward more value-added products. These companies have low costs, superior technology, but no consumer marketing and distribution experience. Semiconductor companies (and some Japanese consumer electronics firms) are liable to provide private label products designed specifically for mass merchandisers, banks (home banking terminals) or other distributors. The development of a few large private label firms is likely when a marriage between technology and mass marketing is fruitful.

(D) AT&T

AT&T is coming free of its legulatory chains, has one of the best R&D facilities in the world, has an established domestic consumer distribution chain of over 2,000 phone centers, and developed (Western Electric) the Unix operating system which may become the 16-bit multi-user personal computer standard.

AT&T would like to develop an intelligent telephone device to access the electronic white and yellow pages, and eventually allow increased advertising, information retrieval and transaction processing through this service. If AT&T is allowed to enter the industry, they will shape their products toward low cost, widely available, communications oriented devices.

(E) Entertainment/Television Enterprises

The importance of software, distribution and audio/visual entertainment will motivate entertainment companies to enter the PC industry. Warner Communications has already acquired Atari as has Zenith acquired Heath Computers. These potential entrants will attempt to shape the industry toward audio/visual software and entertainment.

(F) Spinoffs and Entrepreneurs

Venture capitalists love exponential growth industries and there is still room for the entrepreneur with an innovative idea. Someone could spinoff of Xerox with a derivitive of the very user friendly icon-driven Alto system which has been used internally for years but never released beyond the market research stage. Adam Osborne jumped from his technical publishing house (he self-published An Introduction to Microcomputers in 1975) to produce a $1795 portable standardized computer which may reach 25,000 unit/month sales volume by yearend 1982.(41) Grid Systems announced a flat screen, bubble memory fit-in-your-briefcase computer with a value-added Grid Central national network facility.(20) Fortune Systems is technologically leapfrogging to a Motorola 68000 Unix-based multi-user system using Winchester disks.(42) With an innovative new idea (such as portable, networked or multi-user systems) an entrepreneur can still get venture capital and successfully enter and effect this industry.

8.3 Potential Entrants Conclusion

As the PC industry matures, entry barriers will increase, margins will decline and it will become harder to find viable strategic groups. The threat of potential entrants is still very strong and new participants will change the shape of the PC industry. The Japanese consumer electronics firms will make the industry more cost competitive and commodity based. Coupled with the entrance of minicomputer firms, the Japanese will force further segmentation of the market along home vs. business lines. This trend will carry over into software development and distribution. Entertainment companies will move the industry toward audio/visual software and the personal computer may play a larger role as an interface unit hooked up to videodiscs and other audio/visual equipment. AT&T will attempt to force the PC industry toward an increasing emphasis on networking and communications products.

CHAPTER NINE
STRATEGIES OF THE MAJOR COMPETITORS

The rivalry amongst industry participants is the final competitive force to be discussed. Positioning and intensity of competition continually shapes the structure and evolution of an industry.

Firms can compete on price, advertising, product introduction and any number of additional dimensions. Michael Porter narrows these dimensions into three generic strategies for competition.(42B) A focused strategy concentrates on a particular segment of the larger marketplace. Atari is focused on the home market, just as Osborne is focused on the mobile businessman. Differentiated strategies are utilized to establish one's product as unique. Osborne differentiates its product on portability, just as Apple differentiates its product on software capability. Cost leadership strategies typically involve integration, standardization and decreased advertising expenditures. Commodore and the Japanese electronics firms are apparently following cost leadership strategies. Competitors cannot pursue all strategies simultaneously, and Porter argues that optimal strategies concentrate one's resources and avoid being stuck in the middle.(42C)

This chapter discusses the strategies of seven major competitors in the personal computer industry: Apple, Radio Shack, Commodore, IBM, NEC, Xerox and Atari. These companies are then positioned on two strategic maps and the competitive strengths of each position is discussed. Financial profiles of these competitors appear in Appendix Q.

9.1 Apple

Apple Computer was started in 1976 in the garage of Steven Jabs and Steve Wozniak, two engineers formerly with Atari and Hewlett-Packard. The first four years of operation were financed by private investment and venture capital. Apple's first public offering occured in December 1980 when 4.4 million common shares were sold for at $22 a share (100 times earnings). Insiders now own 64% of Apple's stock, and over 100 Apple employees have become millionaires. Between fiscal 1980 and 1981, Apple's sales rose 2.9 times from $117M to $335M while earnings jumped 3.4 times from $11.7M to $39.4M.

Apple recently overtook Radio Shack as the worldwide market leader in personal computers, with approximately 23% market share. North America accounted for 76% of its 1981 sales, and Apple is rapidly expanding its overseas networks. In an April talk at HBS, Steve Jabs indicated that Apple's worldwide sales will be between one-third and one-half a million personal computers this year. Others estimate 1982 sales at 350,000 units.

Apple is attempting to reach all market segments. It's marketing emphasis in the past two years has been on the business, professional and managerial segment, which accounts for approximately 40 percent of revenues. (1981 annual report) The Apple Education Foundation has captured numerous key educational contracts, and Apple claims that more educational software has been developed for Apple than any other type of personal computer. Apple is sponsoring the "Technology Act of 1982" to enable Apple to give one Apple II system ($2,495 retail price) to each of the nation's 83,000 public elementary and secondary schools in exchange for a tax break of nearly $20 million. (43) Since schools which buy one or two computers in one budget year typically buy three or four in the next, this giveaway could lead to substantial future sales. Apple supplies to the scientific and industrial community as well, including an increasing volume of OEM sales. Apple also offers a high-end Family System for $2,500 which includes game software and six personal finance

packages and has been recently offered through such channels as Macy's in San Francisco.

One major strength in reaching these markets has been Apple's superior software base. Ninety five percent of the available Apple software has been developed externally (Source: Steve Jobs, HBS, 4/82) as droves of independent software developers have jumped on the Apple bandwagon. The VanLoves Apple Software Directory ($16.95) lists 11,000 application programs developed for the Apple II. Some independent software is licensed or purchased by Apple to be refined and debugged by Apple personnel before being marketed. Apple often develops the more crucial, private and sophisticated software itself. Over 40 software packages were introduced by Apple last year, including a number of mainstream Apple III programs such as Business Graphics, Apple Writer III (a powerful word processing system), Access III (a terminal emulator for communications between Apple IIIs and other computers) and a version of the Pascal language (1981 Annual Report).

Another strength has been Apple's uncanny ability to promote its products. Apple actively encouraged the early development of third party software and peripherals to support its products. In early 1980, the company began publishing the Apple magazine and catalog to keep users abreadst of its evolution. It spent 10% and 14% of its net sales in 1980 and 1981 on marketing. Apple has fostered an entire culture and network around its products, perhaps attempting to overcome the alienation and phobia attached to the "still unfriendly" computer. The recent Boston Applefest demonstrates the culture and image which Apple has proliferated.

Another strength is Apple's established network of over 3,000 worldwide dealers. Prior to March 1980, Apple distributed its products in the United States and Canada primarily through five independent distributors which purchased the products for resale to retail outlets. In February 1980, Apple began distributing its products from newly established Company-owned regional support centers directly to the retail stores in order to insure adequate inventory, assist in direct training of retail dealers and gain better access to Apple's end-users. Computerland

is the largest domestic retail chain carrying Apple products, and it accounted for 14% of Apple's 1980 sales. In August 1980 Apple acquired the independent Eurapple distributor (which had accounted for 17% of Apple's fiscal 1980 sales) and began selling its products directly to 21 independent foreign distributors for resale to approximately 1,000 retail dealers. Apple's dealer relationships have historically been very good. It's market leadership virtually guarantees substantial throughput. Apple has historically provided strong credit and financial incentives, and it offers a very reasonable 34%-35% sales margin.(44)

However, Apple has recently experienced some dealer problems. It has been attempting to stop its 75-150 mail order retailers from selling its personal computers. In order to emphasize personal service, and perhaps to protect the margins of its full-service dealers, Apple asked its 1,100 retail dealers in the U.S. and Canada to sign amended contracts not to engage in mail-order sales. The mail order houses are currently challenging this policy change in court on anti-trust grounds.(10) Apple's establishment of a natural account sales force also caused dealer friction. To solve this problem, Apple initiated a national account program in which qualified dealers (with proven productivity, service and support capabilities) receive assistance in identifying leads, receive marketing and promotional assistance, and are given a discount schedule for its wholesale prices in order to facilitate sales to large corporations.

Apple's weakness to date has been its inability to proliferate its product line. Apple could have devastated competitors dependent upon independent dealers by providing a range of products to fill the available product niches and dealer shelf space. The Apple II has been extremely successful but the Apple III has experienced problems.

Nearly 180,000 Apple II systems were shipped in 1981, more than twice as many as last year, increasing the installed base of Apple II systems to well over 300,000 (1981 Annual Report). The Apple III has been much less successful. Announced in May 1980, volume sales did not begin until March 1981, many months behind schedule. The product had minimal software

support and was plagued by technical flaws.(45) The Apple III sold only 10,000 units in 1981. In December 1981, Apple reintroduced the Apple III in a version with more reliable hardware, more software applications, expanded mass-data storage and a lower $3,495 price.(46) Appendix O provides price lists for the current Apple products.

Apple's next product is expected to be a Motorola 68000 based business system called Lisa, with expected retail price of $7,000-$10,000. (47) Lisa has taken over 200 person years of software development as compared to 25 years and 2 years for the Apple III and Apple II. It is compared to the $16,595 Xerox Star, and is supposed to "reduce the time it takes a new user to get up to speed on a personal computer from 20 to 40 hours to 20 minutes." Lisa is supposed to equate computer concepts with simple human concepts (such as interruption, priority and concurrency) and provide a standard user interface for all programs. By tieing the software interface directly into its product, Apple will be able to further increase its software differentiation.

Apple is committed to maintaining its strong distribution relationship, has strong marketing skills and has the most advanced software base in the industry. Although it is not currently moving toward low cost products, its outstanding brand recognition gives it a competitive weapon in all market segments. Apple's primary focus is on the business sector and it will be difficult for Apple to remain "all things to all people" as the PC market becomes increasingly segmented. Apple's ability to show software innovation and the manner in which Apple's new product introductions are instrumented will determine Apple's continued viability as a market leader.

9.2 Tandy (Radio Shack)

In 1963 Tandy Corporation acquired Radio Shack, then a Boston area company with nine stores and a mail order center with annual sales of approximately $12 million. Radio Shack now offers a full line of consumer electronics products (calculators, radios, receivers, VCRs, copiers, computers, etc.) sold mostly under the Realistic label. In number of outlets, Radio Shack is the largest retail electronics chain in the world. By June 1981 there were over 8,000 Radio Shack stores located primarily in the United States, Canada, Europe and Pacific/Asia.

Tandy/Radio Shack has grown steadily over the last several years. Between fiscal (June 30) 1980 and 1981, Tandy's sales increased 22% from $1.38B to $1.69B while earnings rose 51% from $112M to $170M. Domestic sales accounted for 82% ($1.38B) of fiscal 1981 revenues.

As Table 9.1 indicates, computer sales have grown to 22% of corporate 1981 revenues. The retail list price of these sales was $450 million. (49) Although microcomputer shipments increased 78% annually over the last two years, Radio Shack has been losing market share dramatically. In 1978, Radio Shack held 50% market share, selling 100,000 TRS-80 units compared to 25,000 Commodore units and 20,000 Apple units.(50) In 1981 Radio Shack held approximately 22% market share, and was surpassed by Apple as the market leader.

TABLE 9.1

Tandy/Radio Shack Worldwide Warehouse Shipments ($M)

	1978	1979	1980	1981
Corporate Sales	1,059	1,215	1,384	1,691
% Computer	2.4	9.5	15.1	21.8
Computer Sales	25	116	208	368

Source: June 30, 1981 Annual Report

Radio Shack's major strength is its vertical integration into manufacturing and distribution. Radio Shack currently manufactures about 43% of the products included in the Radio Shack line.(1981 Annual Report) As Table 9.2 indicates, Radio Shack has established a worldwide distribution network of approximately 8,000 full line stores which offer all "popular" TRS-80 computer products. Radio Shack has also opened 160 domestic and 45 foreign Computer Centers to provide comprehensive sales, service, leasing and training. To more successfully target large corporations, Radio Shack recently established a large account sales force of 20 former mainframe company salesmen.(51)

TABLE 9.2

Tandy/Radio Shack Worldwide Retail Outlets

	U.S.	International	Total
Company owned	4,132	1,015	5,147
Dealer/Franchise	2,046	968	3,014
Total	6,178	1,983	8,161

Source: June 30, 1981 Annual Report

Another Radio Shack strength is the breadth of its product line. The original $499 Model I is no longer offered, but over 200,000 of these computers were sold by July, 1980.(52) The $3,899 Model II was introduced in May 1979 to provide a more powerful entry into the business market. In 1980-1981 the Model I was replaced by the software compatible $699 Model III and by the $399 Color Computer. For videotext use only, Radio Shack offers a $399 terminal with a built in modem, to access the Dow Jones and CompuServe networks. Radio Shack announced the more sophisticated Model 16 business computer on January 19, 1982.(53) The Model 16 uses the popular 32/16 bit Motorola 68000 microprocessor, in addition to an 8-bit Z80 coprocessor which allows it to run software developed for the Model II. By using the multiprocessing capabilities of the 68000, the Model 16 can attach two

additional terminals without slowing it down. A more complete description of Radio Shack's product line is provided in Appendices A and S.

Radio Shack's major problem has been the quality of its products. Its software is moderately good, but does not approach that of Apple. However, Radio Shack has shown the ability to develop company labeled software, and 2,300 unsupported packages have been externally developed and listed in Radio Shack's Application Software Sourcebook. Radio Shack has realized the benefits of networking its computers and has (1) made a deal to use Datapoint's ARC network to link its computers together and (2) developed programs to make the Model II compatible with IBM mainframes. Yet despite these strategies, Radio Shack is rapidly losing market share. Unless Radio Shack can improve the Realistic image and quality of its entire product line, business and high-income computer buyers may go elsewhere. The establishment of its separate Computer Centers, its large account sales force, and its recent introduction of the sophisticated Model 16 should at least improve the Radio Shack image.

9.3 Commodore

Commodore International was founded in 1958 as a typewriter dealer in Toronto, Canada. Between 1968 and 1975 its main business was merchandising electronic calculators. In 1976 Commodore integrated into the semiconductor industry by acquiring MOS Technology, the original manufacturer of the 6502 microprocessor now used by Apple and Atari. By 1978 Commodore had come out with its first personal computer, the PET.

Commodore's main thrust has been in the overseas market, particularly Euorpe. As table 9.3 shows, foreign sales accounted for 76% of Commodore's computer system sales. In early 1982, industry sources estimated that Commodore held a 65% market share in Europe.

Table 9.3
Commodore's Worldwide Computer System Sales
($Million)

	1979	1980	1981	1982E
U.S. Sales	$11.2	$20.1	$32.1	$80.0
% of total	33%	24%	24%	34%
Foreign Sales	$23.2	$62.7	$100.4	$155.0
% of total	67%	76%	76%	66%
Total Computer Sales	$34.4	$82.8	$132.5	$235.0

Source: Equity Research Associates Report Nov. 13, 1981

Commodore's major strength is its broad line of inexpensive products. The VIC-20 keyboard computer includes 5KB of RAM memory and retails for $299. It plugs into a TV set and can attach to a casette

recorder which sells for $75. The 16KB Commodore PET includes a built in 40 character display monitor and retails for $995. The 32KB CBM Business Machine retails for $1,495 with its build-in 80 column monitor. The 96KB Super PET retails for $1,995 with a similar monitor and additional software. Appendix T provides product descriptions and price lists for the Commodore product line.

