WANG LABORATORIES, INC.

MVP PROGRAMMING GUIDE

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The following document is intended to give the reader an overall view of the MVP Operating System with emphasis on programming considerations for the multi-user system. It assumes the reader is familiar with Wang BASIC. Compatibility with other 2200 systems (2200T and 2200VP) is described as well as techniques for converting existing software for the 2200MVP. The program and data sharing features, unique to the multi-programming environment are introduced.

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I. Philosophy of the MVP

Hopefully, programmers and users of past Wang 2200 systems will find the MVP to be a logical variation on the familiar 2200 theme. The MVP hardware is surprisingly similar to the 2200VP. The BASIC-2 language supported on the MVP is essentially the same as the language of 2200VP, with extentions. Users will find the machine almost as responsive as the VP, and every bit as easy to operate. Programmers will find a high degree of software compatibility with both the 2200VP and 2200T.

In addition to the microcode necessary to implement the BASIC-2 language, the 2200 MVP's control memory contains a multi-programming operating system. The primary goal of a multi-programming operating system is to allow several users to share a single computer efficiently. To accomplish this, the operating system divides the resources of the computer - memory, peripherals, and CPU time - among the users. Once each user has been allocated a share of the computer resources, the operating system acts as the traffic policeman, allowing each user to use the system in turn while preventing users from interfering with each other's computations.

On the Wang 2200MVP, the user memory is divided into fixed size memory partitions by executing the Wang supplied utility program, @GENPART, immediately following system power up (see MVP Intro Manual). Each memory partition behaves much like a single user 2200VP. From the user's point of view, each partition functions independently from the other partitions in the system. Each user may LOAD and RUN BASIC software, compose a program, or perform immediate mode operations. As in a single user environment, the user has complete control over his partition. No other operator or other partition may halt execution or change the program text of his partition.

Each terminal may control several partitions executing independent jobs. At any given time, only one of these partitions is in control of the screen and thus capable of interacting with the operator. The partition in control of the screen is said to be attached to the terminal or running in the foreground. Other partitions assigned to the terminal may continue to execute in the background, until such time as operator intervention becomes necessary. If a background job attempts to print to the CRT or get input from the keyboard, its execution is suspended until the terminal becomes available to it.

The terminal becomes available to the waiting background job when the foreground partition explicitly gives up control of the terminal. Sharing the terminal in this way means that a partition maintains control of the terminal for as long as it desires. Messages from other partitions cannot appear and mess up the CRT display at undesirable times. Foreground/background processing is discussed further in Section VI.

In addition to partitions operating independently, the MVP allows partitions to co-operate. Co-operating partitions may share program text (global subroutines) and/or data (global variables). These features allow considerable memory savings over a situation where each partition has its own copy of the same code or data table. The integrity and independence of a partition is maintained by requiring the partition to explicitly declare itself to be global (sharable). (Sharing program text will be discussed in detail in sections IV and V).

The analogy of completely independent single user machines is clouded somewhat by contention for shared peripheral devices. The situation is familiar to programmers used to working with Wang 2200 systems that share one or more disk drives via disk multiplexers. It is sometimes necessary to request exclusive control of a disk while an update is made. Likewise on the MVP it is necessary for a partition to exclusively control a printer for the duration of the printing of a report, lest one partition's print lines become unreadably intermixed with another's. The concept of disk hog mode has been extended on the MVP. The $OPEN and $CLOSE statements allow a partition to request exclusive control of any device on the system.

The programmer who wishes to take the macroscopic view of the MVP system as a whole is quite correct in thinking of all partitions as executing simultaneously. It doesn't take long to realize, however, that the 2200MVP has only one CPU. The operating system creates the illusion of concurrent execution of several programs by rapidly switching from one to the other in turn.

What follows is a simplified description of the MVP operating system, and as such is neither precise nor complete. The programmer need not generally be concerned with these details of how the operating system does its job, but this presentation may be helpful in giving users an overall feel for how a multi-programmed system attempts to maximize system utilization while maintaining good user response time. The programmer who is aware of some of the operating system duties can actually help the system to perform better with little inconvenience to his own coding techniques.

MVP partitions are serviced in a round robin fashion, with some additional priorities given for certain I/O operations. Each partition in turn is given a 30 ms. timeslice, during which it has exclusive control of the CPU. The CPU has within it a 30 ms. timer which is set at the beginning of the timeslice. At the completion of each BASIC statement and at various points in the middle of long MATRIX and I/O operations, the clock is checked to see whether the 30 ms. timeslice has been exhausted.

When the timeslice is over, the MVP operating system carefully saves the status of the partition so that it may be restored later when that partition's turn comes around again. The status of the next partition in line is then loaded and its 30 ms. timeslice begins. The process of swapping out a partition at the end of its timeslice is called a breakpoint. The programmer cannot predict in advance when a breakpoint will occur. Except for a few cases involving global variables within matrix and I/O statements, the occurrence of breakpoints is of no concern of the programmer.

Timeslices do not always last exactly 30 ms. Unlike many operating systems, the MVP switches users (breakpoints) when it is convenient, rather than strictly by the clock. This reduces the amount of status information that must be saved, giving the MVP comparatively low "operating system overhead".

More importantly, breakpoints may occur in the middle of BASIC I/O statements. If, for instance, the disk is hogged by another partition, this condition is quickly detected and a breakpoint occurs. I/O breakpoints differ from program breakpoints in that the partition is specifically marked as "waiting for I/O". When the partition's turn comes around again, it takes only a few microseconds to decide whether processing may proceed or whether the partition is still waiting for the I/O device and thus may be bypassed. Thus if a printer runs out of paper or a partition that does not currently control the CRT attempts CRT output, processing is suspended in that partition almost as effectively as if it were removed entirely from the system, until the I/O device becomes available.

The CPU is much faster than any of its peripherals. Breakpointing during I/O operations allows the MVP to keep many I/O devices busy concurrently with program processing. To accomplish this I/O overlap requires buffering and quite often microprocessors to control the peripherals. The most sophisticated of these intelligent peripherals is the 2236MXD terminal controller. The MVP CPU does not perform INPUT or LINPUT statements. Instead it asks the microprocessor in the 2236MXD to perform the operation. Just as in the case of the printer out of paper, a partition executing an INPUT or LINPUT statement is marked as waiting for I/O and receives no CPU timeslices until the INPUT or LINPUT statement is terminated with carriage return or a special function key. The MXD also performs the line editing functions to move the cursor, and insert and delete characters.

Lastly, the MVP operating system performs some address translation. After all, every partition refers to the terminal keyboard as address /001, the CRT as address /005, and the terminal printer as address /204. The operating system makes sure that all output gets to the proper terminal and all input comes from the proper keyboard.

II. How Independent Programs can Share the CPU and Peripherals

When configured as < n > partitions and < n > terminals, the 2200MVP can be treated as if it were < n > separate 2200VP computers. The 2200MVP is generally compatible with the 2200VP BASIC-2 language. Users with existing software are encouraged to try their software on the MVP as is. The few compatibility problems that may be discovered are discussed in Section III.

As a first approximation for the required MVP partition size, use the size of the single user system the software is designed for. This may be a few hundred bytes small for programs designed for the 2200T and slightly large for 2200VP programs. Once the program is loaded and resolved, the immediate mode command PRINT SPACEK-SPACE/1024 will reveal the exact partition size necessary in K bytes.

Once the partition size necessary for each application is determined, the user will become interested in the total amount of MVP memory necessary to run several programs concurrently. The total memory requirement for an MVP system is the sum of the partition sizes plus 3K for operating system tables. The amount of user memory taken by the system on the various 2200 systems is compared below.

User Memory Taken for System Use

2200T	2200VP	2200MVP
700 bytes	3K	3K + 1K/partition

Notice that the total MVP memory overhead with 2 or more partitions is less than the memory overhead if separate VP's were used.

Note: The discussion above about determining partition size takes into account the need to reserve 1K for partition overhead.

MVP programming and operating considerations are identical with those of a system of T, VP, and workstation processors multiplexed to a disk, with the added complication that the printer can be accessed directly by any user at any time, without pushing a button on a manual multiplexer.

An operator wishing to use the printer on a manually multiplexed system must (1) determine if anyone else is about to print, (2) press the button on the multiplexer for his own station, and (3) run his program. If he runs his program when the printer is being used by someone else, his program just hangs up. In contrast, an operator wishing to use the printer on a 2200MVP must (1) determine if anyone else is about to print, and (2) run his program. However, if he runs his program when the printer is being used by someone else, the print lines from both jobs will be intermixed on the paper.

A very simple modification to the programs will eliminate the possibility of intermixing lines. The MVP allows an executing program to "hog", or reserve, a peripheral device for as long as it wants. The program must be modified to execute a "$OPEN /215" statement before using the printer, and to execute a "$CLOSE /215" statement when finished with it. A program which prints several reports might execute a "$OPEN /215" before and a "$CLOSE /215" after each separate report. This would guarantee that an entire report would be contiguous on the paper, but would possibly let some other program's output appear between the several reports.

Of course, the above discussion also applies to plotters, typewriters, or any other peripheral device which is plugged into the MVP CPU box. Note that it is not NECESSARY to include the "$OPEN" and "$CLOSE" statements in MVP programs -- this is merely a mechanism to guarantee that a program has exclusive use of a peripheral, and to allow operators to run various jobs without the possibility of spoiling someone else's output.

Another simple method to guarantee that a job has exclusive use of a printer, plotter, typewriter, etc. is to plug the device directly into the output connector on the assigned terminal. The disadvantages of this method are, (1) that it must either be considered permanent or else involve a lot of plugging and unplugging, and (2) references to the device must be modified to address /X04 (e.g., /204, /404) since this is the fixed address of the terminal output device connector. Use of a 2221M printer multiplexer on the MVP should not be completely discounted, for it is a good way for a cluster of terminals, located at some distance from the CPU, to share a common printer.

