CONFIDENTIAL

HEWLETT PACKARD

INTER-OFFICE CORRESPONDENCE

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DATE: March 25, 1974

TO: All Salesmen

SUBJECT: Wang 2200

Competitive Analysis of the 9830 vs. the Wang 2200

We have been fortunate to be able to borrow a Wang 2200B in our office here for the last month. In addition to the 2200B (with 8K bytes) we had a 2216/2217 CRT-Cassette, and a 2215 standard keyboard, and a 2222 Alpha-Numeric keyboard. A number of us had a chance to become familiar with the 2200 and we feel that the following competitive analysis is a fairly accurate picture of it.

SELLING AGAINST THE 2200

When you are in a competitive situation with the 2200, we strongly recommend that you loan the customer a 9830 before he tries the 2200. Emphasize the ease of editing lines of program both before they are entered and afterwards. Also show him how the cassette works and how easy it is to find a location on tape and to learn what is on the tape. If he becomes reasonably familiar with the 9830 then he should become frustrated with the 2200 (as we did).

# THE WANG 2200

There are two ways to look at the 2200: from the standpoint of a user and from that of a programmer. If the user is going to receive a complete program package which he only has to load and run, then the system would probably look pretty nice. The CRT is fast and can be used to put on an impressive demo. From an industrial design standpoint, the 2200 is not as elegant nor as compact as the 9830 but the user may not care about this. If the user is a touch-typist and has to enter a lot of data, he will probably prefer the 9830 keyboard feel to that of the 2200. In this situation, the application program (or lack of one) will probably be the determining factor.

For the average programmer, the 2200 will appear to be not as "user-friendly" as the 9830. There are a number of things that the 2200 does not do as well or at all when compared to the 9830. First and foremost is program editing. This was a constant irritation to those of us who tried the 2200. Secondly, their tape cassette system is more difficult to use and learn than that in the 9830. The 2200 was somewhat faster than the 9830 (depending upon the program anywhere from 10% to 75%). The 2200B contains approximately the same command set as the 9830 and in addition it contains some of the commands found in our String, Plotter, and Extended I/O ROMs. The 2200B also contains an extensive set of bit and byte manipulation commands which might appeal to a sophisticated programmer. Even he, however, would experience the same frustrations as the average programmer when it comes to program editing. The CRT is nice for looking at a portion of a program but there is no scroll capability and there is no way to make a quick listing to take back to ones desk to study at leisure.

To conclude, the 9830 appears to be a better engineered and better designed product which offers more user features and does more to protect the user from himself than the 2200. BASIC is an easy to learn and easy to use language and the design philosophy of the 9830 matches that concept to a much greater degree than the 2200. The following pages describe in greater detail many of the differences that we have found.

# WANG 2200 ANALYSIS

| | HP 9830A | WANG 2200 |
|---|---|---|
| A) - | Memory<br>3520, 7616, or 15,808<br>bytes of memory plus<br>add-on ROMs | 3398 steps to 32,070 ~bytes or character.<br>in blocks of 4096 steps |

Notice that Wang does not really have 4096 steps available to the User (as their data sheet implies) since the first 700 steps are used by the system.

Secondly, I think it is important here to make a comment about "steps", "bytes", "words", and "characters". Wang, in their literature, talks about "steps". We think this is rather strange. Talking about "steps" indicates that they are thinking in terms of a smaller machine, similar to a 9810 where we also talked about steps. However, anyone that has any familiarity with BASIC or time-sharing would be more inclined to think of "words" or "bytes". The important thing here is not to let a customer think that a Wang "step" is the same as an "instruction", or even worse, the same as a line of program. When they say "step", they really mean a byte or character or eight bits of storage or, in the case of an HP word, one-half a word.

One possible advantage of a large read/write memory is that large arrays can be stored and manipulated. However, for many cases, 6 digit accuracy is enough and since the 9830 has split precision whereas the 2200A does not, the 9830 can still hold as many numbers as the 2200A.

$$\frac{15808}{4} = 3952 \text{ 6-digit numbers} \qquad \frac{32,070}{8} = 4008 \text{ 13-digit numbers}$$

The 2200B provides PACK and UNPACK commands which can be used to transfer a number to and from a string and specify the number of digits to be transferred. This, however, is not the same as our split and integer precision since one must UNPACK the number in order to use it (which uses a statement) and when the number is unpacked it still occupies the same space as a full precision number. The purposes of these commands is to save space when storing the numbers on a disk or tape cassette.