Commodore has announced three new products soon to be released. The 2.5KB Ultramex which includes a membrane keyboard and plugs into a TV set will retail for $149. The 256KB CBM-2 will use a new 16-bit microprocessor developed internally and retail (without a monitor) for less than $1,000. The 64KB Commodore 64 will use a 6510 microprocessor (an improved version of the 6502 used in the Apple II) and retail for $595 with its built-in 40 column monitor. This machine is supposed to "emulate" competitive products by accepting other microprocessors through a slot in its back.(29) Commodore almost certainly will offer a plug-in circuit board that will give the Model 64 access to programs that use Z80 microprocessors and the CP/M operating system. Commodore's intent is to "out Japanese the Japanese" in moving the personal computer market toward low cost commodity products.

Commodore's strongest market has historically been the education sector. The installed base of over 100,000 PET's (54) make Commodore the worldwide leader in the educational market. Commodore's womb-to-tomb philosophy places considerable long term emphasis on reaching young users and familiarizing them with the Commodore brand during the markets initial development. Commodore offers a 3 for the price of 2 educational discount which makes the bulk cost of the 16K Commodore PET $663. Educational usage of the Commodore PET has grown to the point where Computer Strategies (Spring Valley, N.Y.) now offers a Daisy Link Monitor to enable the instructor to monitor up to 16 classroom computers and make individual corrections and comments on each student's screen.

Commodore's weaknesses are its software and its domestic distribution. Although Commodore publishes a Software Encyclopedia listing software packages available through book publishing companies,

software houses, private authors, and state and national educational associations, Commodore does not guarantee the support or documentation of these products. Commodore directly offers and supports a more limited line of applications packages. Commodore has established a strong distribution network in Europe, but its domestic network development has only recently been stressed. Commodore is targeting direct large acount sales, office equipment dealers, consumer electronics stores (Tech Hi-Fi) and mass merchandisers. Realizing that its product may have to sell itself in these channels, Commodore has undertaken a six month $6 million advertising blitz which is emphasizing mass market TV advertising on such shows as 20/20 and Hill Street Blues. Nineteen out of twenty homes are targeted to receive 8 exposures to William Shatner selling Commodore products. Commodore also entered into a five year agreement with TRW to service Commodore microcomputers throughout the United States. With more than 2,000 skilled technicians at 220 locations, TRW is the leading supplier of third party computer related service and maintenance in the U.S. (Commodore 1981 Annual Report). Commodore has also established a board swap service program with its retail dealers.

With the recognized microprocessor capabilities of its MOS Technology subsidiary, Commodore may successfully compete as a low cost producer. Although Commodore appears willing to offer plug in CP/M compatability, it has not yet announced a CP/M only based computer or a (more costly) computer with two built-in microprocessors, one for Commodore software and one for CP/M software. Commodore is attempting to establish a proprietary software base (especially in the education market) while offering a flexible, very price competitive product line. Commodore is stradling the line to discover whether it can use its current market power to establish a strong software and distribution base, or whether it will be forced to compete mostly on price and flexibility.

9.4 IBM

IBM is the world's largest supplier of data processing equipment, with 1981 revenues of $29 billion. However, until IBM's entry into the personal computer market, its performance in small computer systems was far from impressive. IBM's 5100 series of small business computers ($12,000) went through three iterations before being reintroduced as the System/23 Datamaster.

IBM's August 1981 entry into the personal computer market reversed IBM's historic strategy of maintaining a high degree of vertical integration. IBM turned to outside sources to provide hardware, software, distribution channels and service. The Personal Computer uses an Epson (Japanese) printer, a Taiwanese monitor, 5 1/4" floppy disk drive by Tandon and a 16-bit Intel 8088 microprocessor. Microsoft Inc. developed the BASIC interpreter and MS-DOS operating system and Digital Research was contracted to develop a modified version of their 8-bit CP/M operating system. Applications programs such as the VisiCalc spreadsheet, Easywriter word processing package, PASCAL compiler and Peachtree accounting systems have been licensed. Due to lower personal computer margins and IBM's desire to quickly gain market share, the Personal Computer is being distributed through Computerland and Sears Business Centers. IBM will also distribute through the IBM product centers and its Data Processing Division's large account direct sales force.

Significant features of the Personal Computer are its price, microprocessor selection, large memory capacity (expandable to 256K) and its compatibility with larger IBM Systems.

The IBM PC standard configuration #1 costs $2,385 and includes the system unit/keyboard, 40KB of ROM, 48KB of user memory, Asynchronous Communications Adapter, 5 1/4" Diskette Drive Adapter and one 5 1/4" 160 KB Diskette Drive. Appendix L includes an IBM PC price list and diagram of its standard configurations. Since IBM is acting almost exclusively as an assembler and reseller, this $2,385 price is very competitive as IBM is

offering a very low initial markup in order to establish its market share position.

The Intel 8088 microprocessor has a 16-bit internal architecture (data bus) and 8-bit external data bus. The 16-bit internal architecture allows increased processing power while the 8-bit external bus allows the 8088 to interface with less expensive and more readily available supporting chips. The use of the CP/M-86 operating system, Microsoft BASIC interpreter and SofTech Pascal Compiler will supposedly allow transfer of hundreds of widely used applications to the IBM PC with "minimal" modifications. IBM's current software base is very limited and its Easywriter word processing package has received terrible press. In hope of establishing a strong proprietary software base, IBM has established a Personal Computer Software Publishing House which will pay authors royalty payments on approved programs. IBM's market power and astronomical early PC success may enable it rapidly attract and develop a competitive software base.

The IBM Personal Computer has displayed extraordinary success to date. IBM's expected first year sales were 90,000 units, but this planned capacity is being increased to accomodate revised first year sales expectations of over 200,000 units.(5)

One factor which may influence IBM's PC strategy is IBM's recent entry into the remote computing (timesharing industry). IBM was forced to sell its Service Bureau Corporation to Control Data in 1973 as part of an anti-trust settlement, and agree not to enter the business for six years. In February 1982, IBM announced the formation of the IBM Information Network, a coast to coast network of data communications and processing which will enable computers that meet IBM network specifications (including the IBM PC) to use the network.(34) This recent entry will encourage the development of sophisticated networking capabilities for the IBM Personal Computer.

9.5 Nippon Electric Company

NEC is a fully integrated communications, computer and electronics firm. Its major communications products include fiber optics, digital switching systems, and cable and radio transmission systems. It's computer products span the gamut of mainframes, minicomputers, microcomputers and peripherals. It is the Japanese leader in semiconductor sales (55) and has experienced record expansion in its color TV sales. NEC's pronounced strategy for growth is an emphasis on "C&C", the integration of computers and communications.

NEC's 1981 worldwide revenues of $4.8 billion are divided below. International operations (including exports from Japan) accounted for $1.4 billion, i.e., 30% of consolidated sales.

Table 9.4

Breakdown of NEC's 1981 Worldwide Revenues

Communications	$1.6B	36%
Computers & Industrial Products	$1.1B	24%
Elecronic Devices (semiconductors, microcomputers)	$1.1B	23%
Home Electronics (TV,VCR,Hi-Fi)	$ .6B	13%
Other Operations	$ .2B	4%

The 1981 Japanese PC market increased roughly two and one-half times over the previous fiscal year and NEC claims approximately 50% of this market (1981 annual report). NEC's personal computer offerings are setting records for installed memory in their price range. The consumer oriented $389 PC-6000 has 16K bytes of both ROM and RAM memory.

Currently NEC's only exported model is the PC-8000, which is distributed through such outlets as the Sears Business Center. The PC-

8000 is based upon NEC's version of the Z80 microprocessor and supports the CP/M operating system. NEC actively promotes Lifeboat Associates as its major software distributor.

NEC's strategy is different from those of many other Japanese computer companies. While other companies selling larger systems have gone through third parties (U.S. partners, third-party systems houses and dealers) to build share without the expense of setting up a sales network, only NEC has been willing to pay the price of setting up a U.S. subsidiary and a direct sales force, maintenance and support staff (56).

In other ways, NEC is very similar to its Japanese competitors. NEC is very strict in its price and quality requirements. Its debt/equity ratio of 1.1 is extremely high and its 2.1% 1981 profit margin is absurdly low by American standards. This Japanese money is very patient and takes a long-term view.

The recent moves toward mass merchandising and standardization of software around the CP/M operating system should help NEC's efforts in the personal computer industry. Coupled with NEC's fully supported line of integrated "C&C" products, NEC could make a very successful sequenced entry into the United States information systems market.

9.6 Xerox

Xerox is the world's leading manufacturer of copying/duplicating equipment and supplies. Its business is truly global, with foreign operations accounting for 45% of earnings.

Xerox has experienced substantial leadership erosion in its reproduction businesses, and has been actively diversifying into other areas of office automation. Xerox declined from a 96% share of domestic copier revenues in 1970 to a 46% share in 1980. It currently holds only 31% share of the low-end copier market, losing substantial sales to lower cost manufacturers selling their machines through independent office equipment dealers.(57) Xerox's income and revenue growth has slowed drastically from its heyday in the mid 1960's when it's stock price peaked at 88 times earnings. Xerox experienced 6% revenue ($8.2B-$8.7B) and 5.9% income ($565M-$598M) growth rates between 1980 and 1981. Its profit margin has dropped from 11% in 1970 to 7% in 1981. In addition to diversification, Xerox promises to reduce its overhead burden and adopt Japanese engineering and management methods in order to overcome the significant cost advantages held by its Japanese competitors.

Xerox's diversification strategy is multi-faceted. Over the last five years Xerox has acquired Shugart Associates (the leading supplier of floppy disk control and memory units), Versatec (an electrostatic printer/plotter manufacturer), Century Data Systems (a large capacity rigid disk drive producer) and Diablo Systems (a terminal printer manufacturer). In addition to providing externally generated revenues, the technological advances of these subsidiaries are immediately available and they provide Xerox with a secure supply of low cost components for the Xerox office information systems.(1981 Annual Report)

Xerox has attempted to develop a complete line of integrated office automation products. In December 1979 Xerox announced Ethernet, a local area network which can link together all the elements of an automated office. By offering the Ethernet license to any manufacturer

for a mere $1,000 and by jointly developing Ethernet with Intel and DEC, Xerox is attempting to establish Ethernet as the defacto standard in local area networking.

The $16,595 Xerox Star workstation is the champion of Xerox's office information system. The Star introduced a revolutionary user interface based on the use of icons-pictorial representations of familiar office objects such as in- and out-baskets, file folders and file drawers. A handhold device called a "mouse" eliminates the need for skilled keyboard commands. Using the mouse, one simply points to the icon on the screen and touches a command button, at which time the system initiates the appropriate action automatically. Text and graphics entry and editing are easy and flexible. The display screen can be divided into a series of "windows" which allows the user to integrate and edit multiple documents while each is in view.

The Xerox 820 personal computer is an integral part of the integrated Xerox product line. The 820 is a combined word processor/personal computer which has Ethernet compatability. It runs on the Zilog Z80 microprocessor under the popular CP/M operating system, and therefore can utilize the established CP/M software base. The standard Xerox 820 system includes 64K memory, an 81K disk, 12-inch black and white monitor and optional printer for $3,695.

Xerox's competitive advantage is its unrivaled large account sales and service network. This sales force has an established reputation and customer base, and has low marginal costs in selling the 820 as part of the integrated Xerox information system. In addition to this sales force, Xerox had established a chain of 29 Xerox Stores. These "office equipment supermarkets for small businessmen" showcase a wide range of Xerox products (copiers, typewriters, word processors, small business computers,personal computers, calculators) and some competitive products to fill out their product line. The Xerox 820 is sold through the Xerox stores, the direct sales force, and a collection of independent distributors such as Computerland.

9.7 Warner Communications (Atari)

Warner Communications is a diversified entertainment business. Warner produces and distributes recorded music, motion pictures and television programs, publishes periodicals and paperbacks, and owns Atari Inc. and 50% of Warner/Amex Cable Communications (a pioneer in two-way cable). Warner is strategically positioned to enter the entertainment centered home of the future.

Warner has shown extraordinary success of late. From 1980 to 1981 Warner's revenues jumped from $2.0B to $3.2B (57%) and profits soared from $137M to $226M (65%). Warner/Amex Cable and Atari Inc. are the major contributors to this insurgence. Warner/Amex is the fifth largest cable company in the United States and by yearend 1982 will be serving one million subscribers in 27 states.

Atari was earning revenues of $39 million five years ago when Warner acquired it for $28 million. From 1980 to 1981 Atari's revenues double from $512M to $1.23B and its income quadrupled from $70M to $287M. Atari's three major businesses are its Video Computer Systems (which accounted for $50M of 1980 income), Coin-Operated Games (which accounted for $30M of 1980 income) and Home Computer Systems (which lost $10M in 1980).

Atari's Video Computer Systems ($149 retail) is its "star" business. Atari holds 75% of the booming home video games market (58), and sold an estimated 2.8 million game players in 1981, along with 18 million cartridges (such as Space Invaders and Asteroids). Atari's margins on its cartridges are over 50%.(59)

Atari's Home Computer division is attempting to open up the very difficult home computer market and has been much less successful. This division lost $10 million in 1980 on sales of $20 million.(6) In May 1981, the Atari 400 was mass market packaged and its price was dropped from $499 to $399 in order to better reach the very price sensitive home consumer. Late in 1981, the Atari 800 was also packaged for mass market,

with similar cost savings being passed on to the consumer. Atari hopes to generate substantial retail sales through mass market channels without demonstration. Atari sold approximately 30,000 home computers in 1981 and this division expects to be profitable in 1982.

Atari will probably not be price competitive with the Japanese home computer manufacturers, so its strategy will be to compete on its established strengths in software, entertainment and consumer marketing. The home computer enables the usage of much more sophisticated game software than that used on game players, and as the programmable home computer becomes more affordable, its added utility may make it the preferred medium for game playing. Atari will attempt to maintain its brand recognition and competitive edge in the development and marketing of proprietary games packages. Atari will also try to capitalize further on its recognized audio and computer graphics capabilities. Atari will lever Warner's strengths in recorded music, motion pictures and paperbacks to offer audio/visual products based upon home computers, video discs and other devices.

Atari's innovative software strategies will continue. Atari recently completed a nationally advertised contest rewarding $25,000 and royalty payments for the best program developed for Atari computers. During 1981, Atari established Atari Program Exchange (APX) offices in the U.S. and abroad to access third party software (1981 Annual Report). These offices make Atari computers available and provide training to programmers in order to allow them to develop more effective home computer programs. With its innovative marketing skills, established reputation in consumer entertainment and ever increasing cash flow, Atari has the resources to influence the home computer market.

9.8 Strategic Maps

The seven competitors described above are very differently positioned within the PC industry. Each strategic position has different entry and mobility barriers, and is affected differently by the six competitive forces. The strategic position (or group) which one chooses influences the defensibility of one's position and the long term profits which can be earned.

The presence of several strategic groups increases the competitive rivalry within the industry since it implies different preferences on risk taking, time horizon, price and quality.(60) The comparable size of the four major competitors increases rivalry due to the absence of a clear market leader.

This section outlines the strategic dimensions along which a competitor can position itself. Six dimensions are chosen to compare the positioning of the seven selected competitors on three strategic maps.

A. Strategic Dimensions

1. Software differentiation - Firms can choose to utilize company specific software or produce a PC which uses an established, standardized software base. Competitors offering company specific software can have high or low levels of software capability and differentiation.