It is possible to reserve a peripheral permanently at partition generation time. This is often done with TC boards, since it is rarely logical for two programs to share a TC board.

III. Compatibility with earlier Wang 2200 Systems

This section deals with the few software imcompatibilities that exist in the 2200MVP. They are listed in the order of frequency with which they are usually encountered. While it is desirable to get existing software up and running quickly, the MVP offers several means of improving performance and reducing memory requirements. Quite often it is possible to reduce the memory requirements of 2200T programs by recoding them using the more powerful BASIC-2 statements. The greatest memory savings are to be realized when program text is shared as discussed in Sections IV and V.

Programs may choose to ignore the potential existence of other programs in the system, but a small amount of "good citizenship" can go a long way in improving overall system performance. Use of the INPUT and LINPUT statements better utilizes the 2236MXD and thus frees a lot of CPU time for other partitions to use in comparison with doing input with the KEYIN statement. If a program must use KEYIN, it is better to use the "VP form" of the statement: KEYIN A$ rather than KEYIN A$, 10, 20.

If a program must test a condition over and over in a tight polling loop, it should perform the test once and then give up the remainer of its timeslice with the $BREAK statement. For programmer convenience, this feature has been built into the polling form of KEYIN. The KEYIN statement is treated as if it actually were KEYIN A$, 10, 20 : $BREAK.

Time delays should be created using SELECT P rather than with FOR/NEXT loops. SELECT P delays are timed by the 2236D terminal, while FOR/NEXT delay loops waste CPU time that could be more productively used by other partitions.

Features of earlier 2200 systems not supported.

1) Users converting 2200T programs for use on the MVP should refer to Appendix C of the BASIC-2 Language Reference Manual for a list of differences between Wang BASIC and BASIC-2.

2) The MVP does not permit $GIO to a disk. This will affect programs that send a CBS strobe to the disk to activate hog mode. The MVP uses the $OPEN and $CLOSE statements to activate disk hog mode, as well as to request exclusive control of any other peripheral. The address form of disk hog, SELECT DISK 390, is supported on the MVP.

3) Some programs use KEYIN to input atom codes from the text atom keys. This works properly on the MVP, but the 2236D terminal does not have all of the atom keys found on a 2226 console. The absence of a PRINT key seems to create the most software transportability problems.

4) Many programs test for the existence of printers and disks before attempting to access them. This is a problem on the MVP because $GIO is not permitted to disks and because several lines worth of buffering separate the terminal printer from the I/O bus. A partial solution is to use the $OPEN and ON ERROR GOTO statements to see if the device address was declared in the master device table when the system was configured using the @GENPART program.

5) Some programs use $GIO with timeout to the keyboard to insist that an operator respond in a fixed period of time. $GIO with timeout is not supported at address /001 on the MVP.

6) Character insert mode is not supported on the MVP. Characters must be inserted into text lines using the insert edit key.

7) The MVP does not permit CI, CO, or INPUT to be selected to any device other than the 2236D terminal. The only exception is that the output of TRACE may be selected to a printer with SELECT CO. The width of the Console Output device may not be redefined to be other than 80 bytes for the purpose of INPUT or LINPUT.

MVP Differences

1) The most obvious difference is that CRT output is somewhat slower on the MVP, depending on the data rate set for the serial line connecting the 2236D terminal to the 2236MXD. This may alter programming strategies that frequently update the entire screen.

2) The 2236MXD allows a maximum of 480 bytes to be entered into a single line request. This places some restriction on the maximum length field that may be entered with a single INPUT or LINPUT statement. This restriction also limits the length of a multiple statement program line that may be entered or edited on the MVP.

3) There are several differences in the LINPUT statement.

   a) The most obvious difference is that the cursor blinks to indicate edit mode. The 2200VP displays an asterisk to the left of the field being edited.

   b) The second difference is that the non-edit mode form of LINPUT places the cursor at the first position of the field instead of following the last non-blank prefill character as on the 2200VP.

   c) The maximum length field is limited to 480 bytes.

4) When an MVP is master initialized, the default disk (SELECT DISK or #0) is the platter the system microcode is loaded from. This differs from the 2200T and 2200VP, which always set the default disk to /310 when master initialized.

5) Time delays using FOR/NEXT loops or $GIO (75xx) not only waste CPU time, but vary in duration as a function of CPU loading. Every 30 ms. a program breakpoint occurs. When the partition's turn comes around again, it is allowed to waste another 30 ms. Time delay loops thus become minimum delay loops on the MVP. It is recommended that SELECT P be used for delays.

SELECT P delays are implemented by the 2236D terminal. Special characters are sent to the terminal to cause the terminal to delay. Since the terminal is buffered, the program does not wait at the PRINT statement causing the delay. It is not unusual for a program to be several PRINT statements ahead of the CRT display while using SELECT P.

6) The 2236 MXD buffers up to 36 keystrokes that have not yet been requested by a program. This helps smooth out peaks in operator typing speed in data entry applications, but it also allows the operator to anticipate program prompts. Sometimes it is necessary to flush this keystroke buffer, for instance, to minimize the effect of an operator beating on the return key while a program overlay loads from floppy disk. It is easy to flush the keyboard buffer with:

```
10 KEYIN A$, 10, 10
```

IV. How to Share Program Text (with No Overlays)

Consider the situation where < n > operators are to sit at < n > terminals attached to < n > partitions, and all run the same job. If the partitions are treated as separate computers, then each partition will have a complete copy of the program, including text and variables. A considerable savings in memory could be realized if only one copy of the program was kept in the MVP, and all the users could share it. This can be done. The text of the program, which does not change as the program runs, can be shared; while the variables, which must change as the program runs, cannot be shared (each user must still have his own copy of all the variables).

In order to share program text, it must reside in a partition which has declared itself to be "global", that is, accessable to other partitions. The simplest way to do this is to create a separate partition, that will not interact directly with an operator, to contain the text of the program (but not the variables), and to let each operator's partition contain only (1) a complete set of variables for the program and (2) a call upon the global partition.

Any partition in an MVP may declare itself to be global and give itself a name by executing a "DEFFN @PART name " statement. Any partition may access a marked subroutine ("DEFFN ' number ") in a global partition by first executing a "SELECT @PART name " statement, and then executing a standard call to the marked subroutine ("GOSUB ' number "). If the name s match and the marked subroutine does not exist in the calling partition, the correct marked subroutine in the global partition will be entered. (See the 2200VP BASIC-2 manual, chapter 16 "The 2200MVP", for a complete description of global and calling partitions). Arguments may be passed to global subroutines in the same manner as if the marked subroutines resided in the calling partition.

Since the calling partition is resolved separately from the global partition, it is the responsibility of the calling partition to contain the necessary DIM or COM statements to define all variables that will be referenced during the execution of the global text. Failure to do so will result in execution time errors.

In order to change a VP program into a shared MVP program, the program must first be modified, and then be properly loaded and run. The following instructions pertain to the modifications.

1. Only marked subroutines can be shared. Change all desired entry points to global text to marked (DEFFN') subroutines. Quite often it is possible to share an entire program, in which case a DEFFN' statement is added to provide a marked subroutine entry to the main line routine.

2. Separate the program into two program files: one, which we will call MAIN, containing all the existing DIM and COM statements and any non-sharable code; and the other, which we will call SUBS, containing all the marked subroutines to be shared.

3. Create a list of all the variables used by all the marked subs. A LIST V operation on the file SUBS is the most convenient method here.

4. Ensure that no DIM or COM statements remain in the file SUBS, otherwise unnecessary storage will be allocated in the global partition.

5. Add to the beginning of the file SUBS the following code:

```
10 DEFFN @PART "jobsubs"
20 $RELEASE TERMINAL
30 PRINT "Partition"; #PART; "background job 'jobsubs'"
40 GOTO 20
```

Line 10 makes the text in the partition accessable to the other partitions and gives it the name "jobsubs".

Line 20 makes it convenient to resolve this partition under operator control, if that becomes necessary. Global partitions are most conveniently loaded by the "automatic program load" feature of system configuration.

Line 30 provides some information if a terminal ever gets attached to this partition, which normally should not happen. Execution is suspended when line 30 is executed until such time as the terminal becomes attached.

Line 40 is needed because it is not logical to execute the global text directly, because the global text is all subroutines and because no variable storage is allocated within the global partition itself. After the branch back to line 20, which releases the terminal, execution again becomes suspended in line 30.

6. Using the existing DIM and COM statements in the file MAIN and the list of variables obtained in step 3, add to the file MAIN a DIM statement containing all the variables used by the text in SUBS which are not already mentioned in a DIM or COM. The purpose of this is to ensure that all of the necessary variables are allocated in the calling partition; any combination of DIM and COM statements which accomplishes this is sufficient.

7. Add to the beginning of the file MAIN the following code:

```
5 SELECT @PART "jobsubs" : ERROR $BREAK : GOTO 5
```

The execution of this statement will allow all marked subroutine calls in this partition to refer to marked subroutines in the global partition named "jobsubs".

The process of global partition definition and reference is accomplished by the execution (not the resolution) of "DEFFN @PART" and "SELECT @PART" statements. If line 5 in this calling partition is executed before line 10 in the global partition has been executed, the system will not know that we intend to have a global partition "jobsubs", and a run-time error will result. This is likely to happen even if MAIN and SUBS are both started using the "automatic program load" feature of system configuration. In order to cope with this possibility, the part of line 5, above, that follows the ":ERROR" will be executed if the global partition is not yet ready, causing the calling partition to "wait a while, then try again".

