SELECTION CRITERIA FOR A SMALL BUSINESS COMPUTER

By

Nonie Diegmann

Computer Science

Submitted in Partial Fulfillment of the Requirements of the

University Undergraduate Fellows Program

1977 - 1978

Approved by:

Dr. Dan Colunga

April 1978

ABSTRACT

This paper evaluates some of the selection criteria of a small business computer cited in current literature and expressed by several small businessmen. The first part of the paper discusses the small businessman's and the computer salesman's point of view concerning the selection of a small business computer. The second part of the paper discusses four selection criteria in detail and then mentions six more. This paper does not, by any means, completely cover this topic because, with all of the differing opinions on which criteria is the most important and the many different types of small businesses that the small business computer must be configured to, it would take volumes of papers to completely cover this topic.

However, by discussing the process of comparing three specific systems, as is done in this paper, the small businessman can get a concrete idea of how to select his own small business computer.

ACKNOWLEDGEMENTS

CONTENTS

FIGURES

SELECTION CRITERIA FOR A SMALL BUSINESS COMPUTER

INTRODUCTION

There was a time when the small business owner did not have to think about a computer. Computers were too big, too complex, too expensive. Computers were for large companies.

But times have changed. Technological advances have come about so rapidly in the last few years, along with lower prices, that many small companies have moved from manual bookkeeping systems to the small business computer (See Figure 1). From a handful of small system manufacturers, such as NCR and Burroughs, just a few years ago, there are now dozens on the market. These include both the large computer manufacturers, such as IBM, Honeywell, and Univac, and the minicomputer manufacturers, such as Digital Equipment Corporation, Harris and Hewlett-Packard. With all of this competition among computer vendors, one can imagine how confusing and difficult it can be for a small businessman, with little or no data processing knowledge, to go out and select the right computer for his small business.

Before delving into this research topic, two terms had to be defined. The first term was small business. A small business was defined as one with less than two hundred employees and with a management structure in which only one or two top people make all or most of the decisions for the company.

The other term which had to be defined was small business computer. A small business computer is an office machine that processes data
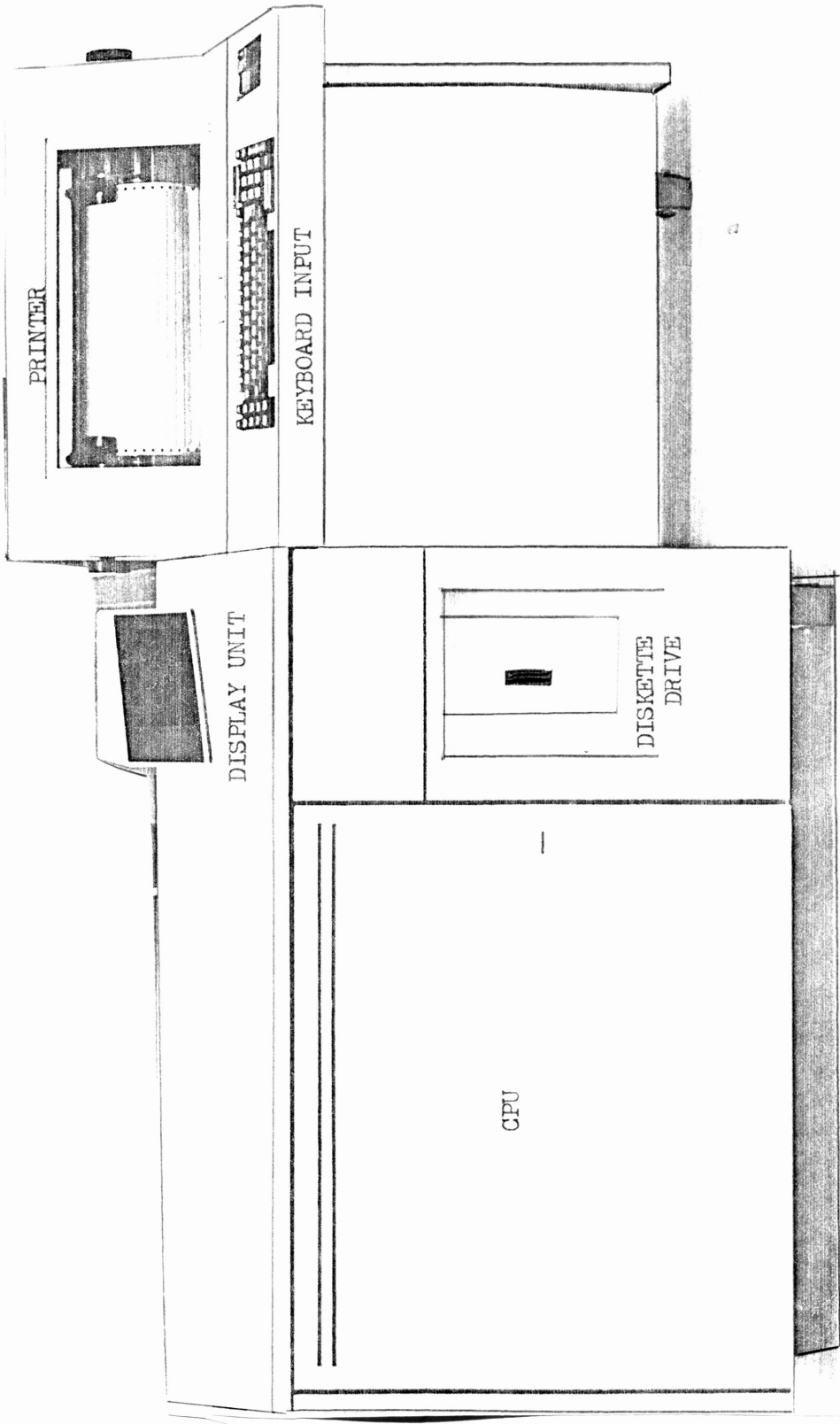
Figure 1. A Typical Small Business Computer

PRINTER

KEYBOARD INPUT

DISPLAY UNIT

DISKETTE DRIVE

CPU

entered by the user and produces calculations and reports as directed by its stored program of instructions and the user's commands. Generally speaking, the small business computer is a large business computer scaled down. Its memory size can range from 16K to 32K bytes for the basic system. The basic system is the smallest size of that model system. Another guideline used in looking at a small business computer was that it be able to support business applications such as accounts receivable, general ledger, and inventory control. And lastly, the small business computer would cost in the price range of $5,000-$100,000.