2. Cost - Firms can compete on cost leadership. Although firms such as Apple, Radio Shack, Commodore and NEC have probably gained some cost advantage due to experience curve affects, lack of accurate cost data forces me to compare price information.

3. Channel selection - Among other alternatives, competitors can choose mass merchandisers, computer store chains, company owned stores and direct sales.

4. End-User buyer selection - Firms can choose to target business, technical, educational or home users. This dimension is highly correlated with price.

5. Vertical integration - Firms can be integrated forward into distribution or backward into semiconductor or perhipheral manufacturer.

6. Brand identification - Firms can transfer brand recognition from other products, establish it through marketing, or build recognition by offering high quality and service.

7. Geographical target - Firms can focus on specific national segments or pursue a global market strategy. NEC holds 50% market share in Japan, Commodore has concentrated in Europe, and the remaining competitors initially targeted the United States. Every competitor discussed is pursuing a more global, as opposed to geographically focused strategy.

8. Technological leadership - Firms pursue technological leadership in order to differentiate their product or gain first mover advantages. R&D expenditures, which can be correlated with technological leadership, are provided in Appendix Q. IBM was the first major competitor with a (modified) 16-bit microprocessor, but its product uses standard components and is not innovative. Radio Shack is the first major competitor to provide the multiprocessing capability of the 32/16-bit Motorola 68000. Their Model 16 is also the first PC to provide a coprocessor (Zilog Z80) to

insure software transferability. Commodore has announced the Model 64 which is promised to provide emulation of other personal computers.

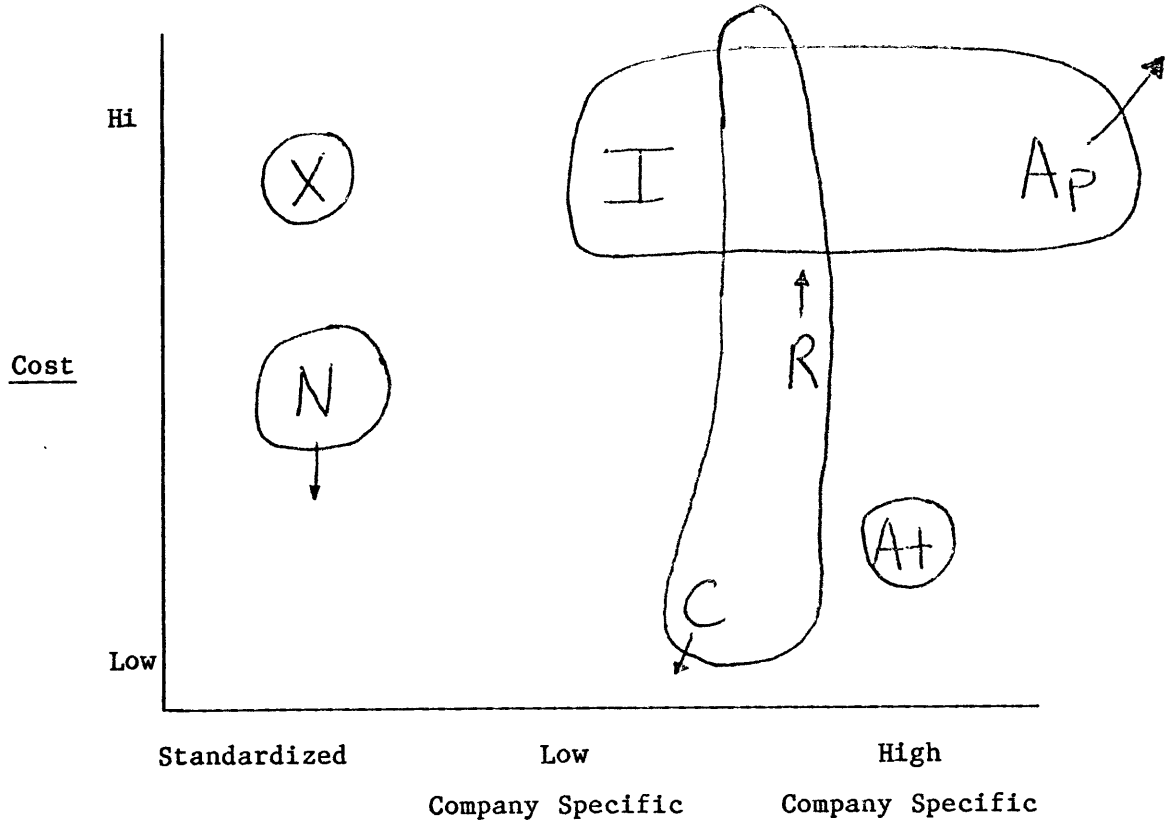
9. Breadth of product line - Firms proliferate their product line to provide a wider range of consumer options, serve more markets, allow upward expandability within their line, and to monopolize limited dealer shelf space. Commodore and Radio Shack have the widest range of PC products. Atari and Apple have produced only two products to date. IBM and Xerox have only one PC offering, but have a wealth of additional information products. NEC has an entire range of products from $399 personal computers to mainframes.

10. Quality - Firms emphasize quality assurance when performance and reliability is important. IBM has very high internal quality standards. NEC has established a reputation for performance and reliability. The manufacturing quality of Apple's products is not quite as high. The quality (and reputation) of Radio Shack's products is comparatively low. The Atari 400 uses a cheap membrane keyboard and is not recognized as a high quality product.

B. Strategic Maps

FIGURE 9.5

Cost vs. Software Differentiation



Company Key:

Ap = Apple	N = NEC
At = Atari	R = Radio Shack
C = Commodore	X = Xerox
I = IBM	

Note: Area of ellipse = market share

This strategic map demonstrates that the major competitors have stressed company specific software in order to maintain product differentiation. Apple has established the most advanced software base, and is trying to increase their differentiation with a powerful user-friendly interface for their upcoming Lisa product. Radio Shack, the other early market leader, is a distant second to Apple in its software capability. IBM has limited software to date, but it is licensing additional software development and hopes that its recognized strengths and successful PC entry will encourage the third-party development and presentation of software to the IBM Publishing Department. NEC and Xerox designed their products to use the CP/M operating system in order to gain an established software base. NEC will compete on dimensions other than software differentiation. Xerox wanted a PC entry to fill their network system product line. As hardware cost/capability decreases, Xerox may incorporate a version of their user-friendly Smalltalk language into a PC less expensive than the $16,595 Xerox Star.

This map also shows that Apple, IBM and Xerox are concentrating on sophisticated systems targeted to higher price users. Radio Shack and Commodore are offering a full product line addressed to all market segments. Atari is clearly focused on the low cost market, where its games packages provide its major software differentiation. To date NEC has only exported its PC-8000 business system but it will soon begin exporting its low cost, extremely price/performance competitive PC-6000.

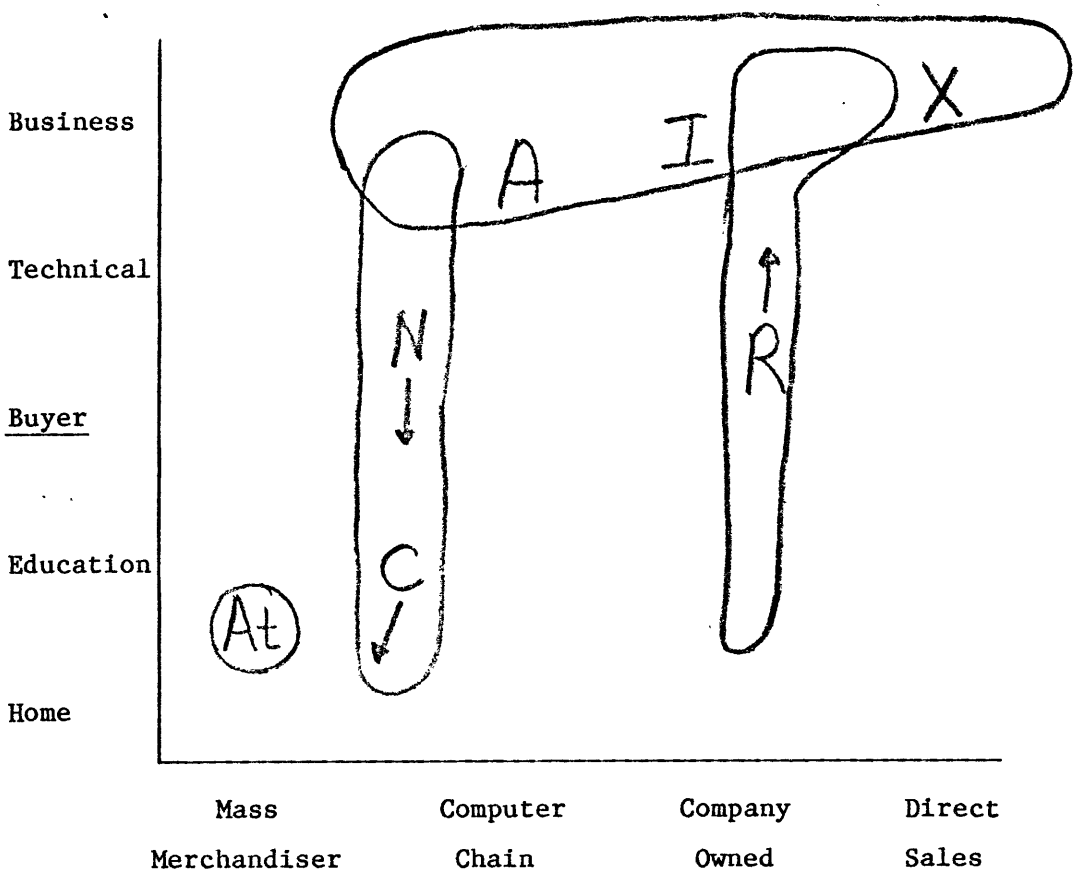
Currently, the most attractive strategic group is that shared by Apple and IBM. They are targeting the fastest growing business segment and their software differentiation will enable them to establish high transfer costs. Radio Shack is moving upward in price and sophistication with its Model 16, marketed to the business segment in part by Radio Shack's new direct sales force. Current involvement in this strategic group is important as business user needs are forcing increased concentration of PC vendors within the lucrative business segment. However the benefits of software differentiation (and transfer costs) will taper

taper somewhat as an independent, more standardized software industry develops.

The most fiercely competitive position is in the low cost market. NEC will soon release its PC-6000 worldwide. Commodore is introducing several low cost products. Commodore, Texas Instruments and Atari have been cutting prices dramatically to gain penetration into the slow moving home market. On May 16, the Atari 400 was advertised for $318 ($399 list) and the Commodore VIC-20 for $239 ($299 list). With the expected entry of Japanese electronics firms with limited software expertise, a strong rivalry will probably develop within the standardized, low cost strategic group. The low cost position will be difficult to defend without additional marketing, distribution or software differentiation.

FIGURE 9.6

Buyer Selection vs. Channel Selection



The competitive positioning depicted in Figure 9.6 is easy to describe. IBM and Xerox are targeting their traditional business segment through computer chains, recently established company owned stores and their historically successful direct sales forces. Apple is distributing almost exclusively through computer chains or similar outlets. Although Apple is emphasizing the business sector, they are also trying to give an Apple II to every public school in America. Radio Shack is targeting all markets through its worldwide 8,000 retail store network. NEC will be distributing an increasing range of products through Sears Business

Center and outlets such as the new Best Data Base store. Commodore has a strong European network to distribute its full product line, but its domestic distribution network is still very weak. Atari is focused on the home/education market where it can utilize its entertainment expertise, but Atari's PC distribution network is terrible. I called four "authorized" dealers in Boston before anyone could tell me the availbility (range), price and specifications of Atari's peripherals.

Due to the pronounced difference in buyer segment behavior, the resources required to develop, market and support products to a variety of markets, the importance of PC distribution and the benefits of using a multi-distribution strategy during the current stage of PC evolution, I believe that moving a broad product line through limited distribution channels will be harder to maintain than a limited product line through multiple channels. Maintaining a variety of distribution channels (horizontal axis) will be more defendible in the long term than attempting to serve all buyer segments (vertical axis).

Apple's narrow channel selection is compensated by its strong dealer relations and the fact that computer chains have remained the most recognized and successful PC distributors. However these chains demand very high margins, and their loyalty tends toward the current hottest selling product.

Radio Shack's forward integration allows it to keep the typical 35%-40% dealer markup, an its 8,000 store network provides a significant presence and competitive advantage. However Radio Shack's success will remain very dependent upon the image of this network.

FIGURE 9.7

Brand Identification vs. Vertical Integration

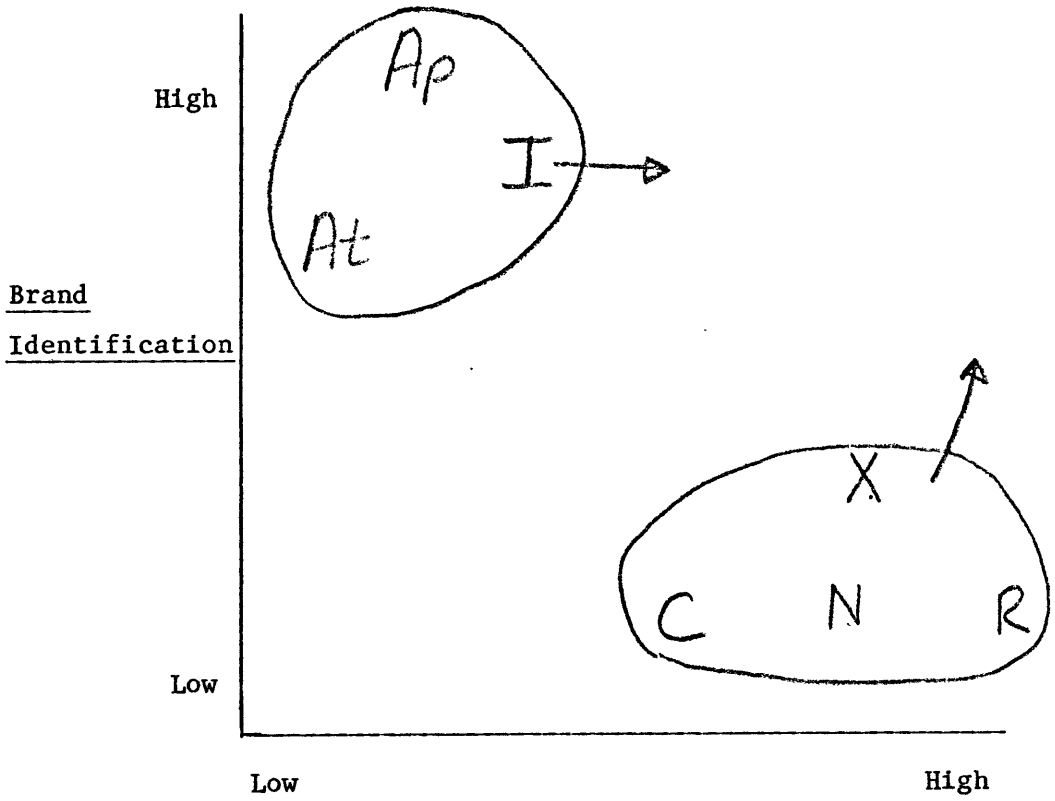


Figure 9.7 portrays the PC competitors strategic positioning vis-a-vis brand identification and vertical integration. Apple acts almost exclusively as an assembler, yet it has the highest brand recognition within the industry. Apple grew from nothing to become the entreprenurial success story (and darling) of America. It promoted an entire culture around the Apple II by distributing the Apple Magazine, and by encouraging software and peripheral development. Apple's investments have been in marketing (flip to Appendix Q), software and distribution, and not into vertical integration. This entry stretegy and Apple's early mover advantage have enabled it to become the current PC market leader.