Once the program has been modified for sharing, it must be properly loaded and run. The most convenient method to do this is to construct a configuration to run the programs, and to use the automatic program load feature to start them up. The following instructions pertain to determining the size of each partition and setting up a memory configuration:

1. Working in a comfortably large program-development partition, load the file SUBS, but do not RUN it. (If you RUN it, you will be attached to another partition by the "$RELEASE TEMINAL" statement. However, nothing else dangerous will happen, and the program will be resolved when you get back to it). Next, execute in immediate mode "PRINT SPACEK-SPACE/1024". The number printed will be the required size of the global partition.

2. Next, LOAD and RUN file MAIN. MAIN must be RUN in order to allocate memory for the variables. (RUNning MAIN should result in an infinitely long wait at statement 5, since "jobsubs" is not defined if a CLEAR was executed after step 1. Use the HALT key). Determine the memory requirements of MAIN with the same immediate mode PRINT command used in step 1.

3. Power down and up again. When the system generation program, @GENPART, is running, construct a configuration with a partition for each terminal, sized with the number from step 2 above, with "program to load" set to "MAIN". Add one partition (any terminal), sized with the number from step 1 above, with "program to load" set to "SUBS".

The following is an example of what the @GENPART program should display when the configuration has been completely specified, assuming (1) the required size of the global partition is 28 KB, (2) the required size of the calling partition is 10 KB, and (3) three terminals are to run the same job:

PARTITION	SIZE(K)	TERMINAL	PROGRAMMABLE	PROGRAM
1	10.00	1	Y	MAIN
2	10.00	2	Y	MAIN
3	10.00	3	Y	MAIN
4	28.00	1	Y	SUBS

Partition #4 has been assigned to terminal #1. This assignment will not be used, but each partition must be assigned to exactly one terminal.

Programming has been enabled for all partitions in this example, but you may want to disable programming if the operators are to be forced to run only the one program, in MAIN.

4. This configuration may be stored on disk. Whenever the system is loaded using this configuration, the calling and global programs will automatically be loaded and started up, and the operators need only to sit down and begin to operate.

V. How to Share Program Text When Overlays are Involved

Many software packages use program overlays to some extent. Since it is generally not appropriate to overlay in global areas this means that it is not as simple a matter to share program text as the last section implies. Several possible strategies for sharing portions of applications that involve overlays are discussed in this section.

First, look for subroutines that are used in several overlays. Disk access methods, such as KFAM, and screen formatting subroutines come to mind. It is easy to apply the methods of the last section to extract a set of subroutines and put them in a global partition. The two basic rules of text sharing still apply: 1) Only marked subroutines can be shared, 2) The calling partition must define all variables that will be encountered during execution of global text.

Many packages are structured with several frequently used overlays and a number of infrequently used overlays. For example, in a data entry package such as Easyform, a number of overlays support forms generation, listing, etc. while one or two support real time data entry activities. It may be efficient to divide such a package into:

(a) The frequently used real time overlays which might be restructured into global programs and made available to a number of operations simultaneously with small calling partitions large enough only to contain the variables.

(b) The infrequently used overlays which might be retained as a single user job, possibly requiring quite a bit more memory than the above, with the intention that only 1 operator will perform these functions.

Some jobs have a number of sequential overlays with little common text, (similar to job steps in a batch run and/or operator prompt and initialization jobs executed prior to a main job). Often these type of jobs cannot benefit significantly from global text storage.

Some things to consider when sharing text from a program which uses overlays:

The LOAD statement clears (resets) the global pointer. That is, when a program, which has established a link with a global partition, loads an overlay, the link with the global partition is broken and must be reestablished. Usually the simplest way to do this is to have the overlay contain a SELECT @PART statement near its beginning. Note, however, that the MVP allows transfer to a specific line number after executing a LOAD, which could be a line in the resident part of the program containing the SELECT @PART and a GOTO to the beginning of the overlay.

If a LOAD statement is encountered while executing global text, the overlay is performed in the calling partition. The usual rules of program overlays apply: 1) The subroutine stack is flushed and 2) execution of the overlay begins in the calling partition. In effect; the system pretends the LOAD statement was encountered within the text of the calling partition.

The steps pertaining to modification of a program using overlays are almost identical to those described for non-overlay programs. The only differences are:

1. The variables used in the extracted global subroutines are inserted via COM or DIM statements in each valid overlay configuration. This is in each overlay, if the entire program is overlayed each time, or it may be once, if inserted in a main section which is never overlayed.

2. The variables should keep the same context as in the original program. That is, common variables if not to be initialized at each overlay, non-common if to be reinitialized at each overlay.

3. It is possible that not all the overlays will reference every marked subroutine in the shared text, and therefore not all the variables mentioned in SUBS will be referenced. Those not referenced need not be defined in the calling partition. The loading of an overlay provides an opportunity to redefine the variables in the calling partition.

VI. How Programs Can Share an Operator (Foreground/Background Processing)

Many CPU bound or disk bound jobs run for a relatively long time without operator intervention (relatively long, meaning long enough for the operator to do something useful elsewhere). In such a case, it would be beneficial if the operator could be running another, perhaps interactive, job in the meantime. Of course, any operator can do this, merely by getting up and sitting down at another terminal.

On the 2200 MVP, it is possible for one terminal to control more than one partition, and therefore more than one job. The $RELEASE TERMINAL statement causes the terminal to be detached from the current partition and attached to another partition (to which it has been assigned at system configuration time).

A single operator can control any number of "background" jobs, plus one "foreground" job. A background job is defined as one which can be expected to run to completion, or at least for a usefully long time, before requiring any attention from the operator. In the commercial environment, there are many programs, usually with the term "update" as part of their title, which operate on a data file or files according to what they find in a command or transaction file. Such programs are ideal candidates for operation as background jobs. On the other hand, there are many programs, often with the term "entry" in their title, which are designed to accept data from an operator (this is where the command or transaction files come from). These obviously must be run as foreground jobs.

Using the most direct method of running two jobs, the operator merely starts a job in one partition, and when it is going well and needs no more intervention from him, he detaches from that partition in order to go start a job in another partition. Unfortunately, if the detached job gets into trouble, there is no terminal available for it to use to call for help. Furthermore, many programs periodically report their current status via the CRT in order to reassure the operator that the job is still alive and running. If a terminal is not available, the job will be suspended at its first status report. A few simple software modifications make the running of multiple jobs much safer and more productive.

The background program should be modified so that after the initial dialog, the program releases the terminal to the foreground partition. Thereafter, whenever the program has something to report which does not require a response from the operator, it must test to determine if the terminal is attached to the partition with $IF ON /005. If it is, the report may be made; if it is not, the report may be discarded. When the program requires a response from the operator, it can simply communicate to the terminal without testing, and the operating system will automatically suspend the partition until the terminal becomes attached. In addition, the background job should provide a means for allowing the terminal to be released back to the foreground job when the operator has read the status report and is satisfied.

The foreground job should be modified so that it periodically releases the terminal to the background job, or at least provides the operator with an option of checking on the background job. Since the method of checking the background job involves releasing control of the CRT, checking the background job must be done when the foreground job is willing to allow the screen display to be cleared or at least is in a position to reconstruct the display when it regains control of the screen.

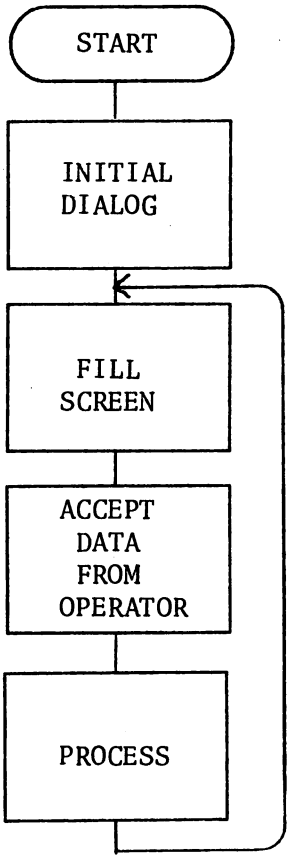
The distinction between two of the forms of the $RELEASE TERMINAL statement is important here. $RELEASE TERMINAL polls the background job for distress messages or operator requests. The background job will respond only if its execution has become suspended due to an attempt to print to a CRT it did not control. $RELEASE TERMINAL TO partition number or partition name attaches the terminal to the background job whether it has asked for it or not. When the background job tests to see if it controls the terminal, it will find that it does and thus may proceed to print its status information.

The method of testing the status of a background job suggested in this section requires the background job to be constantly testing to see if it controls the CRT. Another method of producing background job status reports using global variables is discussed in the next section.

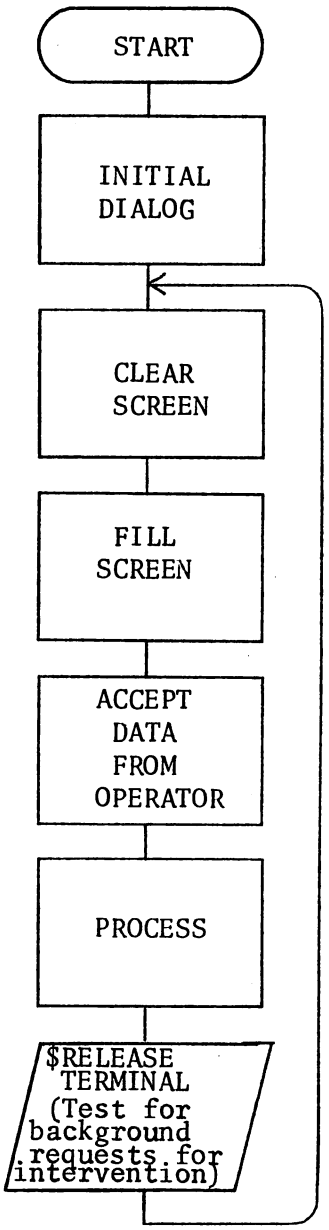
The following examples assume that an analyst has selected a suitable program to be run as a background job, and that the current structure of that program is: first, it conducts an initial dialog with the operator (to find out what files to use, etc.), then begins to execute a loop, which contains some code that reports the results of each trip through the loop, using the CRT. It is further assumed that the analyst has selected a program to be run as a foreground job, and that this program executes a loop containing a section (probably beginning the loop) which updates the entire CRT screen. Your programs may not have this exact structure, but the elementary principles in this example can be adapted or extended to fit many circumstances.