Conclusion: We can provide a machine with as much memory as they can, provided the customer needs the capabilities of our ROMs. The advantages of a ROM are:

(a) permanent
(b) ready at turn on
(c) available now
(d) cheaper than read/write memory
    1K word ROM at $500 = 49 cents per word
    2K word Read/Write memory for Wang at $1500 = 73 cents per word
(e) more efficient

For example, a program to do MAT INV requires about 600 words of user read/write memory without the MAT ROM and no words with the ROM. And, this is only one of many commands in the MAT ROM.

B) - Keyboard

1. Two numeric fields
2. Upper and lower case alpha
3. FIXED N
4. FLOAT N
5. STANDARD
6. Must shift to get the alpha keys
7. No repeat on any key
8. No exclamation point

Conclusion: Wang makes a big point about their 2215 key-per-function keyboard by saying that it is easier to type in lines of BASIC because you need to hit only one key for PRINT or one for THEN, etc. However, this supposed advantage is lost when one examines a typical expression for example, 100 if A> B +C THEN 200. This expression takes 14 key strokes to key in on the Wang since the alphabet must be entered in the shifted mode. The same expression requires 15 key strokes on the HP. Take another example, 110 PRINT "AVERAGE =";A. This expression requires 18 key strokes on the Wang and 19 on the HP. Therefore, their "advantage" of a key-per-function keyboard is lost because of the continous shifting required to complete the rest of the BASIC expression. They also offer a typewriter style keyboard for $700. It is similar in appearance to the 9830 keyboard and can be connected in addition to or instead of their key - per - function keyboard.

Another point to clear up at this time is the following: Wang had originally been telling their salesmen that since we must enter PRINT with five key strokes, we therefore consume five bytes of memory. This is simply not true. Every BASIC instruction in the 9830 compressed into one byte which is stored in memory.

However, a minimum line (eg. 10 PRINT) in the 9830 takes 3 words (or 6 bytes) of memory. This includes the line number and a BASIC instruction. A minimum line in the 2200 takes 7 bytes of memory, and therefore, Wang does not have any advantage merely because they have a key-per-function keyboard.

C) CRT

The Wang 2200 has a CRT which can display 16 lines of 64 characters each. If the line is longer than 64 characters, it spills over onto the next line.

Conclusion: The Wang CRT display is very similar to a 9866 with PRINT ALL on. The CRT really shows the last 16 lines of what has happened. Their LIST command lists the last 15 lines of program. To list the first 15 lines of program, one must push LIST, SHIFT S, EXECUTE. Each LIST after that lists the next 15 lines of program. DELETing a line does delete it from memory but does not delete it from the CRT. One might expect that the CRT shows an image of memory, but it does not. It shows only a history of what has happened. In other words, the only way to show that it has been deleted, is to LIST that section of memory again. Again this is analagous to the printer with PRINT ALL on.

On the other hand, their CRT is very fast and there is no question that it certainly has appeal to some people. This is probably the strongest feature on the 2200 and Wang is pushing it hard.

D) Cassette

| | | | |
|---|---|---|---|
| 1. | Tape length | 300 feet | 150 feet |
| 2. | Capacity | 80,000 | 78,000 bytes |
| 3. | Read/Write | 9.6 ips average | 7.5 ips |
| 4. | Search speed | 28.8 ips average | 7.5 ips (forward only) |
| 5. | Rewind speed | 28.8 ips average | 90 ips |
| 6. | Total rewind time | 125 sec. | 17 sec. |
| 7. | Average search time | 45 sec. | 128 sec. |
| 8. | | Tapes must be marked | Tapes are not marked MAX = 30 files |
| 9. | | Files can be any length | Files must be multiples of 256 bytes or characters |
| 10. | | Files are stored by record number | Files are stored where they are & can be named. |
| 11. | | Files loaded by record number | Files loaded where they are or by name. |
| 12. | TLIST | Yes | No equivalent |
| 13. | FIND | Yes, with interrupt | Skip X files forward or backward. No interrupt |
| 14. | LOAD BIN | Yes | No |
| 15. | Bi-directional Search | Yes | No |

Conclusion: First of all Wang claims that not marking their tapes is an advantage. In one sense it does make life a little bit simpler, however, when a file or data is stored on the tape only enough room is created for that particular file. If it is necessary later to go back and increase the size of that file, it is impossible. For the HP system, a file can be created large enough to provide room for any anticipated future changes or increases.