THE FIRST SEMESTER RESEARCH

The Small Businessman

After deciding on the basic guidelines, the next task was to find out the small businessman's experience and opinion of the small business computer. Therefore, I interviewed several small businessmen in Galveston and Bryan who owned small business computers. Following is the list of questions which guided me as I talked with these men:

1) How many employees does your company have?

2) What is your gross sales per year?

3) What is your growth rate per year?

4) How long have you had your computer?

5) What made you decide to look at a small business computer?

6) To what computer vendor did you first go to?

7) Who was involved in the selection process?

8) How long did it take you to make the selection?

9) Did you buy or lease the computer?

10) How did you "size" the computer to fit your needs?

11) What business applications did you originally want put on your computer?

12) What business applications do you have on your computer now?

13) When you switched from the manual system to the small business computer, what problems did you incur?

14) Is all of the computer hardware from the same computer vendor?

15) How would you rate your maintenance?

16) What is the cost of your computer?

17) What is management's general opinion of the investment that they have made in the computer?

18) Do you have any future plans for your computer?

19) Do you have any suggestions or advice for a small business that is about to go from a manual system to a small business computer?

Most of these small businesses had had their computers for one to two years. They had decided to get one because of the growth rate of their company. The work was getting too tedious and timeconsuming so, either they had to hire more people or turn to the computer. After deciding to acquire a computer, some of these small businessmen shopped around for the computer, while others had no question as to whom they would lease or buy their computer from. Once they received their computer, all were pleased with the maintenance they were receiving from their vendor. Overall, management was pleased with their investment, but there were a few businesses whose management was wary of the computer because they did not understand it. They wanted instant results when they made a change to a report. However, they have now realized that this cannot be so.

One of the small businessmen gave an example of how the computer had helped him in his business. He said it usually takes one person

two working days to do a certain business report, while it took the computer only five hours. Using the computer had thus saved time and left that clerk to do other things.

Most of the businessmen said that the people who worked directly with the computer liked it, once they got used to it. In general, there was a favorable opinion of the small business computer by all of the small businessmen. Some of the suggestions made by the businessmen were:

1) If you have a lot of inventory to keep track of, get a small computer.

2) Know the basic reports you want from the computer.

3) Have a system in mind before you start looking at small business computers.

4) Lease the small business computer.

The Computer Salesman

Next, to see the interaction between the small businessman and the computer salesman, I talked with three different computer salesmen. Each one described his own approach to selling a computer. An example of one of the approaches is given below:

1) He goes in and talks with the boss of the small business to find out what the boss wants and why he wants to computerize. This salesman does this because most people that get in touch with a computer salesman have a preconceived idea of what they want and they feel that they already have the solution. Usually, they have seen another company's computer operations and they want a perfect solution to all their problems.

2) This salesman then goes in and talks to the line people, watches them work, and sees what needs to be done there. He then compares this with the boss's conception of what the small business needs.

3) This salesman then goes back to the boss and points out one or two major applications (ones that take the most time) that can be computerized. He wants to show the customer that he cannot push a button and

get a perfect solution for every application. If the small businessman did buy a small business computer that solved all his problems, then it would be out of his price range.

4) After these three salesman calls, this salesman determines the purchasing power of the customer. If it is good, he then stays on the account. If it is not good, he drops it. Up until this time, he does not mention hardware because he wants the customer to understand the applications and computing.

5) If he did not drop the account, then this salesman starts fitting hardware to what the small businessman needs. If a customer cannot decide between two types of peripherals for his small business computer, then this salesman will usually set up a demonstration so that the business can decide which peripheral device is easier for them to use.

6) This salesman then submits a written proposal, for purchase or lease of a computer, to the small businessman.

7) The small businessman accepts or rejects it.

This is only one approach to selling a small business computer. The other salesmen had somewhat similar approaches with a few variations. This example was to show the way a small businessman, who is selecting a small business computer, is approached by a computer vendor. This can make a big difference, since the computer vendor can have much influence on what computer the small businessman finally selects.

All of the above research was done the first semester. The idea behind it was to see the small businessman's problems in trying to select a computer right for his business needs. The second semester of research involved comparing three small business computers. By doing this, the selection criteria for a small business computer can better be understood.

THE SECOND SEMESTER RESEARCH

Location

The first selection criteria to be talked about is location. This criteria is important because the location of a small business will help to determine which computer vendor will be selected. The company should be near a computer's service office so that when the computer goes down, prompt service can be guaranteed. If the computer goes down in the middle of a payroll run when the payroll goes out the next day, the small businessman wants to be sure that a computer serviceman is reachable and can be there as soon as possible to get the system running again. Or in any case - service to the computer is a necessity. Therefore, the small business must be located near a computer service office. This is why the three systems below were chosen. All three of them have offices in Bryan. The three specific model systems looked at are:

1) Burroughs 731

2) IBM System/32

3) NCR Century 8200

These certain three systems were chosen because these were the ones I was able to run programs on.

Cost

Another important selection criteria, if not the most important to the small businessman, is the total cost of the small business computer. The basic system itself is only part of the cost. The small businessman must also consider the software needed for the computer. Usually, some system software is included in the cost of the basic system. However, the small businessman may want to add other "housekeeping" routines to

his system software so that the computer will run more efficiently. Also, the small businessman must include the cost of the applications programs, which will be run in order to get the reports he needs. He may either hire a contract programmer, who may charge $15 to $25 per hour to write the programs, or else he must buy general application programs from a computer vendor or software house. The small businessman must be aware that software can become a very expensive item.