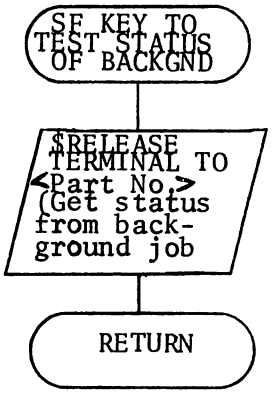
MODIFICATION OF A PROGRAM FOR FOREGROUND OPERATIONS

ORIGINAL PROGRAM



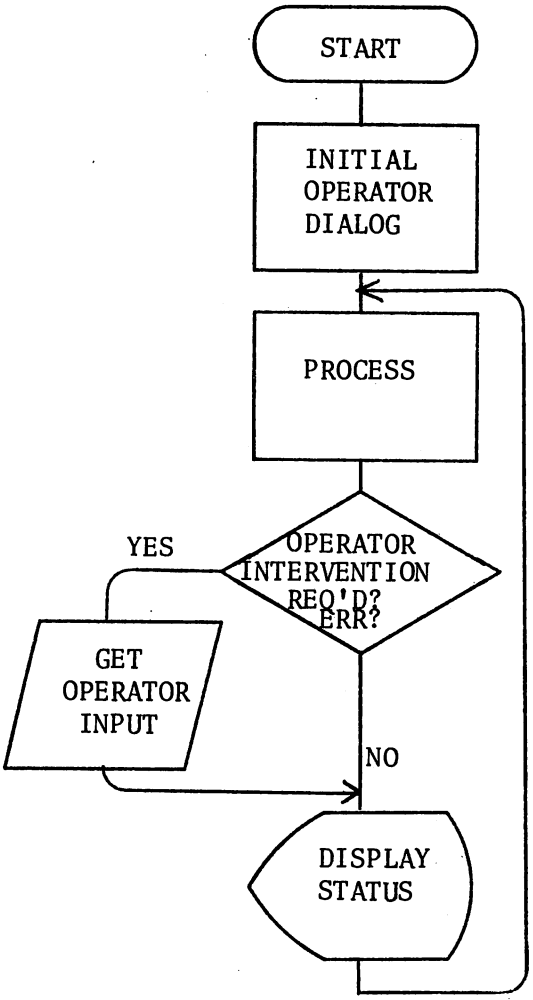
MODIFIED PROGRAM



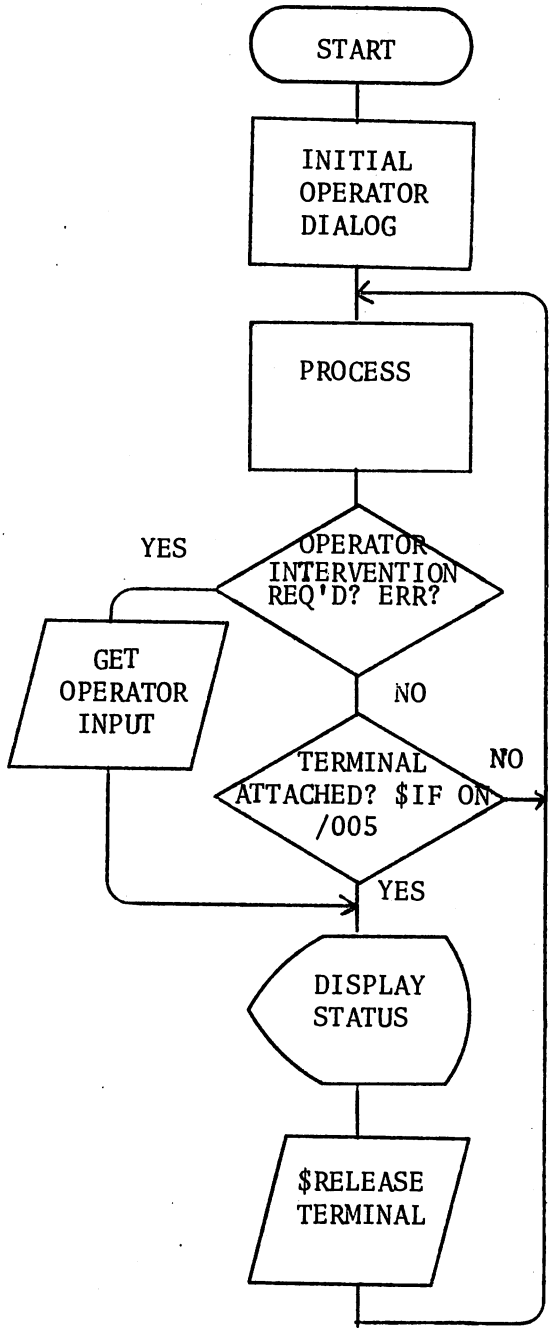


MODIFICATION OF A PROGRAM FOR BACKGROUND OPERATIONS

ORIGINAL PROGRAM



MODIFIED PROGRAM



VII. How Programs Can Share Data

In addition to the sharing of program text discussed in sections IV and V, the MVP allows data to be shared between partitions. Perhaps the most common use for these global variables is to exchange timing and status signals between cooperating programs. It is also possible for jobs to be logically divided into concurrent tasks. For instance, one partition may handle all disk I/O and pass the data to another partition via global variables for computations to be performed. In all cases mentioned so far the advantage of global variables is the speed advantage of communication within user memory instead of the alternative approach of sharing disk files. Use of global variables may also result in memory savings. Table driven systems need have only one copy of the tables contained within the same partition as the shared program text.

Global variables are identified by the character @. Global variables are completely distinct from non-global or local variables. (i.e., A$ and @A$ are separate variables). Both A$ and @A$ may be used in the same program with no ambiguity. Global variables may be defined as numeric or alphanumeric, scalars or arrays according to the same rules as local variables. The difference in defining global variables is that they may not be implicitly defined, but must be defined in DIM or COM statements. Since the purpose of global variables is to allow other partitions to look at or modify their contents it makes sense that global variables should be defined within a global partition.

An intriguing use for global variables is to report the status of a background job. If a background job declares itself global, the contents of its global variables become accessable to other partitions. The background job may now post its status to its global variables. Foreground jobs, and even partitions assigned to other terminals, may learn the status of background job by examining background job's global variables. The flow of the background job is never interrupted with status requests.

When the background job declares itself global to allow other partitions access to its global variables, its marked subroutines become available to other partitions as well. A marked subroutine may thus be included in the text of the background job for the purpose of neatly formatting the status information on the CRT when a foreground job calls it.

The following is an example of global variables and global subroutines used to display the status of a background job.

```
10 DIM @I,@N
.
.
.
60 REM INITIAL DIALOG
.
.
.
90 GOSUB 9000
100 $RELEASE TERMINAL
200 REM PROCESS LOOP
210 FOR @I = 1 TO @N
.
.
.
500 NEXT @I
600 END
.
.
.
1000 REM STATUS SUBROUTINE
1010 DEFFN '16
1020 PRINT "NOW PROCESSING RECORD"; @I; "OF"; @N
1030 RETURN
.
.
9000 DEFFN @PART "BACKGND":RETURN
```

To learn the status of the sample program, a foreground partition executes the following two statements:

```
100 SELECT @PART "BACKGND"
110 GOSUB '16
```

It is possible to call the status subroutine in immediate mode by entering the SELECT @PART statement and pressing special function key '16.

Note that the DEFFN @PART statement is at the end of the sample program. This is because implicitly defined variables are not allocated storage if they are encountered after a DEFFN @PART statement. Rather than include DIM or COM statements for all variables, it is easier to put the DEFFN @PART statement at the end of the program and call it as a subroutine. Remember that a partition does not become global until the DEFFN @PART statement is executed. The sample program chooses to wait until it has finished its dialog with the operator before declaring itself global and making its status available to other partitions.

The discerning reader can probably see that global variables can potentially suffer from the same problem as shared disk files or shared printers if two partitions access the same global variable simultaneously. To some extent, the MVP operating system automatically resolves such conflicts. Sometimes, however, it is necessary for a program to gain exclusive access to a critical region of code that performs updates on global variables.

Most BASIC statements are non-interruptable; that is, the MVP will complete the statement before allowing a breakpoint to occur. The exceptions are I/O and most MAT statements. Chapter 16 of the BASIC-2 Reference Manual contains the complete list of non-interruptable statements. Programmers may be tempted to identify the potential breakpoints in a program by the occurrence of colons and line numbers in the program text, but there are two exceptions to this rule. In the statement

```
100 @A = @A/N:ERROR @A = 9E99:GOTO 500
```

if an error occurs during the division, the first statement of the :ERROR recovery routine will be executed before the 30ms clock is checked. In other words, @A = @A/N:ERROR @A = 9E99 is treated as if it were a single statement.