Atari has established strong brand recognition within the video games industry, which will be transferable into the entertainment oriented home

PC market. Atari has very limited vertical integration, and its strength will continue to be its commitment and expertise in consumer marketing.

IBM's brand recognition transfered directly from its overwhelming presence in business machines. While acting almost exclusively as an assembler, IBM's reputation will enable it to capture 15% of the PC market in its first year of entry. IBM is integrated into direct sales and retail outlets, and is very capable of backward integration.

Commodore has a strong microprocessor base, but has limited brand identification. Commodore is investing heavily on TV advertising to increase consumer recognition. The worldwide star William Shatner is being used as Commodore's spokesman.

NEC has complete backwards integration into electronics and peripherals and has a full line of computers all the way to mainframes. Its expertise in consumer electronics, communications and system integration will be very important in the PC industry. NEC's brand identification is somewhat limited to computer and communications followers. NEC hopes to use the PC as the foothold for a sequenced entry into the United States, and will probably commit substantial resources to establish recognition as a high quality, cost competitive computer and communications company.

Xerox is attempting to change its stereotyped image from that of a reproduction company, to that of a fully networked office systems supplier. Xerox is fully integrated into printers, storage devices, word processors. local area networking, direct sales and retail outlets.

Radio Shack has an image problem it is attempting to correct with the establishment of its independent computer centers and its recent introduction of the Model 16. Radio Shack is fully integrated into distribution and recently licensed the technology to internally manufacture its disk drives and printers.

Refering to Figure 7.3, the positioning of the PC strategic groups along a continuum stretching from high brand identification to high vertical integration reflects a decision as to how one divides limited capital resources. As the PC industry has evolved, successful marketing

and brand recognition have proven to be extremely important. The relative unimportance of vertical integration during this period of market development provides insight into the early (perhaps underlying) market structure of this industry. Vertical integration has historically become increasingly important for defensibility and profit maintenance as industries mature. In examining the PC value added chain (Section 5.7), I described the advantages of integration into peripherals and distribution, so I predict the PC market structure will also evolve toward increased integration. The strategic position sought by most competitors will be higher levels of brand identification and vertical integration. However, Apple and Atari will probably compete on brand identification and software differentiation.

9.9 Competitor Strategy Conclusion

This chapter has discussed the market positioning of seven PC competitors. The dimensions of cost, software differentiation, buyer selection, channel selection, brand identification and vertical integration were discussed in detail.

The current market structure was shown to favor firms with differentiated software offerings to the business sector. The rivalry for cost leadership was predicted to become intense with the standardized software, low cost position being difficult to defend. Positions using a variety of distribution channels were described as more defensible than positions serving several buyer segments. The importance of brand recognition was noted, as was the recognition that most firms will maximize brand recognition and vertical integration in order to maintain profitability during industry maturity.

CHAPTER TEN
CONCLUSION

I believe the PC industry will be one of the most interesting and important global industries ever studied, ranking with the telephone, automobile and television industries. The technology used is not overwhelmingly novel. It is mostly watershed technology, trickling down from historic efficiency advances and price and size reductions in the larger computer industry. However, the personal computer offers the most powerful and complex device ever available to the mass consumer.

The PC will impact the very fiber of our society. We are observing the transition from (personal) computer use in business to personal computer use in education and in the home. Personal computers will increase the overlap between the now independent educational, home and business environments, modifying the way we learn and work. PC variations will be the central end-user devices in the larger information industry, whose evolution will shape the manner in which we communicate and process information. The network of information providers, information carriers and information processors will profoundly shape the structure of our society.

The PC industry is interesting for a number of other reasons. Global competition pervades us and corporate strategy and market structure are changing accordingly. The growth and market potential of the PC will provide an arena to observe the effects of serious global competition on an emmerging industry.

The structure of the PC industry is interesting. It is currently the battleground for an entrepreneur (Apple), distributor (Radio Shack) and established computer giant (IBM). The industry begs the question of why IBM and DEC (May 12, 1982) waited so long to enter. IBM has had prototype personal computers for years, but did not perceive the market seriously. By waiting an extra year to introduce its product, IBM allowed Apple to double its 1980 installed base of 170,000 units and firmly establish its persence in the business community. One hopes this industry can shed

insight on the ability of established firms to assume an innovative and risk taking posture.

Unfortunately this thesis does not investigate the roles of global competition and innovation in sufficient detail. On a more limited level, it attempts to demonstrate how competitive forces interact to determine the structure and evolution of an industry. One major point I would like to make is the importance of complementary products on an industry's structure.

In the evolving information industry, we observe the increasing integration and overlap of previously separate industries. Information providers, network providers and terminal providers are enveloped in an intertwined web of complementarity.

The videotex/teletext evolution demonstrates how the typical ham and egg interpretation of complements can be seen in the light of a chicken and egg problem. In the United States everyone is market testing the Videotext/Teletext technologies (Prestel, Telidon, Antiope, PLP, etc) over an array of communications mediums (telephone, cable, boradcast, text, video, one-way, two-way, hybrid, etc). But standards have not been set, their is no established leader in this industry, and high required investments and the risk of investing in the wrong technology is deterring the videotext/teletext evolution.

I have noted the importance of two complementary forces to the PC industry, i.e. the development of software and networking. The importance of software to support the mass marketed personal computer has led to the establishment of an independent software industry. I have described the trend toward standardization and user friendly software. Drawing on the insights of Earl Lipson at the Sloan School, I would like to describe the historical importance of user-friendliness, standardization and networking in the mass marketing of previous products. In particular, I will discuss their roles in the light bulb, telephone, automobile, television and camera industries.

The light bulb has the most friendly user interface imaginable. The user needs to know nothing about the inner workings of the light bulb, and

must only control an on-off switch. The light bulb quickly developed a standard design and socket interface. Although the early technological elite knew how to incorporate their light bulbs with personal generators, it was the development of a standardized electrical network which enabled the successful mass marketing of the light bulb.

The interface to the telephone is slightly more complex, and one's interaction with the machine is more active. But although the user must remember or look up numbers, the mass consumer need not understand the inner workings of the machine. The control of a common carrier market leader (AT&T) enabled the essential development of a standardized communications network to serve the mass market.

The interface to the automobile was more complex and the power one controlled was somewhat frightening. One had to wind the starter, deal with a clutch and develop sophisticated hand/eye coordination. One also needed to initially understand the innerworkings of the automobile for maintenance. A service network developed to overcome this problem, automatic transmissions and reasonable standardization (ignition, etc) developed, and a network of roads developed to allow widespread use of the auto. Users can generally switch from one automobile to another, and a mass market has definately evolved.

The television has always had a very friendly interface, as one needs only to install antenna wires and select channels. With a less dominant market leader, the obstacle was agreeing upon a standard technology and overcoming the chicken and egg problem of providing televisions and broadcast programs. RCA played a pivotal role in developing the standardized network necessary to give the television mass market appeal.

The camera is a much less standardized product than those previously discussed because it can be used successfully in a stand alone mode, and their is no motivation for camera networks. However the importance of the user friendly interface is important to note. The instamatic became easy to use and provided immediate interaction. The 35 mm cameras were initially very complex, requiring knowledge of film speed, shutter speed, aperture diameter, depth of field and light meter usage . Once

microprocessors were incorporated to make these adjustments automatic, 35 mm cameras started reaching the mass market.

The evolution of these industries demonstrates the importance of user-friendliness, standardization (often related to market leadership) and networking in the development of truly mass markets. Personal computers are not yet standardized, networked or user-friendly. Competitors have attempted to deter standardization in order to maintain product differentiation. A user-friendly interface has not been successfully addressed in the computer industry and represents the important PC departure from watershed computer technology. In turning on an Apple II computer, the mass user does not want to see "DOS Ready." Most consumers cannot type, encouraging the recent development of cursors, touch screens, and icon driven screen displays. This degree of user friendliness is still years away from the mass consumer. The user-friendly Xerox Star and Apple Lisa cost $16,595 and (an expected) $8,000. The software programs to create user-friendliness need substantial internal and external storage capabilities and these systems will not be available at mass market prices for several years. The lack of standardization, networking and user-friendliness are the major obstacles to overcome in the evolution of a mass PC market.

The personal computer industry possesses a number of features which make it very interesting to study. In it one sees the merging of technology and marketing, and the overlap of the work and home environments. This thesis provides a landmark for an industry bound to profoundly affect everyone of us. It is my hope that I have illuminated the interplay of competitive forces shaping the structure and evolution of the PC industry.

Gary Farner, May 18, 1982

APPENDIX A

Typical Personal Computer Systems

Computer	Base Cost	Micro-processor	Working Memory	Mass Storage	Video Display	Printer	Total Cost
Apple II Plus	$1,530	Synertek 8-bit 6502	48K Incl.	140K/disk $645	24x40 B&W $320	Silentype $525	$3,080[1]
Apple III	$4,740	Synertek 8-bit 6502A	128K Incl.	140K/disk Incl.	24x80 B&W Incl.	Silentype $525	$5,265
Radio Shack Model I	$ 499	Zilog 8-bit Z80	4K Incl.	Cassette Incl.	TV --	Line Printer 7 $399	$898
Radio Shack Model II	$3,899	Zilog 8-bit Z80	64K Incl.	486K/disk Incl.	24x80 B&W Incl.	Line Printer 8 $799	$4,698
Radio Shack Model III	$ 999	Zilog 8-bit Z80	16K Incl.	Casette $ 60	16x64 B&W Incl.	Line Printer 7 $399	$1,458
Radio Shack Color	$ 399	Motorola 8-bit 6809	4K Incl.	Casette $ 60	TV	Line Printer 7 $399	$858
Radio Shack Model 16	$4,999	68000 and Z80	128K Incl.	1.2M/disk Dual disks Incl.	24x80 B&W Incl.	Letter Quality $1,960	$6,959
Commodore VIC-20	$ 299	Commodore 8-bit 6502	5K Incl.	Casette $ 75	TV --	Dot-Matrix $395	$769
Commodore PET	$ 995	Commodore 8-bit 6502	16K Incl.	170K/disk $695	25x40 B&W Incl.	Model 4022 $795	$2,485

Computer	Base Cost	Micro-processor	Working Memory	Mass Storage	Video Display	Printer	Total Cost
Commodore IBM	$1,495	Commodore 8-bit 6502	32K Incl.	170K/disk $695	25x80 B&W Incl.	Epson MX80 $795	$2,985
Commodore Super PET	$1,995	6502 plus 6809	96K Incl.	1000K/disk $1,795	25x80 B&W Incl.	Model 8023 $995	$4,785
IBM Personal Computer	$2,385	Intel 16-bit 8088	48K Incl.	160K/disk Incl.	25x80 B&W $345	Epson MX80 $755	$3,860[2]
NEC PC-8000	$ 995	NEC 8-bit Z80	32K Incl.	160K/disk Dual disks $995	24x80 B&W $210	Model 8023 $695	$2,875[3]
Xerox 820	$2,995	Zilog 8-bit Z80	64K Incl.	100K/disk Dual disks Incl.	24x80 B&W Incl.	Epson MX80 $745	$4,090[4]
Atari 400	$ 399	Synertek 8-bit 6502	16K Incl.	Casette $99	TV —	Model 820 $299	$1,016[5]
Atari 800	$ 899	Synertek 8-bit 6502	48K $200	80K/disk $599	25x80 B&W $200	Model 822 $799	$2,196[5]
Hewlett-Packard HP-85A	$3,250	HP 8-bit	32K $195	Cassette Incl.	16x32 B&W Incl.	Dot Matrix Incl.	$3,445
Osborne Portable Computer	$1,795	Zilog 8-bit Z80	64K Incl.	100K/disk Dual disks Incl.	24x52 B&W Incl.	Epson MX80 $745	$2,540[6]

APPENDIX A

TYPICAL PERSONAL COMPUTER SYSTEMS

Footnotes:

[1] Apple II Plus price includes $60 DOS Software.

[2] IBM PC price includes $40 DOS software and $335 display and printer adapter.

[3] NEC PC-8000 price includes $175 CP/M Software.

[4] Xerox 820 price includes $200 CP/M software and $150 RS-232C interface card (to allow printer connection, etc.).

[5] Atari prices include $219 RS-232C interface unit.

[6] Includes RS-232C Interface, CP/M operating system, WORDSTAR word processor, Microsofts MBASIC interpreter, SUPERCALL spreadsheet software.

APPENDIX B

HISTORIC PERSONAL COMPUTER MARKET

	1977	1978	1979	1980	Installed
Business					
Number of Units (1,000)	17	27	60	200	304
Ave. Selling Price ($1,000)	4.6	2.4	1.7	1.9	1.9
End User Value ($1,000)	32	64	103	375	574
Technical					
Number of Units	4	13	30	45	92
Ave. Selling Price	4.0	3.8	3.3	2.7	3.1
End User Value	16	49	100	120	285
Education					
Number of Units	2	15	30	55	102
Ave. Selling Price	1.5	1.0	1.0	1.1	1.1
End User Value	3	16	30	60	109
Hobby					
Number of Units	30	100	130	148	408
Ave. Selling Price	1.0	1.0	1.1	0.9	1.0
End User Value	30	100	140	137	407[1]
Home Application					
Number of Units	4	20	34	52	110
Ave. Selling Price	1.0	0.8	0.6	0.7	0.7
End User Value	4	16	21	38	79
Total					
Number of Units	57	175	284	500	1,041
Ave. Selling Price	1.4	1.4	1.4	1.5	1.4
End User Value	85	245	394	730	1,454
Discounts	18	45	75	175	313
Factory Revenues	68	200	319	575	1,141
End User Value by Region					
United States	72	190	263	405	935
Canada	4	15	24	35	78
Western Europe	8	30	70	190	298
Japan	1	7	25	75	108[2]
Rest of World	0	3	12	25	40
	85	245	394	730	1,454

APPENDIX C

INSTALLED BASE OF DESKTOP COMPUTERS

(as of January 1, 1981)

Manufacturer	Model	Basic Price	Ave. Purchase Price	Date of First Installation	Number Installed in U.S.	Number Installed Outside U.S	Total Installed
Apple	Apple II	1,330	2,500	5/77	124,500	32,500	157,000
	Apple III	4,240	6,000	11/80	1,000	100	1,100
					125,500	32,600	158,100
Atari	400	550	550	9/79	25,000	0	25,000
	800	1,000	1,000	9/79			
Commodore	PET/CBM	795	995	10/77	90,400	106,000	197,000
Radio Shack	Model I	499	1,000	8/77	220,500	24,500	245,000
	Model II	3,450	6,500	6/79	18,500	1,500	20,000
	Model III	700	2,000		2,900	100	3,000
	Color	399	399		1,900	100	2,000
					243,800	26,200	270,000
Hewlett-Packard	HP-85	3,250	3,550	1/80	5,150	5,150	10,300
Texas Instruments	99/4	650	1,000	11/79	13,900	100	14,000

Source: International Data Corporation

APPENDIX D

1981 SALES AND INSTALLED BASE

(as of January 1, 1982)

	1981	Installed	
Apple	180,000	350,000	
Tandy	170,000	400,000	
Commodore	150,000	300,000	
IBM	40,000	40,000	(August-Dec.)
Texas Instruments	30,000	45,000	
Atari	30,000	40,000	
Hewlett-Packard	26,000	36,000	
Others	129,000	180,000	
	755,000	1,391,000	