The maintenance for the computer costs separately, if the system is purchased. If leased, it is usually included in the lease price. And, as mentioned before, maintenance and service are a "must" for the small business computer. Insurance is also a separate cost for a purchased system. Again, if leased, the insurance cost is usually included in the lease price.

Any special improvements made to the office for the computer must also be included in the total cost of the computer. An example of special improvements to the office may be a special electrical outlet for the computer or more air conditioning to accomodate the computer.

All of the above factors must be taken into consideration when figuring the cost of the computer. This can be seen in Figure 2. The basic system cost of each of the three computers is listed and what each includes at that cost. The second cost given for each system is the amount paid by each owner of that system as he has it configured. This shows how the cost of buying a small business computer can really jump as more things are added to it. With the small businessman being on a limited budget, he must consider the total cost of a computer before he signs his name to any purchase contract.

	IBM SYSTEM/32	NCR 8200	BURROUGHS 731
BASIC SYSTEM COST	$33,560	$33,420	$30,400
INCLUDES	CPU (16K) FLOPPY DISK DRIVE NON REMOVABLE DISK KEY BOARD SERIAL PRINTER LINE PRINTER CRT DISPLAY	CPU (32K) FLOPPY DISK DRIVE KEY BOARD CRT CASSETTE TAPE DRIVE	CPU (32K) KEY BOARD SERIAL PRINTER
SYSTEM COST	$61,000	$30,000-$35,000 app.	$40,000
INCLUDES	CPU (>16K) FLOPPY DISK DRIVE NON REMOVABLE DISK KEY BOARD LINE PRINTER REMOVABLE DISK CRT DISPLAY	CPU DISK DRIVE KEYBOARD 2 CRT'S CASSETTE TAPE DRIVE	CPU (32K) KEYBOARD LINE PRINTER 96-COLUMN CARD PUNCH 2 REMOVABLE DISK CASSETTE UNIT 2 AUDIT ENTRIES

Figure 2. Costs of Compared Systems

Performance of the Small Business Computer

Another very important criteria in the selection of a small business computer is the performance of the system. To compare each of the three systems, three programs were run on each computer and timed from the initial input until the completion of the printed output. These timings were to be used only as a benchmark (a reference point), not to compare actual performance of the computers. Nonetheless, these timings are how the small businessman views the performance of the computer. He is not worried about what happens inside the machine. He only cares about how fast and accurate the computer can output the results.

The three programs used were designed to be short and simple, and yet to try to somewhat simulate what the computer does when a business application program is run. The reason for the programs' simplicity was so that they could be easily run on each system. They had to be short so that it would not take long to run the programs, since they had to be run on the small business computer during business hours.

The first program run on each system was the Calculations Program. It is shown in Figure 3a. and 3b. The COBOL program was run on the NCR and Burroughs computers, while the RPG II program was run on the IBM computer. The IBM System/32 does does not support the language COBOL. Therefore, there was no choice, but to run the program in two different languages. However, both programs do the exact same thing. They read in a number (20 in this case) and go through the calculation loop twenty times. There is no printed output, except for the listing of the program. The reason for this program was to see how fast each computer did calculations with no printed output. This would apply to such

```
LINE  DEBUG PG/LN  A...B..................................................................

  1*         000010 IDENTIFICATION DIVISION.
  2*         000020 PROGRAM-ID. ARITHTEST.
  3*         000030 AUTHOR.       NONIE DIEGMANN.
  4*         000040 DATE-WRITTEN. FEB. 11, 1978.
  5*         000050 DATE-COMPILED. 78/03/09.
  6*         000060 ENVIRONMENT DIVISION.
  7*         000070 CONFIGURATION SECTION.
  8*         000080 SOURCE-COMPUTER.   NCR-CENTURY-8200.
  9*         000090 OBJECT-COMPUTER.   NCR-CENTURY-8200.
 10*         000100 INPUT-OUTPUT SECTION.
 11*         000110 FILE-CONTROL.
 12*         000120     SELECT READ-CARD  ASSIGN TO DISC.
 13*         000130 DATA DIVISION.
 14*         000135 FILE SECTION.
 15*         000140 FD   READ-CARD
 16*         000150      LABEL RECORDS ARE STANDARD
 17*         000160      RECORD CONTAINS 80 CHARACTERS.
 18*         000170 01   CARD-REC.
 19*         000180      03  I           PIC 999.
 20*         000190      03  FILLER      PIC 9(77).
 21*         000200 WORKING-STORAGE SECTION.
 22*         000210 77  A               PIC 99V999      VALUE 6.730.
 23*         000220 77  B               PIC 99V999      VALUE 18.716.
 24*         000230 77  C               PIC 99V999      VALUE 8.964.
 25*         000240 77  D               PIC 99V999      VALUE 7.434.
 26*         000250 77  INCT            PIC 999         VALUE ZEROES.
 27*         000260 77  X               PIC 999V999     VALUE ZEROES.
 28*         000270 77  Y               PIC 999V999     VALUE ZEROES.
 29*         000280*
 30*         000290*
 31*         000300 PROCEDURE DIVISION.
 32*00007A   000310 BEGIN.
 33*00007A   000320     OPEN INPUT READ-CARD.
 34*00007D   000330 GET-CARD.
 35*00007D   000340     READ READ-CARD AT END GO TO END-JOB.
 36*000081   000350     MOVE 0 TO INCT.
 37*000084   000360 CALC-PARA.
 38*000084   000370     IF INCT IS EQUAL TO I GO TO GET-CARD.
 39*000088   000380     ADD A B GIVING X.
 40*00008B   000390     SUBTRACT C FROM X.
 41*00008E   000400     MULTIPLY A BY D GIVING Y.
 42*000091   000410     DIVIDE X BY Y GIVING X.
 43*000094   000420     ADD 1 TO INCT.
 44*000097   000430     GO TO CALC-PARA.
 45*000099   000440 END-JOB.
 46*000099   000450     CLOSE READ-CARD.
 47*00009B   000460     STOP RUN.
 48*         ZZZZZZ END PROGRAM.                                    ***END OF
```