The other exception is the IF-THEN-ELSE statement. Because IF-THEN-ELSE is non-interruptable, it may be used as a semaphore to prevent other partitions from entering a section of code while a critical update is in progress.

```
50 $BREAK:IF @S = 0 THEN @S = #PART:ELSE GOTO 50
.
.
.
70 MAT SORT @A$() TO W$(), L$()
.
.
.
100 @S = 0
```

If, in the example, a partition executing line 50 finds global variable @S = 0, it sets @S equal to a non-zero value and proceeds into the critical section of code. When another partition comes along, it will find that @S is not zero and will branch back to try again. The $BREAK statement is included so that waiting partitions only test the semaphore once per timeslice. The fastest way for a waiting partition gain access to the critical region is to yield its time to the partition inside the critical region½ When the partition using the critical region is finished, it sets @S = 0 to allow waiting partitions to enter.

Several variations on the IF-THEN-ELSE semaphore are possible. The semaphore variable @S was set to #PART in the example mainly as a debug aid. If the program hangs up, printing out the value of @S will reveal which partition entered but never left the critical region.

WANG LABORATORIES, INC.

Computers

MARKETING RELEASE

TO DISTRIBUTION	**PUBLICATION #**
FROM JOHN THIBAULT MARKET PLANNING & DEVELOPMENT	**DATE** MARCH 1980
SUBJECT EXPANSION OF MVP TERMINAL SUPPORT	**REORDER FROM:**
THIS RELEASE SUPERSEDES:	**DESTROY SUPERSEDED INFORMATION** ☐ YES ☐ NO

Wang Laboratories is pleased to announce expansion of workstation capability for the 2200 MVP Series. The 2200 MVP computing system can now support an additional four (4) terminals, bringing the total number of terminals supported now to twelve (12). This is accomplished by allowing a third 2236MXD Terminal Processor Controller. This announcement further demonstrates Wang's ability to respond to the expanding needs of the 2200 Series marketplace and our existing MVP customers whose needs for expandability are ever increasing.

Expansion to 12 terminals for the 2200 MVP allows the product to address the needs of the rapidly expanding small business computer marketplace during the 80's. This new expansion feature enables the MVP to become even more competitive in areas such as larger data entry applications or order processing applications where more than seven or eight terminals are required. With the small business community becoming more and more informed on state-of-the-art small business computers, the MVP has a distinct edge over the competition. This is largely due to the MVP's excellent price/performance and its true multiprogramming/multiuser ability. Coincident to this release, Wang Laboratories is pleased to announce an updated version of the 2200 MVP Operating System Revision 1.9. This new operating system is required to operate up to 12 terminals on the MVP system. Even with the increased number of workstations supported, the performance of each terminal still meets the high standard of performance the MVP has set since its introduction almost two years ago.

Current users upgrading to 12 terminals will require the recently released version of the MVP Operating System - 1.9. Current MVP users adding the third 2236MXD Controller will also be required to purchase the A-option CPU chassis extension option (if not already purchased). It should be noted all MVP's ordered since January 15, 1980 include this option.

Before proposing multiterminal configurations to either a new or existing customer, there are several issues that must be addressed. Your analyst should review the application to determine overall I/O requirements. Listed below are areas that must be reviewed.

- Memory requirements per partition.
- Number of partitions required.
- Operator response for heavy I/O jobs.
- Heavy use of KEYIN is not recommended with systems with more than 8 terminals.

WANG LABORATORIES, INC.

Computers

MARKETING RELEASE

TO DISTRIBUTION	PUBLICATION #
FROM JOHN THIBAULT MARKET PLANNING & DEVELOPMENT	DATE MARCH 1980
SUBJECT EXPANSION OF MVP TERMINAL SUPPORT	REORDER FROM:
THIS RELEASE SUPERSEDES:	DESTROY SUPERSEDED INFORMATION ☐ YES ☐ NO

- The use of LINPUT in heavy data entry operations should be encouraged.
- The user should be aware of multiple use of a single peripheral with slow throughput as the number of users increases.
- Customers using KFAM-7 as their only means of file access will be limited to 11 terminals.

The growth to 12 terminals will allow the MVP to compete with systems supporting more than 10 terminals, and offer processing capabilities unmatched by other small business computers.

ANNOUNCING THE NEW FAMILY OF 2200 SMALL BUSINESS COMPUTER SYSTEMS

Wang Laboratories is pleased to announce a new series of 2200 system packages including the latest in 5 1/4" disk storage technology. Combined with aggressive pricing and increased flexibility in hardware configurations, the 2200 family sets a tough, new standard in price/performance.

This announcement fulfills the promise made by John Cunningham in his November 15, 1982 statement on 2200 product line direction, to offer a complete 2200 system for under $12,000 U.S. list.

The family of 2200 products now includes three new MVP packaged configurations as well as a standalone 5 1/4" disk storage peripheral.

New 2200 System Configurations

These packaged configurations are aimed at new customers, existing users as add-on equipment and large corporations buying multiple units. Because of their low entry price and expandability, they are viable as a competitor against a wide range of low-end minicomputers, personal computers and other high-end micros.

MVP-P1
- MVP Processor with 8 Available I/O Slots *9 slots*
- 64KB Memory
- 22C32 Triple Controller
- 5 1/4" Disk Storage Device with 10MB Fixed Storage and 320KB Removable Floppy Drive

MVP-P2
- MVP Processor with 8 Available I/O Slots
- 128KB Memory
- 22C32 Triple Controller
- 5 1/4" Disk Storage Device with 10MB Fixed Storage and 320KB Removable Floppy Drive

MVP-P3
- MVP Processor with 8 Available I/O Slots
- 256KB Memory
- 22C32 Triple Controller
- 5 1/4" Disk Storage Device with 10MB Fixed Storage and 320KB Removable Floppy Drive

New 5 1/4" Disk Storage Technology

This 5 1/4" unit is a new 2200 peripheral aimed at existing users as add-on equipment as well as a component of the three new MVP packages outlined above. The unit can be used as an add-on to VP, LVP, LVPC, MVP and MVPC systems. When configured as an add-on, a 22C03, 22C11, or a 22C32 Controller may be used.

2275-10
- 10MB 5 1/4" Winchester drive
- 320KB Floppy Drive

2275-20
- Dual 10MB 5 1/4" Winchester drives

HIGHLIGHTS

PRODUCT OVERVIEW

The Wang 2200MVP-P1, P2 and P3 systems represent three exciting new small business computer solutions. These configurations provide a powerful, competitive tool to use at the low-end when competing against personal computers, low-end minicomputers and other high-end micros. The pricing, including a workstation and printer, breaks the psychological barrier of $12,000 while still delivering a system that offers maximum expansion potential. The P1, P2 and P3 configurations fill the need for larger storage systems at entry level pricing.

The 2275-10 and -20 provide for low cost add-on storage for existing users. Its compact design will be most attractive to the space conscious buyer. Measuring approximately 14.9" x 6.5" x 16", the unit will utilize an enclosure similar in design to the Wang PC electronics unit and house the disk drives, one printed circuit logic board, one Regulator board, a 60 watt linear power supply and one 50 cfm fan. Because sector size and sectors per track are compatible, the 2275 can represent the media bridge for users who wish to migrate software and data files to the Wang PC. A conversion procedure may be necessary, however. The units can be used with any 2200VP, LVP, LVPC, MVP or MVPC system. When combined with a low cost MVP it makes a very price competitive entry level system. Since this device incorporates the latest in 5 1/4" micro-Winchester technology, it will be helpful in selling new accounts. With the addition of the 2275 unit, the price/performance ratio of our low to middle range 2200 systems has been significantly improved.

SOLUTIONS

The new offerings provide a highly expandable entry level system at the lowest entry level price possible to compete in the small business systems market. The 5 1/4" package price will take greatest advantage of the new storage peripheral for the 2200. The pricing of the 5 1/4" storage device is competitive with that of other offerings in the personal computer marketplace.

The MVP-P1, P2, P3 and the 2275 units address four specific market needs:

1. AFFORDABILITY

High performance at low cost is now a reality with the introduction of the MVP-P1, P2 and P3 line of 2200 small business computers. With an entry level price of $7,525 for a minimum configured MVP-P1, this new line of 2200 systems is most affordable. At $4,000 for the 2275-20 disk peripheral, 20 megabytes of add-on disk storage is now available at low-cost.

2. EXPANDABILITY

With 8 additional I/O slots available, the full complement of existing hardware options can be utilized by the MVP-P1, P2 and P3. A wide variety of communications and peripheral combinations are therefore possible. The user can start with the lower priced MVP-P1 and upgrade memory until reaching the MVP-P3 level. The user can start with a single workstation and expand up to 13 users processing simultaneously. Also, if the user should require a system with more than 256K of memory, an MVP upgrade is available via the addition of a "C" Option (Refer to MVPC upgrade prices).

3. RELIABILITY

With over ten years of proven performance, the 2200 Series of small business computers has been one of the most reliable products in the marketplace. Potential customers will take note of the large installed base of over 60,000 systems worldwide.

4. SOFTWARE AVAILABILITY

Potential customers will take great comfort in the knowledge that a comprehensive array of off-the-shelf software exists for this product line both from Wang and third-party developers. Do not overlook the power of this selling point.

Wang has also announced the availability of P.R.I.S.M., a data dictionary driven software product which is targeted to the same market as the new series of MVP systems. With P.R.I.S.M., a user can perform many of the ad hoc inquiry and reporting functions virtually without programming. The data dictionary is also accessible via a user program. This makes it possible to develop complex applications using P.R.I.S.M. as a foundation.

Of course, all current Wang developed software, including the Operating System and P.R.I.S.M., will be available on 5 1/4" diskettes for use by the 2275-10 disk peripheral.