Source: Future Computing

Forbes, February 15, 1982, pg. 114

APPENDIX E

Projected PC System Retail Sales By Market

Market	System Sales	Market Share (percent of system sales)	Cost per System (dollars)	Retail Sales (thousands of dollars)	Market Share (percent of dollar sales)	AAGR (percent)
1981						
Business	385,000	55	4,500	1,732,500	64	30
Home	175,000	25	2,500	437,000	16	35
Science	105,000	15	4,000	420,000	15	30
Education	35,000	5	3,500	122,500	5	15
Total	700,000			2,712,000		
1982						
Business	500,000	55	4,000	2,002,000	65	30
Home	236,000	26	2,000	472,000	15	35
Science	137,000	15	3,500	478,000	16	30
Education	40,000	4	3,000	121,000	4	15
Total	913,000			3,073,000		
1983						
Business	651,000	55	3.500	2,277,000	67	30
Home	319,000	27	1,500	478,000	14	40
Science	177,000	15	3,000	532,000	16	35
Education	46,000	4	2,500	116,000	3	20
Total	1,193,000			3,403,000		
1984						
Business	846,000	53	3,000	2,537,000	69	30
Home	446,000	28	1,000	446,000	12	50
Science	240,000	15	2,500	599,000	16	35
Education	53,000	3	2,000	106,000	3	20
Total	1,585,000			3,689,000		
1985						
Business	1,100,000	51	2,500	2,479,000	69	30
Home	670,000	31	750	502,000	13	60
Science	323,000	15	2,000	647,000	16	35
Education	64,000	3	1,500	96,000	2	25
Total	2,157,000			3,994,000		
1990						
Business	3,216,000	31	1,500	4,747,000	53	30
Home	5,793,000	56	450	2,566,000	29	40
Science	1,197,000	11	1,200	1,414,000	16	30
Education	211,000	2	1,000	187,000	2	25
Total	10,417,000			8,914,000		

Source: Stanford Research Institute

APPENDIX F

PC APPLICATIONS BY MARKET SEGMENT

A. Business Users

1. Word processing
2. Accounting and payroll
3. Local data management
4. Remote data base and program access
5. Graphics
6. What If analysis
7. Report generation
8. Electronic mail

B. Home/Hobby Users

1. Entertainment
2. Computer assisted instruction
3. Electronic mail
4. Word processing
5. Information retrieval (newsweather, sports, transportation schedules, restaurant info, etc.)
6. Home banking
7. Teleshopping
8. Movies and plays from video libraries

C. Education

1. Computer-assisted instruction (drill and practice, conceptual, etc.)
2. Simulation of audio/visual experience
3. Learning to program
4. Sophisticated problem solving
5. Word processing

D. Science Users

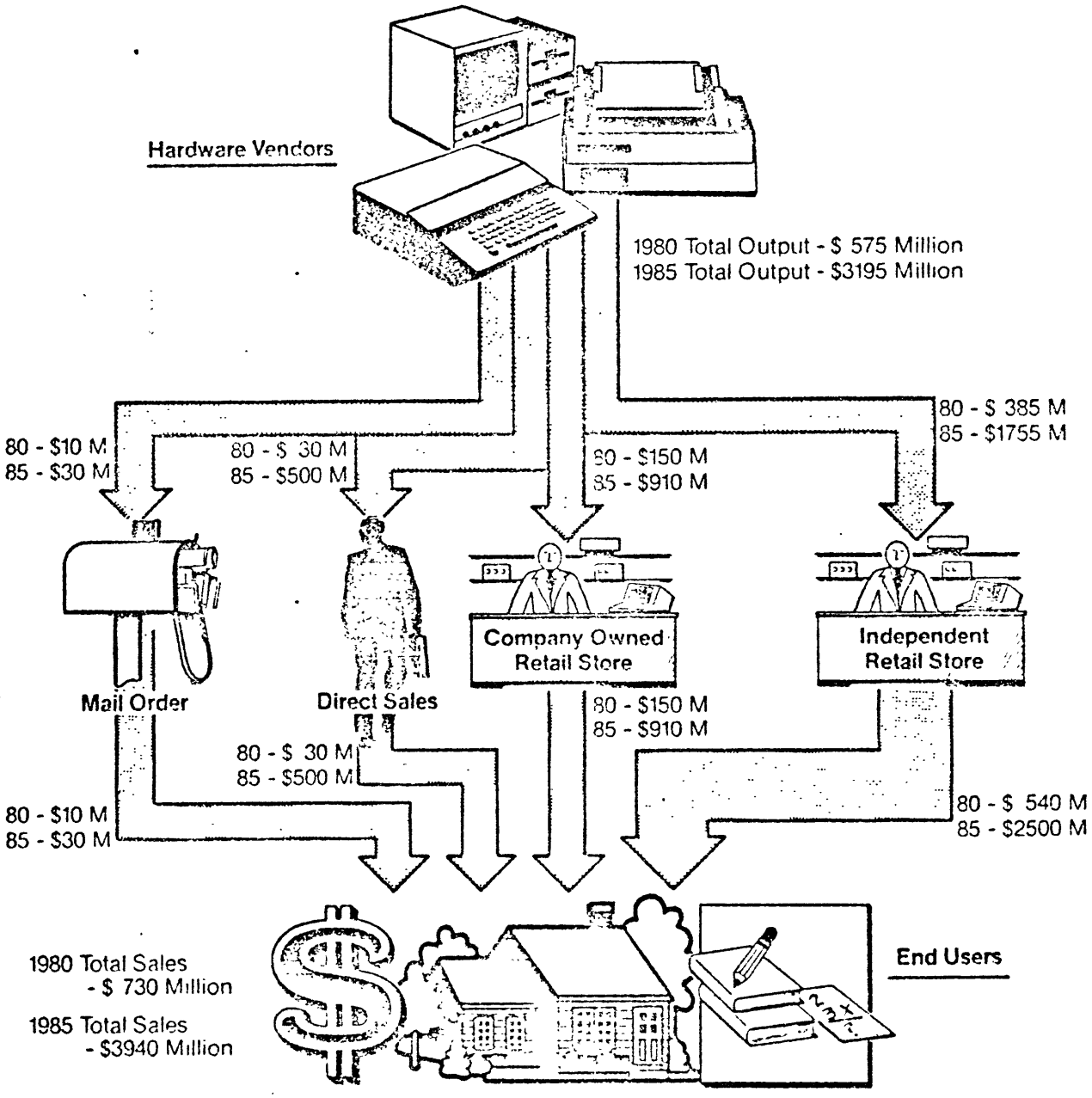
1. CAD/CAM
2. Scheduling (job tracking, material control, etc.)
3. Sophisticated problem solving
4. Graphics
5. Hook up to and control other instruments

APPENDIX G

VENDOR STRENGTHS BY MARKET SEGMENT

	Strong	Medium	Light
Large Enterprise	IBM Xerox Apple Hewlett-Packard	Radio Shack Commodore Osborne NEC	Atari
Small Enterprise	Apple IBM Radio Shack Commodore	Xerox Osborne NEC	Hewlett-Packard Atari
Home & Hobby	Radio Shack Apple Commodore Texas Instruments Atari	NEC (soon)	IBM Osborne Xerox
Education	Commodore Apple Atari Radio Shack	IBM	Xerox NEC Osborne
Science	Hewlett-Packard	Apple IBM Radio Shack	Commodore Xerox NEC

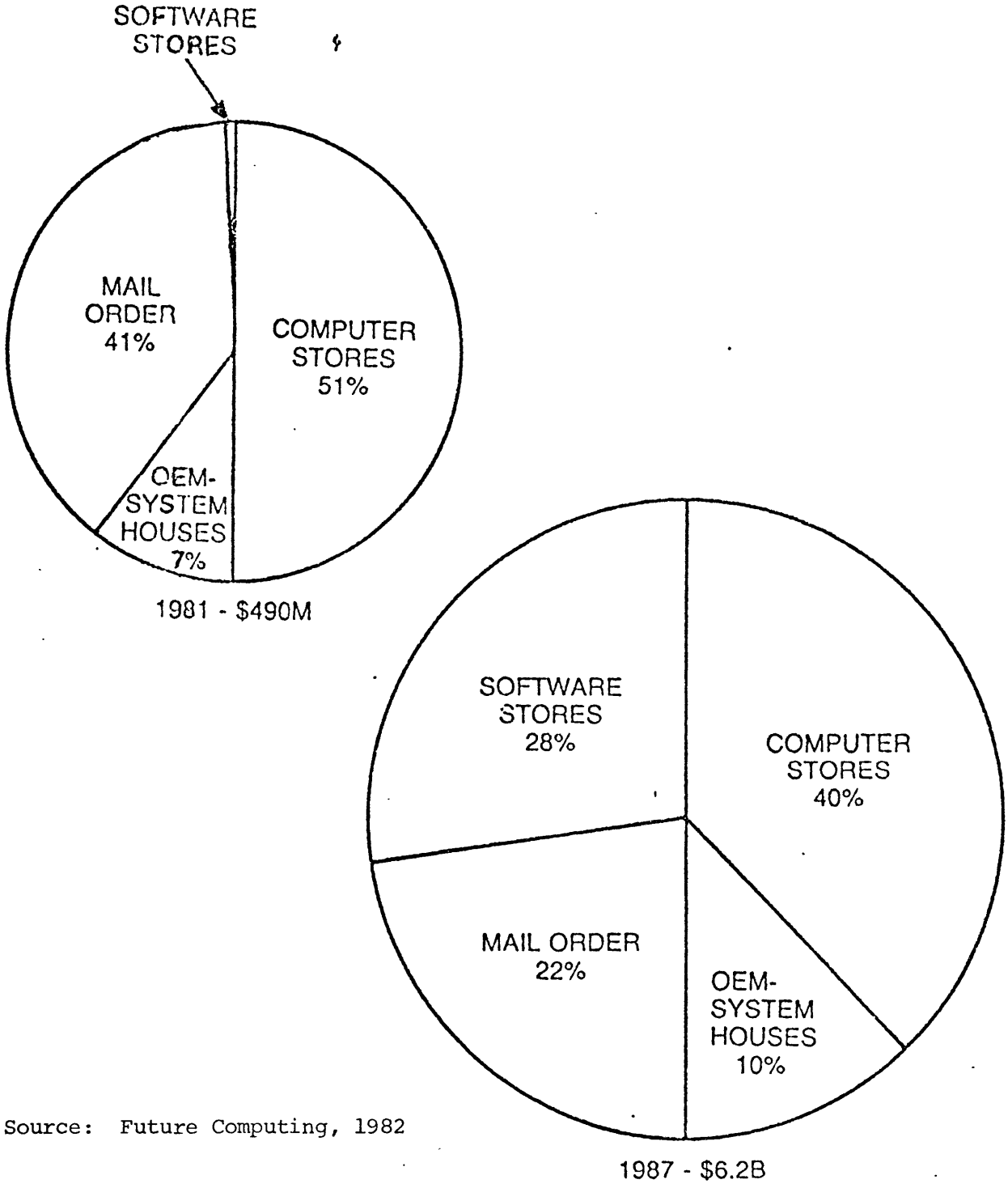
ESTIMATED WORLDWIDE PERSONAL COMPUTER MARKET CONSUMPTION BY CHANNEL OF DISTRIBUTION 1980 AND 1985



SOURCE: DATAQUEST, INC.

APPENDIX I

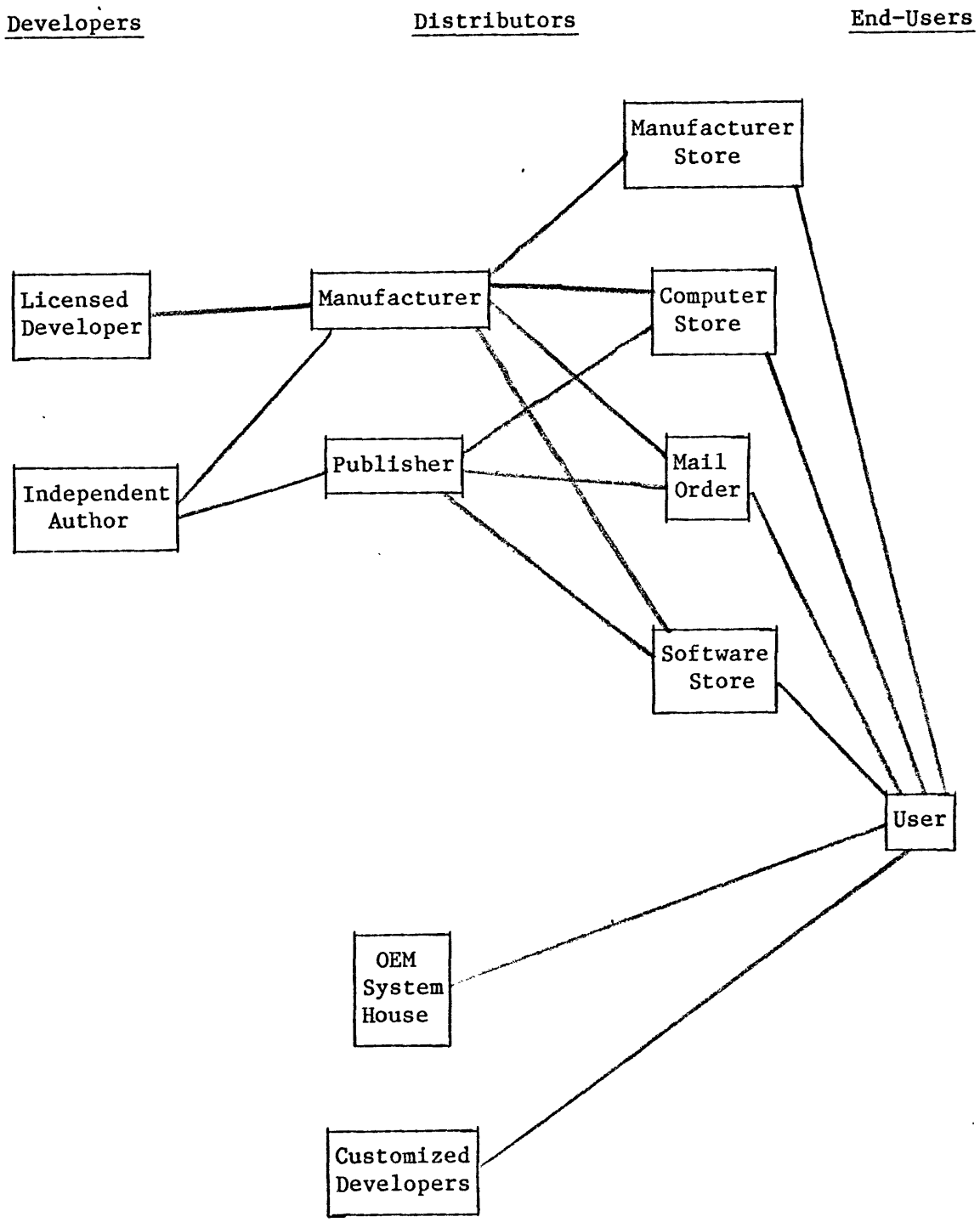
PC SOFTWARE DISTRIBUTION, 1981 and 1987



Source: Future Computing, 1982

APPENDIX J

PC SOFTWARE DISTRIBUTION CHANNELS



[illegible]

Continental U.S. ● Effective November 1, 1981

$100 Registration & Guarantee

This one-time fee covers registration, account set-up, ID and password assignment, *User's Manual* and *SOURCE Digest.* If you are dissatisfied, this registration fee may be refunded upon written request made within 30 days of subscribing. You will be responsible only for usage and other charges incurred.