Figure 3a. Calculation Program - COBOL (NCR & Burroughs)

```
      0001 H       14


0001  0002 FINPUT    IP  F 128 128              DISK


0002  0003 IINPUT    AA  01
0003  0004 I                                              1    20INCT


0004  0005 C             LOOP        TAG
0005  0006 C     01                  Z-ADD6.730    A       43
0006  0007 C     01                  Z-ADD18.716   B       53
0007  0008 C     01                  Z-ADD8.964    C       43
0008  0009 C     01                  Z-ADD7.434    D       43
0009  0010 C     01      A           ADD   B       X1      63
0010  0011 C     01      X1          SUB   C       X2      63
0011  0012 C     01      X2          MULT  D       X3      83H
0012  0013 C     01      X3          DIV   D       X       53H
0013  0014 C     01      INCT        SUB   1       INCT       10
0014  0015 C     01N10               GOTO  LOOP
```

Figure 3b. Calculation Program - RPG II (IBM)

business applications as payroll - when the program figures the pay for each employee.

The second program run on each system was the Input-Output Program. It is shown in Figures 4a. and 4b. Again, the COBOL program was run on the NCR and Burroughs computers and the RPG II program was run on the IBM computer. The programs both read in twenty cards and then printed out the twenty cards. The reason for this program was to see how fast the computers could input something and then print it out with no calculations involved. Many business application programs have much input and output, with few calculations involved.

These two processes - calculations and input/output - were timed separately so that the time it took to do each process could be compared amongst the three computers.

The third program was a combination of the previous two programs. It is shown in Figures 5a. and 5b. It initially read in a number (20 in this case). Then it read a card, printed the card and did a calculation. It did this read-print-calculate loop twenty times. The reason for this program was to see how fast the input-calculate-output process was on each system. This program was closer to a simulation of a business application program in that these business programs usually input files, process them, and then print the results. One type of program that was not tested on any of the three systems was a sorting program. This would have been another good program to test since many business applications include much sorting.

Figure 6 contains the chart of timed results of each program for each computer system. There are three times given for each program - the compile time, the execution time, and the total time. The compile

```
  1*         000010 IDENTIFICATION DIVISION.
  2*         000020 PROGRAM-ID.      IOTEST.
  3*         000030 AUTHOR.          NONIE DIEGMANN.
  4*         000040 DATE-WRITTEN.  FEB.12,1978.
  5*         000050 DATE-COMPILED.  78/03/09.
  6*         000060*
  7*         000070 ENVIRONMENT DIVISION.
  8*         000080 CONFIGURATION SECTION.
  9*         000090 SOURCE-COMPUTER.      NCR-CENTURY-8200.
 10*         000100 OBJECT-COMPUTER.      NCR-CENTURY-8200.
 11*         000110 INPUT-OUTPUT SECTION.
 12*         000120 FILE-CONTROL.
 13*         000130     SELECT READ-CARD  ASSIGN TO DISC.
 14*         000140     SELECT PRINT-IT   ASSIGN TO PRINTER.
 15*         000150*
 16*         000160 DATA DIVISION.
 17*         000170 FILE SECTION.
 18*         000180 FD  READ-CARD
 19*         000190     LABEL RECORDS ARE STANDARD
 20*         000195     BLOCK CONTAINS 6 RECORDS
 21*         000200     RECORD CONTAINS 80 CHARACTERS.
 22*         000210 01  CARD-REC.
 23*         000220     03  CARD-LIST              PIC X(80).
 24*         000230 FD  PRINT-IT
 25*         000240     LABEL RECORDS ARE OMITTED.
 26*         000250 01  PRINT-REC.
 27*         000260     03  FILLER        PIC XX.
 28*         000270     03  CARD-OUT      PIC X(80).
 29*         000280     03  HOLD          PIC X(50).
 30*         000290*
 31*         000300 PROCEDURE DIVISION.
 32*0001CA   000310 BEGIN.
 33*0001CA   000320     OPEN INPUT READ-CARD.
 34*0001CC   000330     OPEN OUTPUT PRINT-IT.
 35*0001CE   000340     MOVE SPACES TO PRINT-REC.
 36*0001D0   000350     WRITE PRINT-REC AFTER ADVANCING PAGE.
 37*0001D8   000360 READ-LOOP.
 38*0001D8   000370     READ READ-CARD AT END GO TO END-JOB.
 39*0001DC   000380     MOVE CARD-LIST TO CARD-OUT.
 40*0001DE   000390     MOVE SPACES TO HOLD.
 41*0001E0   000400     WRITE PRINT-REC AFTER ADVANCING 2 LINES.
 42*0001E7   000410     GO TO READ-LOOP.
 43*0001E9   000420 END-JOB.
 44*0001E9   000430     CLOSE READ-CARD.
 45*0001EB   000435     CLOSE PRINT-IT.
 46*0001ED   000440     STOP RUN.
 47*         ZZZZZZ END PROGRAM.                                    ***END
```

Figure 4a. Input-Output Program - COBOL (NCR & Burroughs)

```
          0001 H       14


0001   0002 FINPUT    IP  F 128 128    2         DISK
0002   0003 FPRINT    O   F 132 132    2         PRINTER



0003   0004 IINPUT    AA  01
0004   0005 I                                                1   20 NAME
0005   0006 I                                               22   39 ADDR
0006   0007 I                                               41   51 CITY
0007   0008 I                                               53   66 STATE


0008   0009 OPRINT    D  2      01
0009   0010 O                            NAME      21
0010   0011 O                            ADDR      56
0011   0012 O                            CITY      84
0012   0013 O                            STATE    115
```