MARKETING STRATEGY

PRODUCT POSITIONING

This announcement demonstrates a continuing corporate commitment to the 2200 product line. The 2200MVP-P1, P2 and P3 represent excellent low cost, proven DP solutions which are attractive to a broad prospect base where cost is a prime consideration. The addition of the 5 1/4" disk storage technology introduces a new dimension to the expandability of the 2200 product line.

TARGET MARKET

Existing Accounts

Significant add-on business can be generated by introducing your customers to the 2275-10 and 2275-20 disk peripherals. Both of these units may be attached to any existing 2200VP, LVP, LVPC, MVP or MVPC system. Priced at $3,000 for the 2275-10 and $4,000 for the 2275-20, this device represents a low cost means for add-on disk storage utilizing the latest in disk storage technology.

The 2200MVP-P1, P2 and P3 make an excellent choice for distributed processing needs for large accounts.

New Accounts

For the small account, the 2200 MVP-P1, P2, and P3 systems represent a low cost entry level solution to their data processing needs. For the large account, these systems are a strong solution to their distributed processing needs.

CONFIGURATION

Two new offerings are being introduced. These are:

1. A new family of 2200MVP small business computers available in three configurations -- MVP-P1, MVP-P2 and MVP-P3

- MVP Processor with 8 Available I/O Slots
- 22C32 Triple Controller
- 5 1/4" Disk Storage Device with 10MB Fixed Storage and 320KB Removable Floppy Drive

The three MVP configurations differ in available memory.

- -P1 has 64K
- -P2 has 128K
- -P3 has 256K

2. An add-on disk peripheral unit available in two models -- 2275--10 and 2275-20

The 2275-10 disk peripheral is equipped with a single 10MB 5 1/4" Winchester drive and a single 5 1/4" 320KB Floppy Drive. The 2275-20 unit comes equipped with dual 10MB Winchester drives. These disk peripheral units must be used with either a 22C03, 22C11, or a 22C32 Controller.

Diskette formats supported by the 2275 disk peripheral unit are:

256 bytes/sector (Standard format used for 2200 disk operations)

Sector size:	256 bytes
Sectors/track:	16
Tracks/side:	40
Sides:	2
Total Capacity:	320KB

512 bytes/sector (Standard Wang PC format)

Sector size:	512 bytes
Sectors/track:	9
Tracks/side:	40
Sides:	2
Total Capacity:	360KB

The 512 bytes/sector format is the standard Wang PC format and is supported by the 2200 for interchange purposes. Sector data is therefore transferrable. However, conversion may be required for file handling. The 512 byte sectoring is transparent to the 2200 Operating System. The Disk Processing Unit (DPU) maps two 2200 256 byte logical sectors into one 512 byte physical sector.

BASIC-2 accesses diskettes with this format as if the platter were formatted with 256 byte sectors. All BASIC-2 disk operations can be performed.

SUPPORT POLICY

Current 2200 entitlement and support policies will apply.

ORDERING INFORMATION

PRICING

Standard 2200 volume discounts apply.

Purchase Pricing

MODEL #	DESCRIPTION	PURCHASE PRICE (U.S. DOLLARS)	MONTHLY MAINTENANCE
MVP-P1	64K MVP	$ 7,525	$161
MVP-P2	128K MVP	$ 8,725	$176
MVP-P3	256K MVP	$ 11,125	$206
2275-10	10MEG/320KB	$ 3,000	$ 56
2275-20	10MEG/10MEG	$ 4,000	$ 84

Rental Pricing

Only the 2275-10 and 2275-20 disk peripherals may be rented.

	MONTHLY RENTAL PRICES			
	1 YEAR	2 YEARS	3 YEARS	5 YEARS
2275-10	$165	$153	$132	$120
2275-20	$220	$204	$176	$160

AVAILABILITY

Effective : May, 1983
First Customer Ship : Q1 FY 84

Customer Engineering Software Support

SPR NO F004274 — Wang Problem Report — Wang Laboratories — ADD / UPDATE X

ORIGINATOR INFORMATION — Date 01/16/84
Name: KEN MAILLOUX — Organization: TSC
Phone: (617) 967 0381 EXT — RDB: 7944

CUSTOMER INFORMATION
Name: MJ SYSTEMS — City:
Cont: LINWOOD FERGUSON — Phone: (804) 977 2732 EXT

PRODUCT INFORMATION
Product: 2200 — Model: MVP — System Rel: 02 05
Component: BASIC II — Ver: 02 05
Other Release Information:

PROBLEM INFORMATION
Description:
When using a 2275-10 disk drive the user attempts to access the diskette drive when the drive is empty. An error I98 is given which is normal. However, a second or third attempt to access the diskette will cause the terminal to hang the only recourse being to hit RESET.

How To Duplicate:
Select the 2275-10 and execute LISTSDCT/B10 with no diskette in the floppy drive. Error I98 is given. Edit/recall and return and the terminal will hang. It may take a couple of tries. Might be related to timing. Customer has an error handling routine that works with our other drives.

Other Materials Submitted:
User must reset out of the application.

PRIORITY Origination 2 Screening 2 Resolution 2

SCREENING STATUS — Date 01/17/84 — Comments

PROBE Contact: COLLETTE — Ext: 382 — Critical Acnt Xref:
Keywords: INTERPRETER PROGRAM

Add Info:

RESOLUTION STATUS	Date	Description
Circumvention	/ /	
Temporary Fix	/ /	
Permanent Fix	/ /	
Rejected	10/25/84	Not reproducible as submitted
Delayed	/ /	

CIRCUMVENTION INFORMATION

CURRENT STATUS: CLOSED-REJECTED
Description: REJECTED - Not reproducible as submitted
See History

WANG LABORATORIES, INC.
ONE INDUSTRIAL AVENUE, LOWELL, MA 01851 • TEL: 617/459-5000, TWX 710-343-6769, TELEX 94-7421

To: Lee Collette (MS 0115)

From: Jerry Sevigny

Date: 28 February 1984

Subject: @RECOVER

The following change to @RECOVER should be given to customers who desire to be able to specify whether this utilty will generate a disk with the new or old hashing algorithm.

The following lines should be added:

```
1115    PRINT AT (13,0,160);
      : K$="O"
      : LINPUT "Do you want to use the NEW (N) or OLD (O) Hashing"
        Algorithm?"-K$
      : ON POS ("OoNn"=K$) GOTO 1120,1120,1125,1125
      : ELSE GOTO 1115


1125    PRINT AT (18,20,60);"Scratching output disk";
      : SCRATCH DISK ' T#2, LS=R1, END=R2
      : PRINT AT (18,20,60);
      : RETURN
```

Note: When I made this change, the size of @RECOVER exceeded the previous disk storage space. Shortcuts could be implemented but this appeared to be the most simple.

To: Ken Mailloux (MS 0115)

From: Jerry Sevigny

Date: 28 March 1984

Subject: TIME Function

The TIME function within the MVP operating system was designed to provide for the capability of centiseconds. This is compatible with the VS. However, the devices which we currently offer (triple controller and the MXE) do NOT have this ability. Therefore, the user will always see a value of 00 when using either of these two devices. In the future, if a more accurate clock is made available then the operating system would be able to handle it.

ANNOUNCING
ADDITIONS TO THE
2200 FAMILY
by 2200
Product
Marketing

Wang Laboratories is pleased to announce two additions to the family of 2200 system packages. The MVP-P4 and -P5 packages include the latest in 5 1/4" disk storage technology. Combined with aggressive pricing and increased flexibility in hardware configurations, the 2200 family continues to excel in price/performance.

The family of 2200 products now includes five MVP packaged configurations as well as four versions of the standalone 5 1/4" disk storage peripheral. The new MVP-P4 and -P5 packages with their unique complement of components define the high performance small business computer market.

HIGHLIGHTS

PRODUCT OVERVIEW

The Wang 2200MVP-P1 through -P5 systems represent five exciting small business computer solutions. The MVP-P1 through MVP-P3 packaged systems address the low-cost entry level market. The MVP-P4 and -P5 systems with increased disk storage capacity and intelligent backup capability provide the growth path from the earlier P-packages while appealing to the needs of the large end-user.

The 2275-30 and -60 provide for low cost add-on storage for existing users. Its compact design will be most attractive to the space conscious buyer. Measuring approximately 14.9" x 6.5" x 16" (38cm. x 16cm. x 40cm.), the unit will utilize an enclosure similar in design to the Wang PC electronics unit and house the disk drives, one printed circuit logic board, one Regulator board, a 60 watt linear power supply and one 50 cfm fan.

Because sector size and sectors per track are compatible, the 2275 can represent the media bridge for users who wish to migrate software and data files to the Wang PC. The units can be used with any 2200VP, LVP, LVPC, MVP or MVPC system. When combined with a low cost MVP it makes a very price competitive entry level system. Since this device incorporates the latest in 5 1/4" micro-Winchester technology, it will be helpful in selling new accounts. With the addition of the 2275 unit, the price/performance ratio of our low to middle range 2200 systems has been significantly improved.

SOLUTIONS

The new offerings provide a highly expandable progression from the earlier systems at prices competitive in the small business arena. The 5 1/4" package prices will take advantage of the new storage peripheral for the 2200. The pricing of the 5 1/4" storage device is competitive with that of other offerings in the personal computer marketplace.

The MVP packages and the 2275 units address three specific market needs:

1. AFFORDABLE — High performance at low cost is now a reality with the availability of the MVP-P1 - P5 line of 2200 small business computers. With an entry level price of $7,525 for a minimum configured MVP-P1, this new line of 2200 systems is most affordable.