Connect Time

These charges are for the amount of time you are actually connected to THE SOURCE.℠ Time is computed to the nearest minute as recorded by computer.

	Services	Weekday 7 am-6 pm	Evening, Weekends & Holidays	Midnight to 7 am daily
THE SOURCE 1,200 information and communication services	300 baud service	$18.00/hr	$ 5.75/hr	$ 4.25/hr
	1200 baud service	25.00/hr	9.00/hr	6.00/hr
SOURCE * PLUS value – added information services	300 baud service	30.00/hr	15.00/hr	10.00/hr
	1200 baud service	40.00/hr	25.00/hr	15.00/hr

Storage

These rates are for storage of personal or business files on THE SOURCE computers. One block equals 2,048 characters.

Storage Rate for Personal Files		Block equals 2,048 Characters
First 1-10 blocks	=	50¢/block/month
Then: 11-99	=	20¢/block/month
Then: 100-999	=	15¢/block/month
Then: 1,000-9,999	=	10¢/block/month
Then: 10,000-99,999	=	5¢/block/month

Minimums

These are minimum monthly charges for THE SOURCE services.

$1	For account maintenance (2 storage blocks)
$9	Usage. (If you use less than $9 in connect time, you will be billed $9.)
25¢	Minimum connect fee each time you access THE SOURCE.

[illegible]

- Holiday rates are effective New Year's Day, Washington's Birthday, 4th of July, Memorial Day, Labor Day, Thanksgiving Day and Christmas.
- For rates other than continental U.S., contact THE SOURCE. Subscribers are responsible for telephone charges.
- Payments must be in U.S. dollars.
- Connect time charges are calculated as of *your* local time.
- System is down from 4-6AM EST for updating of data base and maintenance.
- Rates are subject to change with 30 days prior written notice.

THE SOURCE EQUIPMENT COMPATIBILITY REQUIREMENTS

PERSONAL COMPUTER	NECESSARY HARDWARE
Apple II Apple II Plus Apple III	Micromodem©, acoustic coupler or direct-connect modem, and communications card. Terminal software recommended.
Atari 400/800	Telelink cartridge. 850 Interface Module and acoustic coupler.
Commodore CBM	IEEE interface and acoustic coupler. Terminal software.
Heath/Zenith	Modem.
IBM Personal Computer	Modem and communications card.
Osborne I	Acoustic coupler with modifying circuit (available from manufacturer or Osborne Dealer). Terminal software recommended.
TI 99/4 and TI/99/4A	RS-232 interface, acoustic coupler, and Terminal Emulator I or II.
TRS-80 Model I	RS-232 board and expansion interface. Modem and cassette software.
TRS-80 Model II	Modem.
TRS-80 Model III	RS-232 board and modem.
VIC (Commodore)	IEEE interface and IEEE PET modem.
Xerox (SAM 820)	Modem and communications software.
Most CPM-based computers	Acoustic coupler or direct-connect modem.

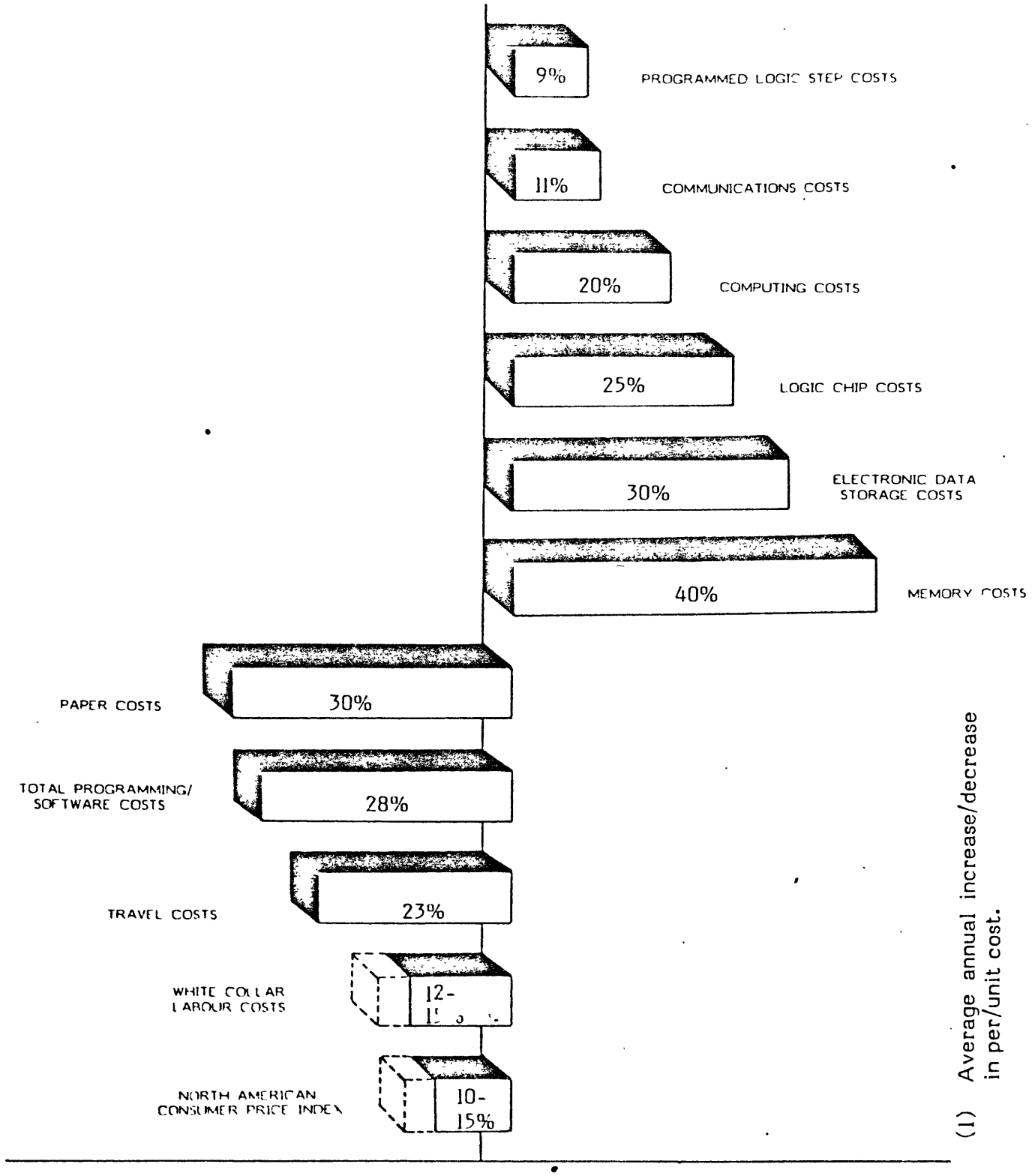
Standard data terminals require only a standard RS-232 interface and a modem.

You also can use THE SOURCE on word/information processing equipment by adding an asynchronous communications package and modem.

Your hardware system must be set up to meet the following technical requirements:

300 or 1200 Baud
Full Duplex
No Parity
8 Bit ASCII Code
1 Stop Bit

OFFICE AUTOMATION COST TRENDS



Source: EDP IN-DEPTH REPORTS, February 1981.

BRITISH USE OF TELETEXT AND VIDEOTEXT

TOTAL WEEKLY USEAGE

Number of times used per week	= 77
Number of different pages accessed	= 29
Average teletext viewing time per week	= 116 minutes

SPREAD OF USEAGE CEEFAX (Teletext)

Weekday	- morning	15%
	- afternoon	23%
	- early evening	71%
	- late evening	52%
Weekend	- morning	26%
	- afternoon	39%
	- early evening	50%
	- late evening	42%

MOST POPULAR TELETEXT PAGES

	% of teletext users watching
News	82
Finance	48
Sport	59
TV Programme Guides	63
Weather/Travel News	48
Food/Farm/Garden	29
Indices	57
For the Deaf	14
Newsflash	54

TELETEXT USER PROFILE

Social Class	% of Population	% of Purchase Users	% of Rental Users
AB	13	53	42
C	22	13	28
C	29	17	19
DE	36	17	11

TELETEXT USER PROFILE

Age	% of Teletext Users
16-24	6
25-34	32
35-44	24
45-54	19
55-64	12
65+	7

USE OF TELETEXT BY FAMILY

	Main User %	Other User %
Husband	66	15
Wife	15	51
Son 15+	11	11
Daughter 15+	3	8
Son 10-15	6	6
Daughter 10-15	1	9
Son/Daughter Under 10	3	14
Other Adult	5	19
Single-self	7	--

OVERALL ASSESSMENT OF TELETEXT

- Extremely useful, couldn't do without it	34%
- Most useful, a good source of information	41%
- Quite useful as a second source to newspaper, TV, and telephone	20%
- Purely a luxury, seldom used	5%

PRESTEL RESIDENTIAL USEAGE

		% of Total Weekly Calls
Weekday	8am - 6pm	50
	6pm - 8am	32
	TOTAL	82
Weekend	Saturday	7
	Sunday	11

PRESTEL RESIDENTIAL USEAGE

Duration (minutes)	% of Calls	Cumulative % of Calls
0-1	19.7	19.7
1-2	26.3	46.0
2-3	6.6	52.6
3-4	4.6	57.2
4-5	5.3	62.5
5-10	13.8	76.3
10-15	6.7	83.0
15-30	14.5	97.5
30+	2.5	100.0

PRESTEL RESIDENTIAL INFORMATION ACCESS

	% of Page Accesses	% of calls accessing information type
Commodity prices	4.8	33.0
Entertainment	25.2	24.3
Travel	7.3	22.3
Sport	5.4	13.6
Market Place	4.3	10.7
Advice	2.4	5.0
Business News	1.8	5.0
News and Weather	0.8	4.0
Country by Country	1.6	3.0
Local	1.2	3.0
Money Advice	1.0	3.0

Source: Videotext, The Software Mystery
MIT Research Program on Communications Policy
January 28, 1982

APPENDIX O

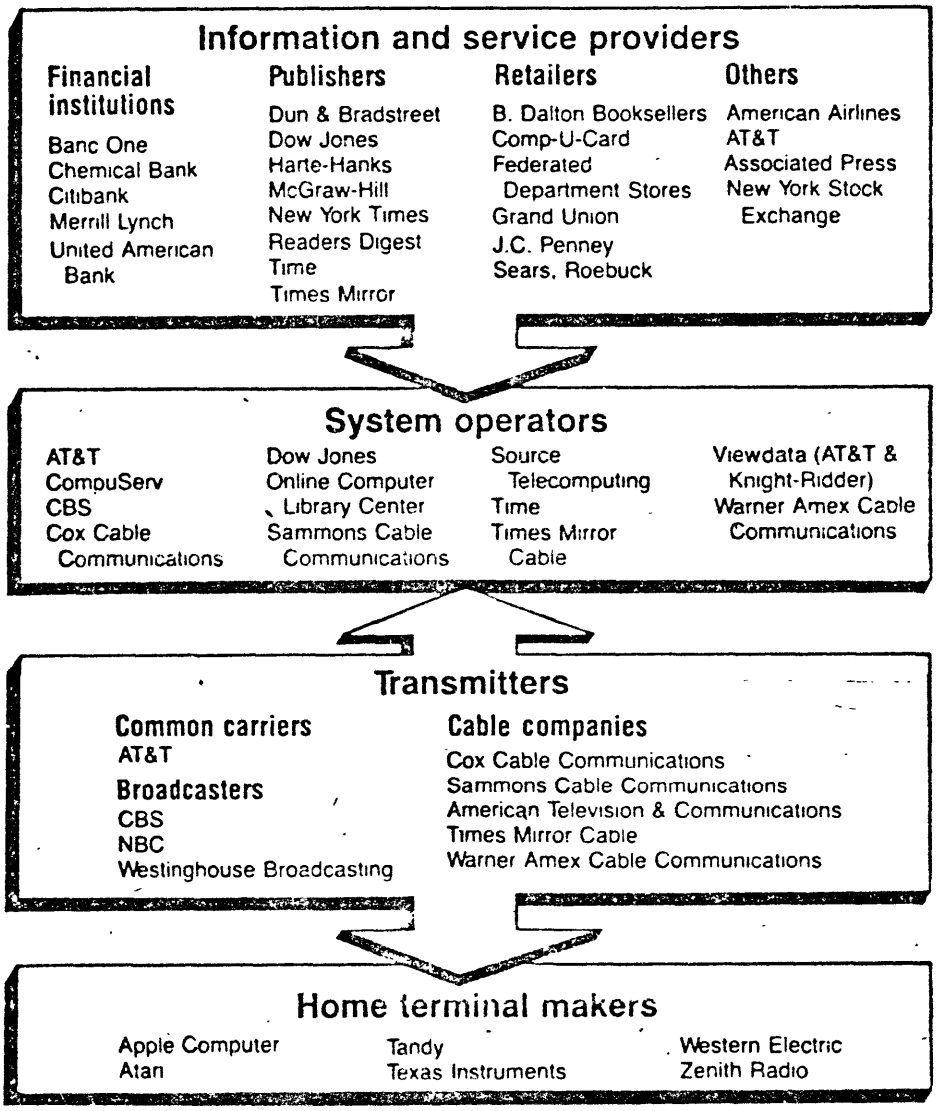
INTERNATIONAL VIDEOTEXT/TELETEXT SUBSCRIBERS

	July 80	Jan. 81	July 81	Feb. 82	
Videotext					
The Source	5,000	7,800	12,000	14,800	
Compuserve	3,035	6,200	11,000	21,000	
Sears/NCI Captioning	20,000	27,000	37,000	50,000	
Dow Jones News		12,000	20,000	35,000	
Prestel (U.K.)	4,354	7,387	10,877	14,000	(12/81)
Teletext					
United Kingdom	80,000	105,000	180,000	300,000	(12/81)
France		1,500	1,500	3,000	
Sweden		20,000	40,000	100,000	
Austria		15,000		105,000	
Germany			6,000	40,000	

Source: International Videtotext
Teletext News

The crowd going after the videotex markets

Major contenders already conducting tests



INFORMATION PROCESSING

BUSINESS WEEK: June 29, 1981 77

APPENDIX Q

FINANCIAL PROFILES OF SEVEN MAJOR COMPETITORS

	Net Sales	% R&D	% Market-ing	Net Income	% Profit	Long-term Debt	Share Equity
Apple							
1977	.8	12.9	25.8	.04	5.2	--	.2
1978	8	7.6	16.6	.8	10.1	--	2.3
1979	48	7.5	8.6	5.0	10.6	.2	9.7
1980	117	6.3	10.3	11.7	10.0	.7	26
1981	335	6.2	13.7	39.4	11.8	1.9*	175*
Tandy (Radio Shack)							
1977	949	NA	8.7	69	7.3	130	164
1978	1,059	NA	9.0	66	6.2	246	139
1979	1,215	NA	9.4	83	6.9	233	208
1980	1,384	NA	9.0	112	8.1	229	283
1981	1,691	NA	8.1	169	10.0	126	572
Commodore							
1977	46	3.0	NA	1.5	3.3	3.8	8
1978	50	4.2	NA	4.0	8.0	5.4	12
1979	71	5.1	NA	6.5	9.2	5.5	21
1980	126	5.2	NA	16.9	13.5	24	36
1981	187	4.5	NA	25.4	13.4	32	62
IBM							
1977	18,133	NA	NA	2,719	15.0	255	12,618
1978	21,076	NA	NA	3,111	14.8	285	13,494
1979	22,863	NA	NA	3,011	13.2	1,589	14,961
1980	26,213	NA	NA	3,562	13.6	2,099	16,453
1981	29,070	NA	NA	3,308	11.4	2,669	18,161

APPENDIX Q (Continued)

	Net Sales	% R&D	% Market-ing	Net Income	% Profit	Long-term Debt	Share Equity
NEC							
1977	2,877	NA	NA	35	1.2	NA	385
1978	3,224	NA	NA	33	1.0	NA	402
1979	3,632	4.5	NA	35	1.0	954	444
1980	3,943	5.1	NA	66	1.7	780	584
1981	4,820	4.8	NA	99	2.1*	848*	782*
Xerox							
1977	5,190	5.2	NA	415	8.0	1,052	2,520
1978	6,018	5.2	NA	489	8.1	938	2,854
1979	6,996	5.4	NA	563	8.1	913	3,221
1980	8,197	5.3	NA	619	7.6	898	3,625
1981	8,691	6.1	NA	598	6.9	870	3,728
Warner Communications							
1977	1,143	NA	NA	71	6.2	262	324
(Atari)	171			(6)	(3.5)		
1978	1,243	NA	NA	87	7.0	256	385
(Atari)	178			(3)	(1.5)		
1979	1,648	NA	NA	201	12.2	242	615
(Atari)	238			6	2.6		
1980	2,059	NA	NA	137	6.6	210	747
(Atari)	513			70	13.7		
1981	3,237	NA	NA	226	7.0	187	1,151
(Atari)	1,227			286[1]	23.3		

All non-ratio figures are in $millions.