Figure 4b. Input-Output Program - RPG II (IBM)

```
LINE  DEBUG PG/LN  A...B............................................................

   1*         000010 IDENTIFICATION DIVISION.
   2*         000020 PROGRAM-ID.     COMBTEST.
   3*         000030 AUTHOR.         NONIE DIEGMANN.
   4*         000040 DATE-WRITTEN.   FEB. 13, 1978.
   5*         000050 DATE-COMPILED.  78/03/09.
   6*         000060*
   7*         000070 ENVIRONMENT DIVISION.
   8*         000080 CONFIGURATION SECTION.
   9*         000090 SOURCE-COMPUTER.        NCR-CENTURY-8200.
  10*         000100 OBJECT-COMPUTER.        NCR-CENTURY-8200.
  11*         000110 INPUT-OUTPUT SECTION.
  12*         000120 FILE-CONTROL.
  13*         000130     SELECT READ-CARD  ASSIGN TO DISC.
  14*         000140     SELECT PRINT-IT   ASSIGN TO PRINTER.
  15*         000150*
  16*         000160 DATA DIVISION.
  17*         000170 FILE SECTION.
  18*         000180 FD  READ-CARD
  19*         000190     LABEL RECORDS ARE STANDARD
  20*         000200     BLOCK CONTAINS 6 RECORDS
  21*         000210     RECORD CONTAINS 80 CHARACTERS.
  22*         000220 01  CARD-REC.
  23*         000230     03  CARD-LIST          PIC X(80).
  24*         000240 FD  PRINT-IT
  25*         000250     LABEL RECORDS ARE OMITTED.
  26*         000260 01  PRINT-REC.
  27*         000270     03  FILLER             PIC XX.
  28*         000280     03  CARD-OUT           PIC X(80).
  29*         000290     03  HOLD               PIC X(50).
  30*         000300*
  31*         000310 WORKING-STORAGE SECTION.
  32*         000320 77  A                      PIC 99V999      VALUE 6.730.
  33*         000330 77  B                      PIC 99V999      VALUE 18.716.
  34*         000340 77  C                      PIC 99V999      VALUE 8.964.
  35*         000350 77  D                      PIC 99V999      VALUE 7.434.
  36*         000360 77  X                      PIC 999V999     VALUE ZEROES.
  37*         000370 77  Y                      PIC 999V999     VALUE ZEROES.
  38*         000380*
  39*         000390 PROCEDURE DIVISION.
  40*0001DA   000400 BEGIN.
  41*0001DA   000410     OPEN INPUT READ-CARD.
  42*0001DC   000420     OPEN OUTPUT PRINT-IT.
  43*0001DE   000430     MOVE SPACES TO PRINT-REC.
  44*0001E0   000440     WRITE PRINT-REC AFTER ADVANCING PAGE.
  45*0001E8   000450 READ-LOOP.
  46*0001E8   000460     READ READ-CARD AT END GO TO END-JOB.
  47*0001EC   000470     MOVE CARD-REC TO CARD-OUT.
  48*0001EE   000480     MOVE SPACES TO HOLD.
  49*0001F0   000490     WRITE PRINT-REC AFTER ADVANCING 2 LINES.
  50*0001F8   000500 CALC-PARA.
  51*0001F8   000510     ADD A B GIVING X.
  52*0001FB   000520     SUBTRACT C FROM X.
  53*0001FE   000530     DIVIDE X BY Y GIVING X.
  54*000201   000540     GO TO READ-LOOP.
  55*000203   000550 END-JOB.
  56*000203   000560     CLOSE READ-CARD.
  57*000205   000570     CLOSE PRINT-IT.
  58*000207   000580     STOP RUN.
  59*         ZZZZZZ END PROGRAM.                                    ***END O
```

Figure 5a. Combination Program - COBOL (NCR & Burroughs)

```
           0001 H        14


0001  0002 FINPUT    IP  F 128 128      2        DISK
0002  0003 FPRINT    O   F 132 132      2        PRINTER



0003  0004 IINPUT    AA  01
0004  0005 I                                              1  20 NAME
0005  0006 I                                             22  39 ADDR
0006  0007 I                                             41  51 CITY
0007  0008 I                                             53  66 STATE



0008  0009 C    01                Z-ADD6.730      A        43
0009  0010 C    01                Z-ADD18.716     B        53
0010  0011 C    01                Z-ADD8.964      C        43
0011  0012 C    01                Z-ADD7.434      D        43
0012  0013 C    01        A       ADD   B         X1       63
0013  0014 C    01        X1      SUB   C         X2       63
0014  0015 C    01        X2      MULT  D         X3       83H
0015  0016 C    01        X3      DIV   D         X        53H



0016  0017 OPRINT    D  2      01
0017  0018 O                              NAME      21
0018  0019 O                              ADDR      56
0019  0020 O                              CITY      84
0020  0021 O                              STATE    115
```

Figure 5b. Combination Program - RPG (IBM)

	PROGRAM	COMPILE	EXECUTION	TOTAL
IBM SYSTEM/32	CALCULATIONS		49 secs.	3:48
	I/O		56 secs.	3:48
	COMBINATION		55 secs.	4:02
NCR CENTURY 8200	CALCULATIONS	52 secs.	3 secs.	
	I/O	47 secs.	17 secs.	
	COMBINATION	61 secs.	15 secs.	
BURROUGHS 700	CALCULATIONS	6:54	5 secs.	7:29
	I/O	6:50	11 secs.	8:08
	COMBINATION	8:50	11 secs.	9:11

Figure 6. Chart of Timed Results.

time, in this chart, is the time that it took the computer to input the program, convert it to machine language, and print a listing of the program. The execution time (not the standard definition of execution time) is the time from input of the data of the program to the completion of the printed results of the program. This time also included the real execution time of the program in the computer memory. The reason for the separate timings of the compile and execute processes is that when a program is run on the computer, it first compiles the program, outputs a listing of the program, and then stops. The computer waits for the operator to "push the button" so that it may begin executing the program. The computer stops again after the completion of the printed results.