Secondly, when Wang stores files, the 2200 stores only in multiplies of 256 bytes or 128 words. Therefore, if their program or data requires 230 bytes, then two 256-byte blocks would be used and an extra 252 bytes would be wasted on the tape.

If they do not load and store programs by name, the command is simply LOAD or STORE and they store or load the file which happens to be under the head at the time. The only way to specify a file (that is to load a file from a specific location) is to do it by-name. Here they can use alpha names and this sounds like an advantage. However, one must realize that when you load a fine by-name, the cassette does not know where that file is. Therefore, it must search through the entire tape to find that file. This search is done at low speed; the same speed that they use for read/write which is 7.5 inches per second. If the file that is desired is farther downstream than where it is sitting now, it will search to that place and load it correctly. If the file that you are looking for happens to be behind the file you have just read, it will search to the end of the tape. It will then stop and give an error message after which you must rewind and do it again. Since the searching is done at slow speed, it takes a long time (4 min.) to get to the end of the tape and therefore one would normally rewind before doing any load-by-name operation. The HP system, however, using numbered files, knows immediately where the desired file is with respect to where it is now and can go at high speed to that location. The result is that the search time on the 9830 system for any file from any place is about 45 seconds on the average, whereas it is about 128 seconds on the 2200. File-by-name can be done on the HP system, of course, by making a small program that relates names to file numbers and this would produce a faster and more reliable system than the Wang.

The 2200 tape does not have interrupt capability. That is, if the 2200 performs a SKIP 5 F (advanced the tape over the next 5 files), the calculator must sit and wait until the tape motion is complete before continuing with the program. This is not the case with the 9830 when performing a FIND command.

There are no TLIST or FIND commands or equivalent and therefore you never really know where you are on the tape. This can be a very frustrating experience. It is very easy to store a program in the wrong place and thus wipe out a previous program or data

Finally, the 2200 cannot LOAD BINary programs. The ability to load binary (assembly language) programs is a powerful capability that the 2200 does not have. This allows us to add new system commands and statements to the 9830 in the future by using a minimum amount of R/W memory.

E) Editing

| | |
|---|---|
| 1. Character insert and delete. | 1. No character insert or delete capability. There is a cursor which can be backed into the line before it is stored. However, as the cursor is moved from right to left into a line, it erases the line as it goes and therefore, it must be retyped from that point to the end. Furthermore, there is no repeat function on the cursor buttons so they must be pressed repeatedly to move the cursor several positions. |
| 2. RECALL, FETCH | 2. There is no RECALL or FETCH. Once a line is stored it must be completely reentered in order to correct it. |
| | 3. Another funny thing that happens is that an incorrect line can be stored in memory. In other words if a line is typed in and it is mis-spelled or something is wrong with it and an attempt is made to store it, an error message appears which points out that something is wrong with that line. However, that line is already in memory and if it is not corrected, it stays in memory. Every time the program is listed, it lists the erroneous line. When the program is RUN, it will stop with the same error message again when it gets to that line. |
| 4. Trace | 4. Trace |

Comment: Wang has a good TRACE feature. The TRACE can be turned on while the program is running and it will display each line as it is executed and the result of each variable which is changed or the address of any branch.

Conclusion: The lack of character insertion or deletion capability when compared to the 9830 is a serious drawback. Secondly, storing bad lines in memory can be both confusing and time consuming when debugging. The 2200 does have an error pointer which points to the spot in the line which is at fault, however, this error pointer was sometimes misleading since it did not always point to the exact place that was in error. Many times I waisted time looking for an error in one place when the real error was somewhere else in the line. Figuring out what is wrong in a line without a pointer is usually not really that difficult. Finally, the error messages were not always logical. Entering:

10 PRUNT "HP"

gives:

? ERROR 06 (missing equals sign)

The 9830 gives ERROR 5 which means "command not recognized".