* Figures which deviate significantly from the norm.

[1] Atari's net income figures are actually operating margins. Warner historically has had 15% operating margins, and 7% after tax income.

Apple Systems Price Data

Model	Description	Purchase Price $
	APPLE II	
A2S0016	Apple II Computer (w/16KB RAM, typewriter-style kybd w/N-key rollover, ROM-resident Integer BASIC interpreter, monitor, mini assembler & disassembler, & power supply)	1,330
A2S0032	Apple II Computer (same as A2S0016 except w/32KB RAM)	1,430
A2S0048	Apple II Computer (same as A2S0016 except w/48KB RAM)	1,530
	APPLE II PLUS	
A2S1016	Apple II Plus Computer (w/16KB RAM, typewriter-style kybd w/N-key rollover, ROM-resident Applesoft Extended BASIC interpreter, auto-start ROM, disassembler, & power supply)	1,330
A2S1032	Apple II Plus Computer (same as A2S1016 except w/32KB RAM)	1,430
A2S1048	Apple II Plus Computer (same as A2S1016 except w/48KB RAM)	1,530
	APPLE II PLUS	
	Student System (incl Apple II Plus w/32KB RAM & Disk II diskette & interface)	2,075
	Educator System (incl Apple II Plus w/48KB RAM, Disk II diskette & interface, 12-in. video monitor, & Silentype printer)	3,130
	Scientist System (incl Apple II Plus w/48KB RAM, Disk II diskette & interface, Disk II second disk drive, 12-in. video monitor, Silentype printer & Apple II interface, language sys w/Pascal, & Apple FORTRAN)	4,350
	Business Manager System (incl Apple II Plus w/48KB RAM, Disk II diskette & interface, Disk II second disk drive, 12-in. video monitor, Qume Sprint 5/45 printer, Qume forms tractor, high-speed serial interface cd, & The Controller gen bus. software)	7,060
	APPLE II ACCESSORIES	
A2M0003	Disk II Drive	525
A2M0044	Disk II Drive and Interface	645
A2M0005	Video Monitor (9 in)	240
A3M0005	Video Monitor (12 in.)	320
A2M0007	Hand Controller	30
A2M0016	16KB Memory Expansion Module	120
A2M0019	Programmer's Aid Number 1 ROM (for use w/Integer BASIC)	50
A2M0024	Clock/Calendar Card	280
A2M0027	Auto-Start ROM Package (not for Apple II Plus sys)	65
A2M0029	Graphics Tablet	795
A2M0036	Silentype Printer and Apple II Interface	635
A2M0039	Centronics 737 Printer	1,025
A2M0045	Qume Sprint 5/45 Printer	2,995
A2M0047	Qume Forms Tractor	225
	APPLE II INTERFACE CARDS	
A2B0001	Prototyping/Hobby Interface Card	24
A2B0002	Parallel Printer Interface Card	180
A2B0003	Communications Card and DB25 Connector Cable	225
A2B0005	High-Speed Serial Interface Card	195
A2B0006	Language System with Apple Pascal	495
A2B0007	Centronics Printer Interface Card	225
A2B0009	Applesoft II Firmware Card (incl auto-start ROM)	200
A2B0010	Integer BASIC Firmware Card (incl Monitor & prog aid ROMs)	200
	APPLE II SOFTWARE	
	Languages, Operating Systems, and Utilities	
A2D0010	Disk Utility Pack with DOS	25
A2D0023	DOS	60
A2D0028	Apple PILOT	150
A2D0029	DOS Tool Kit	75
A2B0005	Language System with Apple Pascal	495
A2D0032	Apple FORTRAN (req A2B0006)	200
	Applications	
A2D0007	Dow Jones Portfolio Evaluator	50
A2D0012	The Controller General Business System	625
A2D0013	Apple Post	50
A2D0014	The Shell Games-Education	30
A2D0015	Elementary, My Dear Apple-Education II	30
A2D0025	The Apple Cashier Retail Store Management	250
A2D0026	Apple Writer	75
A2D0029	DOS Tool Kit	75

Model	Description	Purchase Price $
A2D0030	Dow Jones News and Quotes Reporter	95
A2D0033	Apple Plot	70
A2D0040	Tax Planner	120
	APPLE III	
A3P0101	Apple III Option A (incl Apple III w/128KB RAM, built-in disk drive, sculptured typewriter-style kybd w/auto-repeat keys, built-in num pad, Sophisticated Operating System [SOS], built-in modem & printer interfaces, 12-in. video monitor w/u/lc display, & Information Analyst Package, incl SOS, Visicalc III, & Apple III Business BASIC)	4,740
A3P0102	Apple III Option B (same as A3P0101 except w/Apple III Disk II)	5,285
A3P0103	Apple III Option C (same as A3P0101 except w/Apple III Disk II & Silentype thermal printer)	5,810
	APPLE III ACCESSORIES	
A3M0001	Silentype Thermal Printer III	525
A3M0003	Apple III Disk II	545
A3M0005	Video Monitor (12 in.)	320
	APPLE III INTERFACE CARDS	
A3B0001	Apple III OEM Prototyping Card	45

Source: Auerbach Publishers, Datapro Research, 1982.

Radio Shack TRS-80 Price Data

Model	Description	Purchase Price $
	TRS-80 POCKET COMPUTER	
26-3501	Pocket Computer (incl two 4-bit CMOS microproc w/1 9KB total RAM & 7KB BASIC interpreter, 4KB monitor ROM, 57-key A/N kybd, 24-char. 7-x-5 dot matrix LCD w/manual playback & 80-char. input buffer, batteries, & manual)	249
-3503	Cassette Interface	49
14-1812	Minisette-9 Cassette Recorder	80
	TRS-80 POCKET COMPUTER SOFTWARE	
26-3510	Real Estate	25
-3511	Civil Engineering	25
-3513	Aviation	25
-3514	Math Drill	15
-3516	Statistics for Business, Marketing, and Sales	20
-3517	Business Financial	20
-3518	Personal Finance	20
	TRS-80 COLOR COMPUTER	
26-3001	Color Computer (incl 6809E 8-bit microproc w/4KB dynamic RAM & 8KB ROM; 53-key kybd; VDU w/16 lines × 32 uc char. & color graphics capabilities of 32 × 64 w/8 colors, 196 × 256 w/1 color, & 3 intermediate formats w/background color; RS-232C serial I/O port; memory expandable to 16KB; opt. 1,500-baud I/O cassette recorder; can function as a term. w/ VIDEOTEX Software; w/o color vid receiver)	399
-3002	Color Computer (same as 26-3001 except w/16KB RAM & extended BASIC)	599
-3015	16KB Memory Conversion	119
-3018	Extended BASIC Add-On	99
-3010	TRS-80 Color Video Receiver	399
-3008	Joystick Controls (2-dimensional; 2)	25
-1155	Quick Printer II (120 lpm; 32 cpl)	219
-1167	Line Printer VII	399
-1172	Modem I	149
-3014	RS-232C Connecting Cable	20
-1206	CTR-80A Cassette Recorder	60
	TRS-80 COLOR COMPUTER SOFTWARE	
26-3018	Extended Color Computer BASIC ROM (w/manual; installation extra)	99
-3019	Diagnostic ROM	30
	TRS-80 MODEL I MICROCOMPUTER	
26-1051	Level I Starter System (incl Z-80 8-bit microproc w/4KB RAM [expandable to 32KB] & 4KB ROM, cassette recorder w/interface, & 53-key integrated kybd)	499
-1056	Level II System (same as 26-1051 except w/16KB RAM, Level II BASIC, & kybd unit incl built-in 12-key num data pad)	849
-1101	16KB RAM and Keypad	200
-1102	16KB RAM Expansion Interface Memory Kit	119
-1103	Keypad	79
-1104	Lowercase Kit	59
-1120	Level I to Level II ROM Upgrade	150
-1140	Expansion Interface (w/o memory upgrade)	299
-1141	Expansion Interface (w/16KB RAM)	429
-1142	Expansion Interface (w/32KB RAM)	559
-1145	RS-232C Interface Board	99
-1146	Communications Software (3 prog that put TRS-80 in transmit, host, & term. modes)	30
-1147	RS Terminal (dumb term. prog w/printer support)	10
-1160	Mini Disk Drive (1st)	499
-1161	Mini Disk Drive (2nd, 3rd, or 4th)	499
-310	TRSDOS/Disk BASIC	15
-1171	Telephone Interface II	199
-1172	Direct-Connect Modem	149
-1180	TRS-80 Voice Synthesizer	399
-1181	TRS-80 VOXBOX	170
-1182	Plug'n Power Controller	40
-1451	Power Line Filter	49

Model	Description	Purchase Price $
	TRS-80 MODEL III DESKTOP COMPUTER	
26-1061	Desktop Computer (incl Z-80 microproc w/4KB RAM expandable to 48KB, parallel printer interface, 65-key kybd w/12-key data pad, Level I BASIC in 14KB ROM, expansion interface, monitor, bus, & software compat w/Model I)	699
	Starter System (same as 26-1061 except packaged sys w/120-lpm printer & cassette recorder)	998
26-1062	Desktop Computer (same as 26-1061 except w/16KB RAM & Model III BASIC)	999
	Engineer System (same as 26-1062 except packaged sys w/100-cps printer & cassette recorder)	1,887
26-1063	Desktop Business Computer (same as 26-1061 except w/32KB RAM, 12-in. VDU w/u/lc char., dbl-density disk storage units w/178KB memory storage ea, parallel printer port, & RS-232C serial comm interface, incl prog manual)	2,495
	Word Processing System (packaged sys same as 26-1063 except also incl Scripsit WP software & 50-cps dot matrix printer)	3,623
	Business System (same as 26-1063 except also incl 100-cps line printer, sys desk, & printer stand)	3,972
-1102	16KB RAM Kit	119
-1121	Model III BASIC and 16KB RAM Kit	299
-1148	RS-232C Interface Board (incl cable)	99
-1408	Model III RS-232C Cable	20
-1162	Disk Drive Kit 1 (incl TRSDOS & disk BASIC, installation not incl)	849
-1163	Disk Drive Kit 2 (installation not incl)	399
-1164	External Disk Drive (3rd)	499
-1161	External Disk Drive (4th)	499
-312	DOS Diskette	15
-1206	CTR-80 Cassette Recorder (w/cable)	60
	TRS-80 MODEL I AND MODEL III SOFTWARE	
	Languages	
26-2002	Tape Editor/Assembler (16KB Level II; Model I only)	30
-2009	Tiny Pascal Tape (16KB Level II)	20
-2201	FORTRAN (32KB, 2 disks)	100
-2202	Macro Editor/Assembler (32KB, 2 disks)	100
-2203	COBOL (48KB, 2 disks)	199
-2204	Compiler BASIC (48KB, 2 disks)	149
	Utilities	
26-1704	Double Precision Subroutines (16KB, Level II or Model III BASIC)	10
-2001	T-Bug (4KB, Level I or 16KB, Level II; Model I only)	15
-2004	Renumber (16KB, Level II; Model I only)	10
-2008	Cross Reference Utility (16KB, Level II; Model I only)	15
	Business Management Software	
26-1566	Visicalc (32KB, 1 disk; for Model I)	100
-1567	Visicalc (32KB, 1 disk; for Model III)	100
-1562	Profile (32KB, 1 disk)	80
-1565	Microfiles (32KB, 1 disk)	100
-1705	Advanced Statistical Analysis (16KB, Level II; Model III BASIC; 32KB, 1 disk)	40
-1604	Versafile (32KB, 1 disk)	30
-1563	Scripsit (disk-based wd proc, 32KB, 1 disk)	100
-1505	Scripsit (cassette-based WP; 16KB, Level II or Model III BASIC)	70
-1564	Mailgram (16KB, Level II or Model III BASIC; req RS-232C coupler)	40
	Disk-Based Business Applications Software	
26-1551	Disk Mailing List (32KB, 1 disk; Model I only)	40
-1552	General Ledger (32KB, 2 disks)	100
-1553	Inventory Control (32KB, 2 disks)	100
-1554	Accounts Payable (32KB, 2 disks)	150
-1555	Accounts Receivable (32KB, 2 disks)	150
-1556	Disk Payroll (32KB, 2 disks)	200
-1557	Concrete Take-Off (32KB, 2 disks)	200
-1558	Business Mailing List (32KB, 2 disks)	100
-1559	Manufacturing Inventory Control (32KB, 2 disks)	200
-1560	Fixed Asset Accounting (32KB, 2 disks)	80
	Cassette-Based Business Applications Software	
26-1501	Level I Payroll (4KB)	20
-1503	Cassette Mailing List (16KB, Level II or Model III BASIC)	20
-1504	Level II Cassette Payroll (16KB, Level II or Model III BASIC)	50
-1508	In-Memory Information (16KB, Level II or Model III BASIC)	20
-1571/ 2/3/4	Real Estate I/II/III/IV (16KB, Level II or Model III BASIC)	30
-1577	Surveying (16KB, Level II or Model III BASIC)	50