The third timed result given for each program is the Total Time. Each computer system had an instruction such that when a program was run, it would go straight from the compile to the execution of the program without operator intervention. Thus, the Total Time was the time from initial input of the program to the final printing of the results. This Total Time is approximately the addition of the compile and execute times. However, there is some difference, as can be seen by looking at the chart in Figure 6.

Still looking at the chart in Figure 6, you will notice blanks in the compile time of the IBM/System 32 and in the Total Time of the NCR Century 8200. Both of these times can be estimated by looking at the rest of the times for that system. The compile times for the IBM System/32 will range anywhere from $1\frac{1}{2}$ to $2\frac{1}{2}$ minutes. This can be seen by looking at the Total Time and the execution time. The Total Times of the NCR Century 8200 can be estimated to range between 1 and $1\frac{1}{2}$ minutes. Again, this can be seen by looking at the separate compile and execute

times.

To compare the timed results in this chart, a person would think to choose the NCR computer over the other two computers. However, there are reasons why the NCR computer was faster then the other two systems. These reasons will help to prove to the small businessman that he must be careful in selecting what type of peripheral devices he wants to put on his small business computer.

First of all, the way the programs were input into each computer bears directly with how fast that program went through the computer system. As the speed of each input device (peripheral device) increased, so did the speed in which the program went through the system. This can be seen by looking at Figure 7. The Burroughs 731 used the 96-column card as input. It is the slowest way of the three shown to input a program or data. It also was the slowest in compiling the program (input - reading in the program on cards) and executing the program (input - reading in the data on cards). The IBM System/32 used the diskette as the input medium. This medium is faster than cards, but slower than the CRT (Cathode Ray Tube) display unit. The IBM System/32's timed results compared like its input medium does with the other two systems. The NCR 8200, which had the fastest processing times on the chart, also had the fastest input medium of the three, the CRT. This shows how the input device does make a difference on how fast the program gets through the system.

Another factor included in the compile time on the diagram in Figure 7 is the type of compiler used (only compile time shown on diagram). The speed and accuracy of the compiler will also have a bearing on how much time it will take to compile a program. Again,