2. EXPANDABLE — With 6- 8 additional I/O slots available, the full complement of existing hardware options can be utilized by the MVP-P1 through P5. A wide variety of communications and peripheral combinations are therefore possible. The user can start with the lower priced MVP-P1 and upgrade memory and/or disk until reaching the MVP-P5 level. The user can start with a single workstation and expand up to 13 users processing simultaneously. In the case of the P4 and P5 packages up to four workstations can immediately be supported by the 2236MXE controller.

3. RELIABLE — With over ten years of proven performance, the 2200 Series of small business computers has been one of the most reliable products in the marketplace. Potential customers will take note of the large installed base of over 60,000 systems worldwide.

MARKETING STRATEGY

PRODUCT POSITIONING

This announcement demonstrates a continuing corporate commitment to the 2200 product line. The 2200MVP-P1 through P5 represent excellent, reasonably priced DP solutions which will prove attractive to a broad prospect base where cost is a consideration. The addition of the 5 1/4" disk storage technology introduces a new dimension to the expandability of the 2200 product line.

TARGET MARKET

Existing Accounts

Significant add-on business can be generated by introducing your customers to the line of 2275 disk peripherals. These units may be attached to any existing 2200VP, LVP, LVPC, MVP or MVPC system. Priced between $3,000 for the 2275-10 and $8500 for the 2275-60 in quantities of one, these devices represent low cost means for add-on disk storage utilizing the latest in disk technology.

New Accounts

For the small account, the packaged systems represent a low cost solution to their data processing needs. For the large account, these systems are a strong solution to their distributed processing needs.

PRODUCT DESCRIPTION
DETAILED DESCRIPTION

Two new offerings are being introduced. These are:

1. Two additions to the family of 2200 packaged systems -- the MVP-P4, and MVP-P5

2. An add-on disk peripheral unit available in two models -- 2275-30 and 2275-60

The 2275 Disk peripheral units must be used with either a 22C03, 22C11, or a 22C32 Controller.

Diskette formats supported by the 2275 disk peripheral unit are:

256 byte/sector (Standard format used for 2200 disk operations)

Sector size:	256 bytes
Sectors/track:	16
Tracks/side:	40
Sides:	2
Total Capacity:	320k bytes

512 byte/sector (Standard Wang PC format)

Sector size:	512 bytes
Sectors/track:	9
Tracks/side:	40
Sides:	2
Total capacity:	360k bytes

The 512 byte/sector format is the standard Wang PC format and is supported by the 2200 for interchange purposes. The 512 byte sectoring is transparent to the 2200 Operating System. The Disk Processing Unit (DPU) maps two 2200 256 byte logical sectors into one 512 byte physical sector.

BASIC-2 accesses diskettes with this format as if the platter were formatted with 256 byte sectors. All BASIC-2 disk operations can be performed.

2200 SYSTEM CONFIGURATIONS

These packaged configurations are aimed at new customers, existing users as add-on equipment and large corporations buying multiple units. Because of their low entry price and expandability, they are viable as a competitor against a wide range of low-end minicomputers, personal computers and other high-end micros. The following table highlights the positioning of the new MVP-P4 and P5 within the family of 2200 packaged systems.

CONFIGURATION SUMMARY

	MVP-P1	MVP-P2	MVP-P3	MVP-P4	MVP-P5
Memory	64K	128K	256K	128K	256K
Controllers	22C32	22C32	22C32	22C11 2236MXE 2229IOP	22C11 2236MXE 2229IOP
I/O Slots Available	8	8	8	6	6
Disk Device	2275-10	2275-10	2275-10	2275-30	2275-30
Tape Device				2229	2229

SUPPORT POLICY

Current 2200 entitlement and support policies will apply.

ORDERING INFORMATION

PRICING

Standard 2200 volume discounts apply.

Purchase Pricing

Refer to the pricing section at the end of this issue for pricing information.

PACKAGED COMPONENT DESCRIPTION

Controllers

22C32	Triple controller board for diskette, printer, and 1 2200 terminal
22C11	Dual controller for printer and diskette
2229IOP	Controller supporting 2229 Cartridge Tape Drive
2236MXE	4 port terminal processor for 2200 workstations and provides asynchronous communications capabilities

Disk Peripherals

2275-10	Disk device containing one 10MB Winchester drive and one 320K floppy drive
2275-20	Disk device containing dual 10MB Winchester drives
2275-30	New disk device containing one 30MB Winchester drive and one 320K floppy drive
2275-60	New disk device containing dual 30MB Winchester drives

Disk Upgrades

UJ-5054	Upgrades 2275-10 to a 2275-30
UJ-5055	Upgrades 2275-20 to a 2275-60

Tape Device

2229	Intelligent start/stop tape device suitable for disk backup and archiving

AVAILABILITY

	Domestic	International
Effective:	April, 1984	May, 1984
First Customer Ship:	May, 1984	June, 1984

FREQUENTLY ASKED QUESTIONS ABOUT THE MVP

How compatible is MVP BASIC-2 with the Wang 2200 BASIC and BASIC-2 of earlier 2200 models?

For the most part, MVP BASIC-2 is upward compatible with VP BASIC-2. BASIC-2 is in turn compatible with Wang BASIC as supported on the 2200T. The MVP imposes some restrictions on $GIO, especially $GIO with delays or timeouts. The main software compatibility problems arise with program logic, not individual statements. An MVP is much like a multiplexed disk environment, with the added complication of a shared printer. MVP BASIC-2 contains new statements to allow programs to "hog" a shared printer.

Can terminal 1 terminate a program executing in a partition assigned to another terminal?

No. Unlike most multi-programming systems, the MVP has no main console with ultimate control over the system. It is true that terminal #1 controls the system at partition generation time, but after memory has been partitioned, terminal #1 has no special status. (The only special power terminal #1 maintains is the ability to set the Broadcast Message). Of course, programs may cooperate by exchanging control information via global variables.

How fast is the MVP?

The MVP CPU processes at the same speed as a 2200 VP (6 to 10 times faster than the 2200T). However, CPU time is shared among the partitions, with a small swapping overhead. Dividing CPU speed by the number of partitions as a measure of partition execution speed is quite conservative since during most I/O operations, the partition is put to "sleep" releasing this partition's CPU time until I/O completion.

How are the terminals numbered?

Terminals are numbered according to which port on which 2236 MXD they are plugged into. The terminals plugged into the first MXD are numbered 1-4. The terminals plugged into the second MXD are numbered 5-8. It is not necessary to fill the MXD ports in order, nor is it necessary to assign a memory partition to unused MXD ports. A good use for spare MXD ports is to set them to various baud rates for use with various speed remote terminals. It does not hurt the MXD to move the terminal connectors around while the system is powered on.

Does the MVP support foreign terminals?

No. The communication protocol between the 2236 MXD and the 2236D terminals is 8 data bits plus odd parity. This is not a popular mode of asynchronous communication. Secondly, the MXD frequently sends special control characters such as atoms to facilitate compressed data to the terminal. These would appear as random garbage on most foreign terminals. Third, the MXD does not have any facility to translate our cursor control characters into different characters that may be required by the foreign terminal. (To support foreign terminals, the MXD would have to be redesigned to provide PROM space for the extra microcode).

Are global partitions associated with a terminal?

Yes. All partitions on the MVP are assigned to a terminal. The terminal to which a partition is assigned exercises ultimate control over it. (i.e., the operator at that terminal may CLEAR the program from the partition). Global partitions differ from non-global partitions in that a global partition executes a DEFFN @PART statement, which makes its subroutines and global variables available to other partitions. By default, any MVP partition may access the global partition. Access may optionally be restricted to specific terminals.

May a terminal be attached to a global partition and execute it?

Yes. A global partition may contain the appropriate DIM and COM statements to allocate variable storage. It is then possible to execute the global partition directly, rather than calling it from another partition. A directly executed global partition is still reentrant its program text may still be shared by other calling partitions. There are at least 3 practical situations where directly executing a global partition is desirable. First, the 1K system overhead of setting up a separate calling partition is saved. Second, unrelated jobs may use the global partition naming facility to locate each other and pass synchronizing information back and forth through global variables. Third, it may be desirable to merely give jobs a name, so that an operator responsible for controlling several partitions can refer to them by name rather than partition number.

Does the MVP support Batch processing?

Yes, but not directly. The MVP operating system does not form queues of pending jobs, assign priorities, or provide an automatic means for processing a queue of BASIC programs one at a time. ~~Also, the MVP does not support a card reader at the present time.~~ However, BASIC-2 provides all of the tools necessary to write a batch processing system.

Does the MVP support Print Spooling?

Not really. The goal of automatic print spooling is to make a disk file look exactly like a printer from the program's point of view. BASIC-2 has the PRINTUSING TO statement that allows one form of MVP output operation to be targeted to variables in memory, rather than a printer or CRT. This could be used to write a SPOOLING program, at the expense of some normal I/O flexibility. It would probably be easier, however, to implement batch processing and sequentially process report generating programs. Batch processing would also require less disk space. A more automatic spooling is a consideration for a future release.

What happens if 2 or more partitions assigned to the same terminal try to print to the CRT?

At any given time, only one partition is "attached" to the terminal. The attached partition has exclusive control of the terminal. If another partition attempts to access the terminal, it is "put to sleep" until the terminal becomes available to it. The "attached" partition maintains control over the terminal until it explicitly gives up control by executing a $RELEASE TERMINAL statement, either in program or immediate mode. Control of the terminal is usually released to "any waiting partition", though it is possible to specify which partition control is to be released to.

Why must the MVP be powered down in order to reconfigure memory?