Model	Description	Purchase Price $
	Personal Applications Software	
26-1506	Cassette Portfolio (16KB, Level II)	30
-1507	Standard and Poor's STOCKPAK System (32KB, 2 disks)	50
-1602	Personal Finance Level I (4KB, Level I)	15
-1603	Budget Management (16KB, Level II; 32KB [on 2 disks], Model III BASIC)	20
-1703	Statistical Analysis Level I (4KB)	30
-1509	Trendex Stock Package	50
	Educational Software	
26-1715	K–8 Math Program — Volume I (incl reporting function, teacher's manual, & 10 prog on both cassette & diskette, 16KB, Level II Model I or Model III w/Model III BASIC)	199
-1718	AlphaKey (incl both cassette & diskette; 16KB, Level II Model I or Model III w/Model III BASIC)	30
-1714	Advanced Graphics (16KB, Level II Model I or Model III w/Model III BASIC, incl 1 cassette & 1 diskette)	30
-1211	Network II Controller (controls up to 16 TRS-80s; 16KB, Level II Model I or Model III w/Model III BASIC)	499
-2150	Introduction to BASIC — Part 1 (incl teacher's manual, 143 transparencies, & 25 student workbooks)	159
-2151	Additional Workbooks (set of 25)	65
-2152	BASIC Programming — Part 2 (incl teacher's manual, 164 transparencies, & 25 student workbooks)	199
-2153	Additional Workbooks (set of 25)	99
-1708	TRS-80 Hands-On Basic Computer Literacy Package (incl Student Guides, Algebra I, Program World, Level II BASIC Course, Part I, & Teacher Aide)	100
-1716	Essential Math — Volume One (16KB, Level II Model I or Model III; incl prog on both cassette & diskette)	199
-1719	Geometry Tutor (16KB; volume 1; for Model III/Model I Level II)	40
-1720	Vector Addition (16KB, Level II Model I or Model III; manual incl problem section, programmer's guide, & user's guide)	30
-1721	Interpreting Graphs in Physics: Position and Velocity versus Time (16KB, Level II Model I or Model III; manual incl problem section, programmer's guide, & user's guide)	30
-1722	Graphical Analysis of Experimental Data (16KB, Level II Model I or Model III; manual incl problem section, programmer's guide, & user's guide)	30
-2162	K–8 Math Worksheet Generator (32KB, Model I or Model III disk sys)	90
-2205	TRS-80 PILOT PLUS (32KB, Model I disk sys; incl user's manual, sample lessons, & reference section)	50
-1725	K–8 Math Program with Student Management (incl 26-1715 plus student management, 32KB, Model I or Model III disk sys)	199
-1728	Quick Quiz (32KB; testing sys for Model I/Model III disk)	30
-3201	Color Math	40
	Personal Educational Software	
26-1706	I.Q. Builder (8 tapes w/38 prog; 4KB, Level I or 16KB, Level II)	30
-1712	Show and Spell (16KB, Level II)	30
-1701	Math I (4KB, Level I)	20
-1702	Algebra I (4KB, Level I)	20
-2003	Level I BASIC Course (4KB, Level I)	13
-2005	Level II BASIC Course — Part I (16KB, Level II)	15
-2006	Level II BASIC Course — Part II (16KB, Level II)	20
-2007	Disk BASIC Instruction (16KB, disk)	30
-2010	Model III Disk Course	30
	TRS-80 MODEL II BUSINESS COMPUTER	
26-4001	Business Computer (incl Z-80A 8-bit microproc w/32KB RAM expandable to 64KB, bootstrap ROM, dual-density disk drive, 1 Centronics parallel & 2 RS-232C serial ports, 76-key kybd w/data entry keypad, VDU w/24 × 80 char., Model II Interpreter BASIC & TRSDOS software, power supply, & reference manual)	3,450
-4002	Business Computer (same as 26-4001 except w/64KB RAM)	3,899
	Starter System (same as 26-4002 except packaged sys w/100-cps line printer)	4,727
	Basic Business System (same as 26-4002 except packaged sys w/100-cps line printer & sys desk)	5,467
	Word Processing System (same as 26-4002 except also incl 43-cps printer & SCRIPSIT WP software)	6,197
	Deluxe Business System (same as 26-4002 except also incl 120-cps printer, sys desk, & 1MB 2-drive external disk subsys)	7,917
	Business Management System (same as 26-4002 except also incl 120-cps printer w/stand, 1.5MB 3-drive external disk subsys, & sys desk)	8,666
-4102	32KB Memory Add-On	449
-4160	1-Drive Disk Storage Expansion Unit	1,150
-4161	2-Drive Disk Storage Expansion Unit	1,750
-4162	3-Drive Disk Storage Expansion Unit	2,350
-4163	Disk Drive Kit (drive only)	600
-4301	Model II System Desk	369
-4302	Model II Printer Stand	149
-4403	Model II RS-232C Cable	40

Model	Description	Purchase Price $
	TRS-80 MODEL II SOFTWARE	
	Optional Languages	
26-4701	FORTRAN	299
-4702	Editor/Assembler	199
-4703	COBOL	299
-4704	COBOL Run-Time Package	40
-4705	Compiler BASIC	199
-4706	Compiler BASIC Run-Time Package	30
-4710	Program Editor	79
	Application Programs	
26-4501	General Ledger	199
-4502	Inventory Management	199
-4503	Payroll	399
-4504	Accounts Receivable	299
-4505	Accounts Payable	299
-4507	Mailing List II System	119
-4510	Versafile	69
-4511	Visicalc	299
-4512	Profile II	179
-4530	Model II SCRIPSIT	299
-4554	Accounts Receivable, Series I	199
-4601	3-Disk General Ledger	499
-4604	3-Disk Accounts Receivable	499
-4605	3-Disk Accounts Payable	499
	TRS-80 PERIPHERALS AND ACCESSORIES	
26-1154	Line Printer II (100 cps; 10/5 cpi, 80/132 PP; 7-x-7 dot matrix, u/lc char.)	799
-1155	Quick Printer II (120 lpm, software-selectable 32/16 cpi; 18/9 cpi)	219
-1158	Daisy-Wheel Printer II (43 cps; 136 PP, 10 cpi)	1,960
-1159	Line Printer IV (50 cps; 10/16.7 cpi)	999
-1165	Line Printer V (160 cps; 7.5/15 cpi)	1,860
-1166	Line Printer VI (100 cps; 132 PP; 10 cpi w/5, 7.5, 15 cpi opt.; bidirectional 7-x-9 dot matrix in 4 u/lc print size char.)	1,160
-1190	Plotter/Printer (5 lpm; 75 PP; 9 cpi; bidirectional feed under software control)	1,460
-1301	Model I System Desk	199
-1303	Auxiliary Fan Kit for Model I Disk Bay	29
-1304	Model I Space Saver Desk	56
-1305	Model III System Desk	179
-1306	Model III Expansion Bay	29
-1307	Space Saver Desk	65
-1308	Universal Printer Stand	99

Source: Auervach Publishers, Datapro Research, 1982.

Product	Description		Retail
COMMODORE PERSONAL COMPUTER RANGE — VIC Series			
VIC 20	Full-Featured, expandable color computer system. 5K RAM. Including RF Modulator & TV switch box.		$ 299.95
C2N DATASETTE RECORDER	Cassette storage for PET/CBM/VIC		75.00
VIC 1515 GRAPHIC PRINTER	VIC dot-matrix printer, 30 CPS, 8" paper; prints full VIC character set; tractor feed.		395.00
COMMODORE EDUCATIONAL/SCIENTIFIC COMPUTER RANGE — 4000 Series			
PET®	System with graphic keyboard and numeric keypad. 12" display/40 characters. — 16K RAM	4016N 4032N	995.00 1295.00
COMMODORE BUSINESS COMPUTER RANGE — 8000 Series			
CBM™ 8032B	Typewriter-style keyboard, numeric keypad, 80 column x 25 line display. 32K RAM, BASIC 4.0.		1495.00
CBM 64K MEMORY EXPANSION BOARD	64K Add On-Memory. Expands CBM 8032 to 96K RAM.		500.00
COMMODORE ADVANCED COMPUTER RANGE — 9000 Series			
SuperPET COMPUTER SP9000	Enhanced 8032 with additional 6809 microprocessor, total 134K memory including 96K RAM includes Waterloo microBASIC, Waterloo microAPL, Waterloo microPascal, Waterloo microFORTRAN and Waterloo 6809 Assembler interpreters.		1995.00
COMMODORE PERIPHERALS			
DISK DRIVES			
CBM 2031 SINGLE DISK	Single drive intelligent 5¼" floppy disk system. 170K (DOS 2.6)		695.00
CBM 4040 DUAL DISK	Dual drive intelligent 5¼" mini-floppy disk system. 340K (DOS 2.1)		1295.00
CBM 8050 DUAL DISK	Dual drive intelligent 5¼" mini-floppy disk system. 1 Megabyte (DOS 2.5)		1795.00
PRINTERS			
CBM 4022 PRINTER	80 Column printer with tractor feed Prints full PET graphics, variable line spacing, and programmable characters.		795.00
CBM 8023P PRINTER	136 Column, Dot-Matrix 150 CPS, bi-directional, graphics		995.00
CBM 8300P PRINTER	Letter quality, daisy wheel printer, 40 CPS, IEEE interface		2250.00
ADDITIONAL PERIPHERALS			
CBM 8010 MODEM	High performance 300 BAUD IEEE interfaced modem.		280.00
CBM 4010 VOICE SYNTHESIZER	Features phoneme syntheses for vocabulary construction. User port interface.		395.00

Product	Description	Retail
CABLES		
IEEE-IEEE	Designed to connect more than one peripheral to any PET/CBM computer.	$ 49.95
PET-IEEE	Use for connecting one peripheral to any PET/CBM computer.	39.95
PET/CBM SOFTWARE		
For a comprehensive list of all software available for PET/CBM computers, please refer to the Commodore Software Encyclopedia.		
SOFTWARE ENCYCLOPEDIA		4.95

SOME SUGGESTED SYSTEMS

Personal System	
VIC 20 Computer	$ 299.95
C2N Datasette Recorder	75.00
VIC 1515 Graphic Printer	395.00
	769.95

Educational System	
CBM 4016 Computer (PET)	995.00
CBM 2031 Single Disk Drive	695.00
CBM 4022 Dot-Matrix Printer	795.00
	2485.00

Economy Business/Word Processing System (4000 Series)	
CBM 4032 Computer (PET)	1295.00
CBM 4040 Dual Disk Drive	1295.00
CBM 4022 Dot-Matrix Printer	795.00
	3385.00

Advanced Business System (8000 Series)	
CBM 8032 Computer	1495.00
CBM 8050 Dual Disk Drive	1795.00
CBM 8023P Dot-Matrix Printer	995.00
	4285.00

Advanced Word Processing/Business System	
CBM 8032 Computer	1495.00
CBM 4040 Dual Disk Drive	1295.00
CBM 8300P Letter Quality Printer	2250.00
	5040.00

Source: Commodore

IBM CORP

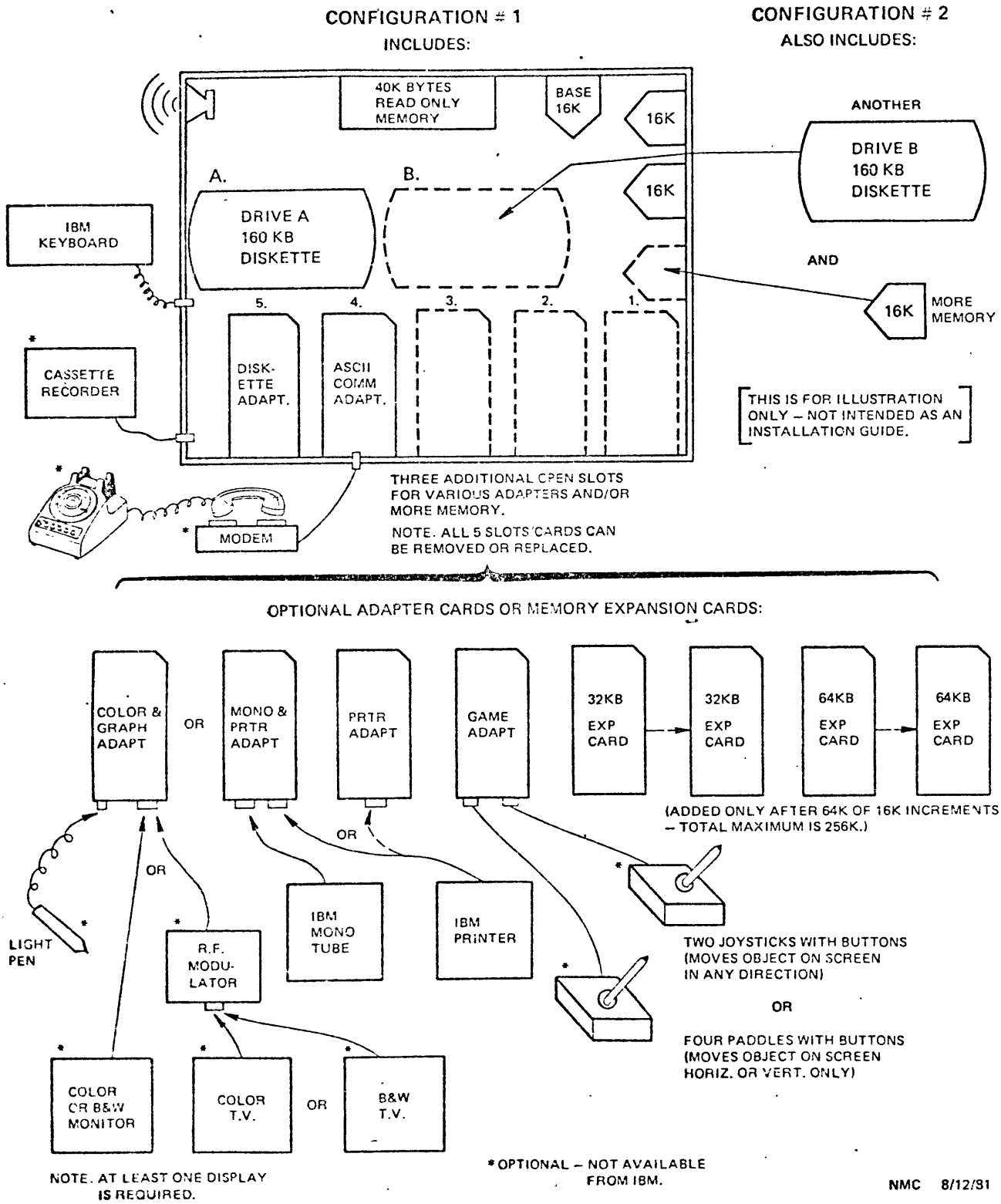
Personal Computer Price Data

Model	Description	Purchase Price $	Annual Option $/Yr	Warranty Extension Option $/Yr
	SYSTEMS			
813	Basic System (incl sys unit/kybd, 40KB ROM, 48KB user memory, prgmbl speaker, cassette attach. jack, 5-1/4-in. diskette drive adapter, 5-1/4-inch 160KB diskette drive, & async comm adapter)	2,385	204	161
824	Same as 813 except w/64KB user memory & two 5-1/4-in., 160KB diskette drives	3,045	274	216
	Memory Expansion			
	Memory Expansion Kit (16KB)	90	8	6
	Memory Expansion Option (32KB)	325	41	32
	Memory Expansion Option (64KB)	540	122	96
	PERIPHERALS			
	Terminals			
5151-001	Monochrome Display	345	67	53
	Keyboard	270	—	—
	Color/Graphics Monitor Adapter	300	41	33
	Monochrome Display and Printer Adapter	335	20	16
	Printer			
5152-001	Matrix Printer (80 cps)	755	179	141
	Printer Adapter	150	2	2
	Diskette Drive			
	Diskette Drive (5-1/4 in., 160KB)	570	62	49
	Diskette Drive Adapter (5-1/4 in.)	220	6	5
	DATA COMMUNICATIONS			
	Asynchronous Communications Adapter	150	8	7
	SOFTWARE			
	Diskette Software (DOS)	40		
	Pascal Compiler	300		
	Asynchronous Communications Support	40		
	VisiCalc	200		
	EasyWriter	175		
	General Ledger	595		
	Accounts Receivable	595		
	Accounts Payable	595		
	Microsoft Adventure	30		
	Advanced Diagnostics	155		

Note:
— Not available

Source: Auerbach Publishers, Datapro Research, 1982.

IBM PERSONAL COMPUTER
STANDARD CONFIGURATIONS



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