INPUT

COMPILE   EXECUTE

BURROUGHS
731
(1973)*

96-COL.
CARDS

IBM
SYSTEM/32
(1975)*

O

DISKETTE

DISK

CPU

NCR
CENTURY
8200
(1974)*
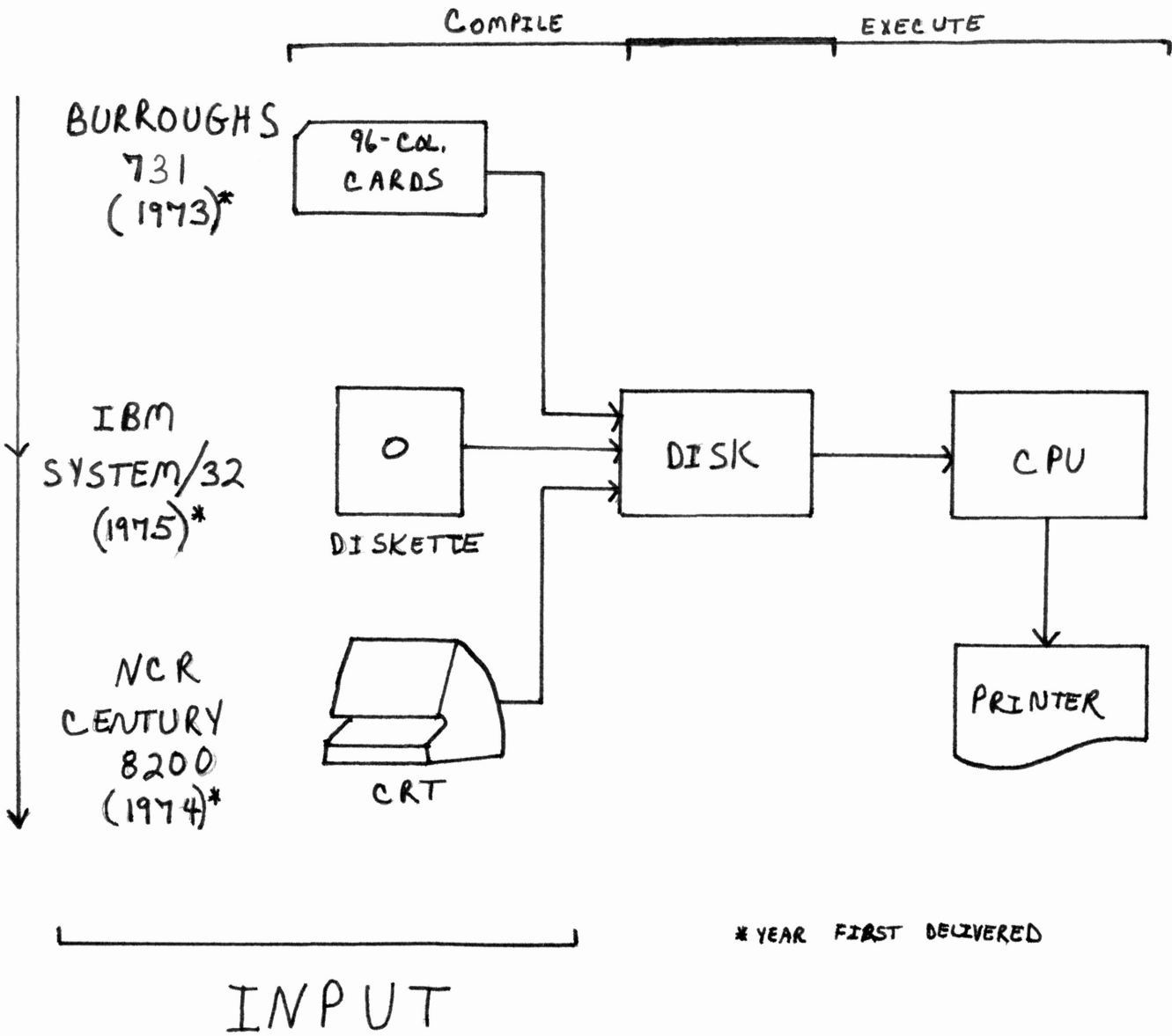
CRT

PRINTER

INPUT

* YEAR FIRST DELIVERED

Figure 7. Diagram of Input Device of Each Computer System.

compare the compile times of each system in Figure 6. The difference in times is not due just to the different input mediums of the NCR and the Burroughs computers, but also to the different compilers used.

Another factor which makes a big difference to the small businessman and his small business computer is the speed of his printer. This is evident in the fact that most small businesses have much printed output. Therefore, the speed of the printer makes a difference in the number of reports that are printed in a certain amount of time.

The printing of the output is included in both the compile time (printing out the listing of the program) and the execution time (printing out the results of the program). Shown in Figure 8 is a repeat of the chart in Figure 6, but with the printer speeds of each system added. As can be seen, the computer with the slowest total timing has the fastest printer of the three systems. This can be explained in that the other factors, such as input medium, compiler, etc., have offset the speed of the printer. This fact is evident in the difference of execution times of the NCR (fastest overall) and the Burroughs (slowest overall). For the two programs with printed results (the Input-Output program and the Combination program), the execution time of the Burroughs is faster than the NCR system. However, if you look at the execution time of the Calculation program with no printed results, the NCR system is faster, just like its overall time. Therefore, it is the faster printer speed of the Burroughs which made the execution time of the Input-Output program and the Combination program faster than the NCR computer. This shows that the printer speed can make a difference, especially when there is a lot of output to be printed.

The execution time of the IBM/System 32 was quite higher than the

PROGRAM		COMPILE	EXECUTION	TOTAL	PRINTER SPEED
IBM SYSTEM/32	CALCULATIONS	app. 1:30 → 2:30	49 sec.	3:48	
	I/O	app. 1:30 → 2:30	56 sec.	3:48	155 lpm
	COMBINATION	app. 1:30 → 2:30	55 sec.	4:02	
NCR CENTURY 8200	CALCULATIONS	52 sec.	3 sec.	app. 1:00 → 1:30	
	I/O	47 sec.	17 sec.	app. 1:00 → 1:30	110 lpm
	COMBINATION	61 sec.	15 sec.	app. 1:00 → 1:30	
BURROUGHS 731	CALCULATIONS	6:54	5 sec.	7:29	
	I/O	6:50	11 sec.	8:08	180 lpm
	COMBINATION	8:50	11 sec.	9:11	

Figure 8. Chart of Timed Results (With Printer Speeds of Each System)

execution time of the other two systems. This can be seen in Figure 8.
In trying to find out why there was the difference, I first checked the
real execution time of the Calculation program. This was the time that
it took to do the calculations only. This was timed by doing a test in
which the program would print an 'X' when it entered the calculation
loop, and would print another 'X' once it fell out of the calculation
loop. The time between the printing of the X's was less than a second.
(This is not to be compared with the execution times listed in the
chart for the other two systems. The execution time just noted for the
IBM system is the real execution time. The execution times in the chart
are not the real execution times for those systems). The significant
increase in the execution time could not be due to the printer speed
because the IBM's printer is faster than the NCR's, whose execution
time was faster than the IBM system. Thus, the increased execution time
of the IBM system was due to something in the architecture of the com-
puter - not the input or the output phase of the system, which is what
has been discussed here.

From the above explanation of the effect that the method of inputting
and outputting programs and data has on the speed of the program being
run through the system, the small businessman can see that he must select
the peripherals, such as card reader, tape unit, disk unit, and printer,
with extreme care. He must know the expected performance of each peri-
pheral and hope that in conjunction with one another, they will achieve
his desired goals.

The above discussion on the performance of the three computers was
not to compare the performance results of the systems, but it was to
bring out some of the important aspects of the computer hardware, which

must be considered by the small businessman. Just because one of the computers ran these certain programs faster than the other two computers does not mean it is the best choice. All the other factors must be taken into consideration (those discussed earlier).

The computer salesman can always help the small businessman in finding out what is available and what will fit his needs. For example, to see what speed printer the small businessman needs, he should approximate the number of programs he will be running. Then he should estimate the number and size of files that the small business will be using. He should allow for 40% growth. From this, the small businessman will get a good idea of the amount of output the computer will be printing. Then the computer salesman can inform the small businessman of the different speed printers he has available. The small businessman should rate each of these at 70% of their rated capacity. Knowing the amount of printed output and the calculated speed of the printers, the small businessman will have a good idea of the printer he should choose for his small business computer.

Expandability

Another important selection criteria of a small business computer is the expandability of the computer. This allows for future growth of the business. Looking at the chart in Figure 9, the memory expandability of each of the three systems is shown. The maximum memory capacity of each system is shown, as is the increment size to add on memory. For example, the basic NCR 8200 system of 32K bytes can have 12 increments of 8K memory added on before it reaches its maximum memory size of 128K. This allows for plenty of growth!