F) Calculator Mode

| | |
|---|---|
| 1. Separate EXECUTE and END OF LINE keys. | 1. A single key for both EXECUTE and END OF LINE. |
| 2. RESULT key. | 2. No RESULT key. |
| 3. "5 + 6 EXECUTE" produces a result of 11. | 3. You must say "PRINT 5 + 6, EXECUTE". This is because the 2200 does not have separate Execute and End-of-Line keys. |

Conclusion: It appears that the HP method is more logical and less error prone. For example, typing "10 + 6 EXECUTE" on the Wang produces an error and if the user then corrects that by saying "PRINT 10 + 6 EXECUTE", he gets the correct result of 16. However, the fact that he executed "10 + 6" will erase line 10 and create a new line 10 which has in it a "+6". This, of course will be detected at run time. Result: another user inconvenience.

Wang implies that the 2200 calculator mode is more powerful than that of the 9830 becuase the 2200 can execute many BASIC commands from the keyboard including displaying and printing variables. Well, the 9830 can do this also and, therefore, we have equivalent capability.

| | |
|---|---|
| 1. SCRATCH | 1. CLEAR |
| 2. AUTO number L1, L2. | 2. STATEMENT NUMBER key. |
| 3. REN | 3. REN - This is equivalent to the HP REN with the addition that they can renumber from the middle of the program to the end. |

Conclusion: They have about the same commands that we do except that HP offers more user convenience with the AUTO # key. Their STATEMENT NUMBER key must be pressed for every line and it only provides a line number which is ten greater than the last one. It has no line number parameters. The typewriter keyboard does not have a STATEMENT NUMBER key.

H) BASIC

| | |
|---|---|
| 1. Twelve digit precision. | 1. Thirteen digit precision for + - * ÷ . Twelve digit precision for all other functions. |
| 2. Split and integer precision. | 2. Full precision only. |
| 3. Extra spaces are ignored when typing in a line of BASIC. | 3. Extra spaces are stored in memory. |

Conclusion: The 9830 appears to be more efficient in that spaces entered with a statement are deleted before the statement is stored and then recreated when the statement is pulled from memory for listing or display. Wang apparently stores the spaces which means that if you wish a program to appear neat for listing purposes, the spaces will take up extra space in memory.

| | |
|---|---|
| 4. 26 arrays from A to Z plus 286 scalars. | 4. 286 arrays and 286 scalars. |

Conclusion: The Wang has somewhat more flexibility since they can have more than 26 arrays. However, use of more than 26 separately-named arrays requires extremely inefficient programming.

| | |
|---|---|
| 5. Functions do not require parentheses.<br>As an example:<br>SIN A | 5. All functions require left and right parentheses.<br>SIN (A) |
| 6. LGT | 6.<br>ARC SIN<br>ARC COS |

Conclusion: Functions are about the same. We have one that they don't have and they have two that we don't have.

7. AND, OR, NOT 7.

This is a good time and space saver. These operators can also be used as relational operators (see 11 below).

8. 8. Multiple statements per line

Conclusion: This is similar to the 9820. It may, under some circumstances, make the program easier to understand and in others, it would make it more difficult to understand. However, it does not save any storage except that used for the line numbers. Also, one tends not to use multiple statement lines since they are difficult to edit. The longer the line, the more chances for error and the harder it is to edit.

9. WRITE - FORMAT 9. PRINT USING

We chose to add the WRITE - FORMAT capability of FORTRAN because it is more powerful than PRINT USING.

10. Variables not initialized 10. Variables initialized to zero.

Wang claims that the 2200 is better than the 9830 because the 2200 initializes all variables to zero whereas the 9830 leaves them undefined. At first glance, this sounds like a good feature. For example, when performing a summation it is necessary, in the 9830, to set the sum equal to zero before entering the summation loop. This uses one line of program (e.g. 140 S=0) which is really not that bad. Consider, however, another case:

```
100 B = 0.003
 .
 .
200 A = B + 73.456
```

Suppose that the programmer omitted line 100 by mistake. The 9830 would give error 40 (undefined variable) in line 200 which would immediately alert the programmer that he had forgotten to define B. The 2200, on the other hand, would have initialized B to 0 and it is possible the programmer would never notice that his answer was wrong. If he did suspect he was getting the wrong answer, it could take him a considerable amount of time to track down the problem. Therefore, we are convinced that the HP way is better.