As far as the operating system is concerned, reconfiguring memory is a very drastic operation. It is not possible to move an executing program from one memory address to another. Further, it is not possible for the operating system to detect whether a partition may be safely cleared. (We can't tell the difference between the case of an operator leaving the terminal without clearing the program text and a program under development, where the operator has not keyed 'return' lately). By insisting that the system be powered down in order to reconfigure memory, we hope to impress upon the user how drastic the action of reconfiguring memory is on the current contents of the system.

Can a program executing in a partition assigned to one terminal cause a message to appear on the CRT or local printer of another terminal?

Not directly. Part of our protecting MVP users from each other's programming errors is to not allow direct access to the other guy's terminal. In order to send a message to another terminal, the message must be put someplace where a program executing in a partition attached to the receiving terminal can access the message. Global variables and disk files are means by which terminals may communicate. Even the Broadcast Message requires a specific effort by the receiver before it will be displayed. Terminals communicate on the MVP system by mutual co-operation.

Are global partitions reentrant?

Yes. Any number of partitions may be simultaneously executing the global shared program text. This is possible because each calling partition contains its own set of variables.

In cases where the global partition contains shared data (global variables), it may be necessary to "hog" the shared data while critical updates take place — just as it is sometimes necessary to hog shared disk files. Global variables may be used as semaphores to easily implement this hog mode.

How difficult is it to modify an existing 2200 program to be loaded into a global partition and accessed by several calling partitions?

Modifying a program to be shared as a global partition is a fairly simple clerical change, if the program does not require overlays.

A DEFFN @ PART statement must be added to declare the partition global. A DEFFN' statement must be added to form the entry point to the global program. DIM and COM statements are removed, otherwise variable storage will be allocated within the global partition, which will waste memory.

A short calling program must be written. This program will be loaded into all partitions wishing to call the global program. This short calling program consists of a SELECT @ PART statement, several DIM and COM statements (like the ones removed from the global text) and a GOSUB' to cause execution of global text to begin. All variables, including numeric scalars, must explicitly appear in the calling partition, usually in DIM or COM statements.

Can a program tell which partition it is loaded into or which terminal it is assigned to?

Yes. The numeric function #PART returns the partition number. The function #TERM returns the terminal number. Example:

```
PRINT #PART, #TERM

10 IF #PART = 3 THEN 20
```

(In the case of global text, #PART and #TERM give values that apply to the calling partition).

Can a program tell the size of the partition it is loaded into?

Yes. The SPACEK function gives the partition size in K (including the 1K system overhead). The SPACE function gives the free space (the space not currently used by program and variables).

Example: PRINT SPACEK

In the case of global text, SPACEK applies to the calling partition.

(By the way, if you want to know how much memory is being used by a VP or MVP program, PRINT SPACEK - SPACE/1024. The answer will be output in K).

How are global partitions identified?

By a name of up to 8 characters.

Can a global subroutine call a global subroutine in yet a different global partition?

Yes.

What happens if a LOAD statement is encountered in global text?

Example clarify

The program overlay is loaded into the original calling partition. Execution proceeds in the original calling partition, just as if the LOAD statement had been encountered in the original calling partition.

What happens if a STOP statement is encountered in global text? executed from which terminal

The program stops. The CONTINUE command will cause execution to resume with the next statement in the global partition.

What security features are provided on the MVP?

No hardware protection, such as memory storage keys, are required because the MVP microcode Operating System/BASIC interpreter controls all memory allocation and memory references. A user program cannot escape from its partition and run wild through memory. The operating system allows a partition to access only the terminal it is assigned to. This insures that a programming error in one partition will not disturb the screen of another terminal.

An important MVP security feature is the ability to disable programming on any partition. This forces the operator to go through software to access disk files. With programming disabled, the operator may only load a program called "START". The "START" program is responsible for causing other programs to be loaded. The operator running with a non-programmable partition cannot read or alter the contents of memory, list the program, or list the disk catalog without the aid of software. Pass word protection of disk files is built into KFAM7 software.

Programs saved with SAVE! command are encrypted when stored on disk and thus cannot be examined by an unauthorized person. When an encrypted program is loaded, it cannot be modified or listed.

Will the MVP eventually support all 2200 peripherals?

Some 2200 peripherals present potential timing problems on the MVP. Others present logical problems. We will add new peripherals to the MVP as we test them to make sure they perform well and don't bog down the system. The 2226 console will probably never be supported, because it lacks necessary keyboard buffering.

How much memory does a typical program require?

The Wang 2200 is very memory efficient. Programs are stored in atomized form, where each BASIC keyword is represented by a 1 byte atom. One benchmark showed that the average BASIC statement required 11 bytes. Numeric variables require 8 bytes. Alpha variables require the number of bytes mentioned on the dimension statements. Wang BASIC is rich with data conversion statements that allow numeric data to be stored to less than full 13 digit precision in alpha variables.

Memory requirements on the MVP differ from other 2200 systems only in the amount system overhead. If one thinks of the 2200T and 2200VP as "single partition systems" the comparison of per partition overhead is as follows:

2200T	2200VP	2200MVP
700 bytes	3K	1K 4K actually

In addition, the MVP requires 3K bytes for tables used in the control of the system as a whole.

Shall I write 2200T compatible BASIC programs for my MVP?

The BASIC-2 is a more efficient language than Wang BASIC as far as program size and execution speed are concerned. Even so, writing 2200T compatible programs for the VP is justifiable since only a single program need be maintained for either CPU.

However, on a multi-programming system the considerations are different. Since an inefficient program uses more CPU time, less CPU time is available for processing other programs. Thus, not only does the inefficient program run more slowly, but the entire system performance is degraded. Good MVP programming must consider the effect of the program's execution on the total system performance, and thus, should be written efficiently making use of the tools provided by BASIC-2. This primarily involves areas of terminal/keyboard I/O and delay loops.

For example, character entry is often performed on the 2200T as follows:

```
100 KEYIN A$, 110, 120 : GOTO 100
```

The program loops on line 100 until a character is entered, but note that no meaningful processing is actually being performed. The BASIC-2 form of KEYIN is much preferred

```
100 KEYIN A$,, 120
```

since the program is put to "sleep" until a character is entered. The CPU is only involved when characters are actually entered.

Better yet is to request an entire line of data, for example:

```
100 LINPUT A$
```

in which case the program is put to "sleep" until the entire line of data is entered.

Using dummy FOR/NEXT loops to delay for a specific period of time is clearly wasteful of CPU time since no meaningful processing is taking place. Implementing delays with SELECT P is recommended since the partition is put to "sleep" during the SELECT P pause (the timing is done by the terminal). Unlike FOR/NEXT delays, SELECT P has the additional advantage of being independent of the CPU work load.

Big words that describe the MVP: (Reference Encyclopedia of Computer Science by Ralston and Meek)

Multi-programming: We execute more than one job at a time. We interleave I/O with computation. We also switch CPU bound users out every 30 ms. to insure good response time for all.

MFT: This is a big word used by IBM. It means multi-programming with a fixed number of tasks. This term applies to the MVP because, like IBM OS 360/MFT, we divide memory into a fixed number of partitions of fixed size.

Front end processor: This is a small, limited capacity computer used to augment the I/O capability of a larger computer. On the MVP, we use a microcomputer (based on 8080 microprocessor) to buffer keystrokes from the terminals, buffer data to be printed to each CRT and local printer, and to do editing of text lines. Our front end processor is called a 2236 MXD. An MVP system has one 2236 MXD for every four 2236D terminals.

Background/Foreground: This is a limited form of multi-programming supported on mini-computers. Background/Foreground involves one high priority job of a real time nature (e.g., monitoring instruments) and a lesser priority background job that runs when the CPU is not processing the Foreground job. On the MVP all partitions have equal priority, but there is some extra priority given to I/O. For the purpose of the MVP, we define a background task as one that runs with no operator intervention. Further, a background job on the MVP releases control of the terminal, so that the terminal may be used to interact with a program running in another partition assigned to that terminal.

Because background/foreground implies a scheduling priority, the term does not truly apply to the MVP. It is, however, the best way to describe the situation where one terminal controls more than one partition.

Time Sharing, Time Slicing, Time Division Multiplexing: These roughly synonymous terms describe a multi-programming system that is optimized for fast response time to interactive users. The MVP is definitely optimized for interactive use. Our time slice is 30 ms, which is comparitively fast by industry standards. The BASIC INPUT statement is handled by the 2236MXD as far as responding to individual keystrokes. From the time the operator types carriage return until the MVP begins to process that user's BASIC program can be no longer than 1/2 second (assuming 16 partitions, none of which are waiting for I/O). The above figure is very much a worst case.

Batch Processing: As the name implies, batch processing has to do with collecting jobs into a group or "batch" to be submitted to the computer in a job stream. The MVP operating system does not support batch processing directly, but it is possible to write BASIC software to perform jobs scheduling, queing, etc.

Re-entrant code: Re-entrant code is program text that may be accessed by several users in the multi-programming environment simultaneously, yet the individual user need not worry about the presence or absence of any other users that may be contending for the program code. This term precisely describes a global partition that is used to contain shared program text. All calling partitions must have their own copy of the variables.

RS-232-C: This is the electrical standard that describes the connector and cable used to connect the terminals with the 2236 MXD. The RS-232-C standard connector and interface are also found on the 2227B and 2228B telecommunications controllers.

Asynchronous/Full duplex communication: Communication between the terminals and the MXD is serial-by-bit and asynchronous. This differs from bisync used by the 928 word processor in that each byte in asynch must send along some timing information. Full duplex means that both parties may talk at once. It is possible to type on the keyboard of a 2236D terminal while output is being printed on the CRT or local printer. Our character format is 8 data bits plus odd parity. This is a perfectly acceptable format, but it is not very commonly used.