E XPAN DA BILITY

	BURROUGHS 731	IBM SYSTEM/32	NCR 8200
CAPACITY OF BASIC SYSTEM (BYTES)	32K	16 K	32K
MAXIMUM CAPACITY (BYTES)	80K	32K	128 K
INCREMENT SIZE (BYTES)	8K	8K	8 K
# I/O PORTS ON BASIC & MAXIMUM	6, 8	—	5, 8

Figure 9. Chart - Expandability of Each System.

Also, on the last row of this chart, the number of input-output ports for a basic system is given. These ports indicate how many peripheral devices the small businessman can add to his system. Some of the ports can support multiple peripheral devices. The number that each port can support is up to the individual system. For example, the Burroughs 731 basic system can support at least six peripheral devices up to a maximum of eight. If the small businessman is thinking of expanding his computer, he must also take into consideration the extra cost of adding on more memory and/or peripheral devices. For example, a card reader can cost around $2,500, while a printer can cost anywhere from $10,000 to $12,000. Of course, these costs will vary amongst computer vendors.

Selection Criteria

Summarizing the selection criteria talked about so far, they are:

1) Location of vendor (Service).

2) Total Cost of the small business computer.

3) Performance of the computer.

4) Expandability of the computer (Growth).

After talking with small businessmen, I think that, to the small businessman, service and the total cost of the computer are the most important selection criteria. The other two are important, but are considered to be secondary in the initial stages of selecting the small business computer.

Other things for the small businessman to consider when trying to select a computer are:

1) Reliability of Equipment - How often must the system be ser-

viced?

2) <u>Maintenance</u> - What is the cost and what is included in the maintenance contract?

3) <u>Ease of Operation</u> - Is the computer easy to operate? Can an office secretary pick up the computer procedures easily?

4) <u>Education Provided By Vendor</u> - Does the vendor provide education about the computer for the employees of the small business?

5) <u>Documentation To The Computer</u> - Are there manuals documenting the system and its procedures so that if something about the computer is not understood, it may be referenced in the documentation?

6) <u>Compatibility With Other Vendors' Computers</u> - Can a peripheral device of another computer vendor be put on the small businessman's system and run with no problems? This criteria is for the future when a business may want to add on another peripheral device and can obtain one from another vendor at a lower price than the one offered by his computer vendor.

Some of these criteria are more important to some small businessmen than they are to others. However, all of these criteria should be considered by any small businessman before he makes his final selection of a small business computer.

CONCLUSION

In conclusion, I had hoped to compare the three systems that I have talked about and come up with the best small business computer out of the three. However, I quickly learned that there are too many factors to be considered when trying to select the best small business computer without having concrete ideas of exactly what is needed. Therefore, any small businessman who is selecting a computer should know exactly what he needs and should consider all criteria, not just the ones most important to him. There is much literature now on small business computers,

including charts of small business computers with their characteristics listed. Two reports, which should be read by any small businessman selecting a computer, are the Auerbach Report and the DataPro Research Report on Small Business Computers. The DataPro Research Report contains such valuable information as a chart of 226 different small business computers and their characteristics. It also includes a table of User Ratings for 1,738 small business computers. (These two reports cannot be reproduced. Therefore, they are not included in this paper).

Also, a small businessman should consult with an expert on computers who can help him in selecting the best performing computer for his needs. Otherwise, the small businessman's limited budget may pay for it later. It has happened before and it will happen again if careful consideration of all selection criteria is not made. Thus, any small businessman going from a manual system to a small business computer has a long, hard road ahead of him, but if he travels it in the right way, his journey will be well worth the effort!

REFERENCES*

Armstrong, Don. Personal interview, Lilly Ice Cream - Bryan, Texas.

Auerbach Computer Technology Reports. Evaluation and Selection of Small Business Computers. Auerbach Publishers, Inc., 1972.

Auerbach Computer Technology Reports. Evaluation and Selection Chart. Auerbach Publichers, Inc., 1977.

Boening, Robert. Personal interview, The Moody House - Galveston, Texas.

Byrd, Nelson. Personal interview, Bluebonnet Warehousing Corp. - Galveston, Texas.

Camp, Vernon. Telephone interview, Farmers Marine - Galveston, Texas.

Carter, Bill. Personal interview, Burroughs Corp. - Bryan, Texas.

Colson, Mr. Telephone interview, IBM Corp. - Bryan, Texas.

DataPro Research Corp. All About Small Business Computers. Delran, N.J., 1976.

Digital Equipment Corp. The Beginner's Guide To Small Business Computers. U.S.A., 1977.

Feidelman, Lawrence. "It's A Small World," Infosystems, 24(April, 1977), 50-54.

Feidelman, Lawrence. "The Small Business Computer Grows Up!" The Office, 84(July, 1976), 69-72.

Gorman, Alyn J., Edmund J. Armon, and Kathleen M. Fehrenbach. "Survey of Small Business Computers." Datamation, September, 1977, pp.189-230.

Hansen, John R. "Minis Move To The User," Infosystems, June, 1977, pp.43-48,148.

Hirschfeld, David J. "Planning The Business Information System," The Office, 84(July, 1976), 48-50.

Joslin, Edward O. Analysis, Design, and Selection of Computer Systems. Arlington, Virginia: College Reading Series, 1974.

*Also, many small computer brochures were referenced.

Langford, Roger. Personal interview, Computer Services - Texas City, Texas.

Leonard, Al. Personal interview, NCR Corp. - Bryan, Texas.

Lester, Mr. Personal interview, Lester's Dept. Store - Bryan, Texas.

Matlack, Richard J. "Who Will Win the Small Business Computer Market?", The Office, 84(July, 1976), 32-37, 55.

Mencacci, Sherrie. Personal interview, Kelso Marine - Galveston, Texas.

Munyan, Jack. So You're Going To Automate. New York: Mason Charter Publishers, Inc., 1975.

O'Rear, Don. Personal interview, McLean's, Inc., - Texas City, Texas.

Thompson, Tracey. Personal interview, H.C. Price - Galveston, Texas.