11. Relational Operator 11.

The 2200 does not have the ability to use a relational operator as a function. Suppose, for example, that one wishes X to be equal to 3 is A is less than 10, equal to 5 if A is greater than 10, and equal to 0 if A is equal to 10. The following program lines perform this operation in a straight forward manner:

```
100 IF A< 10 THEN 140
110 IF A> 10 THEN 160
120 X = 0
130 GO TO 170
140 X = 3
150 GO TO 170
160 X = 5
```

By using relational operators, this program can be rewritten:

```
100 X = 3 * (A<10) + 5 * (A>10)
```

Obviously this is much more efficient and this is a feature that the 2200 does not have. For a further discussion of relational operators, see pg. 2-19 of the 9830 manual.

I) Strings

| | |
|---|---|
| 1. Maximum string length = 255 characters | 1. = 64 characters |
| 2. | 2. String array. This is a nice feature, however, we can overcome this with programming or the API ROM. |
| . LEN, POS, VAL | 3. 2200A has LEN, the 2200B has two functions called POS and VAL but they are not the same as the 9830 POS and VAL. The 2200B does not have any equivalent functions and therefore they must be programmed. This is time and space consuming. For example, the 9830 POS function is 20 times faster than the 2200B equivalent subroutine. |
| 4. | 4. Trailing blanks are ignored in a string quote field. |

Conclusion: This is rather strange. They are saying that "YES " = "YES". With the 9830 string ROM trailing blanks are not ignored.

5. Leading blanks are ignored on the INPUT statement.

Conclusion: Again, this is a strange way of treating strings. Leading blanks are not ignored, but are accepted as part of the string in the HP string ROM.

| | |
|---|---|
| 6. | 6. A comma is a terminator in an INPUT statement. |

Conclusion: This means that one cannot easily enter "Doe, John" as a string in the 2200, whereas it can be entered in the 9830.

| | |
|---|---|
| 7. Sub strings A$[3,7] | 7. STR [A$3,4] |

Conclusion: The HP system requires 8 key strokes to enter this and the Wang system requires 12 key strokes to enter it.

| | |
|---|---|
| 8. Lower case alpha with the shift key PRINT "JOHN DOE" | 8. Uses a double quote to get upper case and a single quote to get lower case PRINT "J", 'OHN'; "D"; 'OE'. |

Conclusion: This is unbelievably kluggy. The HP system uses the SHIFT key as you normally would to produce John Doe. This requires 18 key strokes with a print statement on the 9830 and 24 key strokes on the 2200.

J) BENCH MARK

Following is a simple bench mark program you can use if you want a program that runs faster on the 9830 than on the 2200. It calculates the first 11 right triangles in which each side is a whole number. This program runs 22 seconds on the 9830 and 50 seconds on the 2200. Use it with caution, however, since it may not be representative of the customer's problem.

```
10 FOR X=1 TO 25
20 FOR Y=X TO 25
30 R=SQR(X↑2+Y↑2)
40 IF R#INTR THEN 60
50 PRINT X,Y,R
60 NEXT Y
70 NEXT X
80 END
```

| | | |
|---|---|---|
| 3 | 4 | 5 |
| 5 | 12 | 13 |
| 6 | 8 | 10 |
| 7 | 24 | 25 |
| 8 | 15 | 17 |
| 9 | 12 | 15 |
| 10 | 24 | 26 |
| 12 | 16 | 20 |
| 15 | 20 | 25 |
| 18 | 24 | 30 |
| 20 | 21 | 29 |

K) Price and Delivery

A copy of the price sheet for the Wang 2200 and its peripherals is enclosed. Notice that there are two calculators mentioned, the 2200A and the 2200B.

The 2200A can drive typewriters, high speed printer, CRT's, keyboard, and cassettes. The 2200B can drive these peripherals plus plotters, paper tape readers, mark sense card readers, and discs.

Following is a price comparison of the Wang 2200B vs. HP 9830:

| | | | |
|---|---|---|---|
| 9830A | $6475 | 2200B CPU | $4500 |
| Opt. 274 | 500 | 2216/17 CRT/Cass. | 2500 |
| | | 2215 Keyboard | 700 |
| | | 2290 Stand | 200 |
| | $6975 . . . . . | | $7900 |
| 9866A | $2995 | 2201 Selectric | $2100 |
| | $9970 . . . . . | | $10000 |

As you can see, in spite of their claims, the 2200B (with or without a printer) is more expensive than the 9830. Finally, make sure that your price comparison includes the B Model and not the A Model and the stand for making a realistic comparison because the 2200 is really two boxes (a CPU and a power supply) and the 2216/17 is another piece of hardware and the 2215 keyboard is yet another.

L) Matrix ROM

Wang has announced a MATRIX ROM for the 2200B. Price is $500 and delivery is 6 months.

It has almost the same features as the 9830 Matrix ROM with the following exceptions:

1) It has MAT INPUT which the 9830 MAT ROM does not have.

2) The determinant is calculated at the same time as the Inverse (i.e. MAT A = INV (B), D where D is the determinant). This appears to be a drawback compared to the 9830 if one only wishes to find the determinant. With the 2200 ROM, one must either provide an additional matrix for the inversion or invert the matrix into itself, thus destroying the original matrix. The 9830 matrix ROM can, however, find the determinant with out inverting the matrix.

3) All arithmetic matrix operations automatically redimensions the matrix on the left side to the appropriate size. For example:

```
10 DIM A (10,10) , B (2,3) , C(3,6)
20 MAT A = B * C
```

As a result of line 20, Matrix A will be redimensioned to 2 by 6. This sounds like a good feature, but we feel that the 9830 Matrix ROM, which does not redimension automatically, is a better method since it forces the programmer to provide the appropriate dimensions. That is, the array dimensions will not change unbeknownst to the programmer.

M) EDIT ROM

Wang has announced an Edit Rom for $400 but we have not had a chance to use it or even see the manual. Therefore we cannot make any comment on this new capability.

N) Output Writer

The Wang output writer is rated at 15 cps. However, we found that when listing a program it ran at 6.3 cps. It is thus slower than a teletype.

Also, the typewriter does not contain the characters: <>, or #. The characters !, [, ], are substituted for the first 3 characters respectively, but there is no substitute for the #. Instead they use <>which isn't too bad except that it comes out []. This produces some strange output:

110 IF (X!2 + Y!2) [] 3 THEN 150.

Now imagine what happens when someone uses such a listing, must enter that line on the 2215 keyboard. It does not have the !,[, ] characters.

O) 2232 Flatbed Plotter

Wang has just announced a new flatbed plotter. It has a plotting surface of 31" x 42" and costs $7500. Alpha numeric characters can be drawn under program control with any orientation and any size. Any type of paper including linen, vellum, and nylon may be used as well as fiber tip, ball-point, or drafting pens. See attached picture.

P) Model 2230 Fixed/Removable Disk Drive

There are three versions of this disk:

| Model No. | Bytes of Storage | Price |
|---|---|---|
| 30-1 | 1,228,800 | $ 9,500 |
| 30-2 | 2,457,600 | 11,500 |
| 30-3 | 4,915,200 | 13,500 |

In each configuration, half of the capacity is on the fixed disk and half is on the removable disk. This unit will only operate with the 2200B.

We believe that this drive is manufactured by Diablo. A few of the differences between this unit and the 9880 are:

1. The cartridge is top loading (see attached picture)

2. The disk rotation speed is 1500 RPM compared to 2400 RPM on the 9830.

3. The average access time is 65.9 millisecs. compared to 42.5 ms on the 9880B.

For more detailed competitive info on the 2230 see the MM Newsletter No. 3.

Q) Model 2227 Telecommunications

Wang has announced communications capability for the 2200A and B. It costs $900. It is an interface to a modem, but it does not provide any additional commands or capabilities to the 2200. In other words, it is our 11206 interface card, but without the terminal ROM. It can operate at 10 to 120 characters per second. This rate is switch selectable, but we don't know whether the switch is conveniently located. It operates by inputting and outputting data using the standard INPUT, PRINT and PRINT USING commands. This has several implications:

1. A program must be running in the 2200 in order to transmit or receive any data.

2. A transmission cannot be initiated from the keyboard unless it is preceded by INPUT or PRINT.

3. There is no "free text" capability. Beware, however, that Wang talks about the ability to input and transmit COBOL and FORTRAN programs. They must do this by running a small program which inputs each line of text as a string.

4. It appears that they have no ability to transmit or receive programs from the 2200 memory.

5. They can act as a Time-Share Terminal by providing some sort of an executive program which must be running at all times.

6. Because of these features they can transmit and receive data under program control.