VisiCalc®

INSTANTLY CALCULATING 'ELECTRONIC WORKSHEET'

VisiCorp™

PERSONAL SOFTWARE™

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INSTANTLY CALCULATING 'ELECTRONIC WORKSHEET'

User's Guide for the Commodore PET™/CBM™ 2001 & 8032

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VisiCorp™
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PART I. INTRODUCTION

How To Use This Manual

This manual is divided into four parts. It has been designed with the consideration that different people using VisiCalc will have differing levels of computer experience.

Part I contains an overview of VisiCalc, information about your equipment needs, and complete instructions for loading VisiCalc and making blank diskettes ready for use with VisiCalc.

Part II is a step-by-step Tutorial in the use of VisiCalc with your computer. Those with little or no experience with personal computers will find that it anticipates many of the questions and problems that may arise. The Tutorial comprises four lessons which guide you from the point at which you finish loading VisiCalc in Part I, through several examples that show you how to use VisiCalc and your computer to solve problems in your professional work and your everyday life. Each lesson will show you exactly what to type, keystroke by keystroke, and should be done with the computer in front of you. As you practice, you'll gain familiarity and confidence in using some of the more advanced features of VisiCalc. Before long, you'll need only Part III and the VisiCalc Reference Card.

Part III is the VisiCalc Command Reference. It contains a chart of VisiCalc commands illustrating their relationship, notes on the elements of the VisiCalc screen display and a detailed discussion of each command with examples of its use. You will probably find yourself referring to this section frequently, especially as you use the advanced features of VisiCalc to speed your work and do complicated applications. The commands presented in this part of the manual are summarized in the VisiCalc reference card which you'll find in the pocket on the inside back cover of the binder holding this manual.

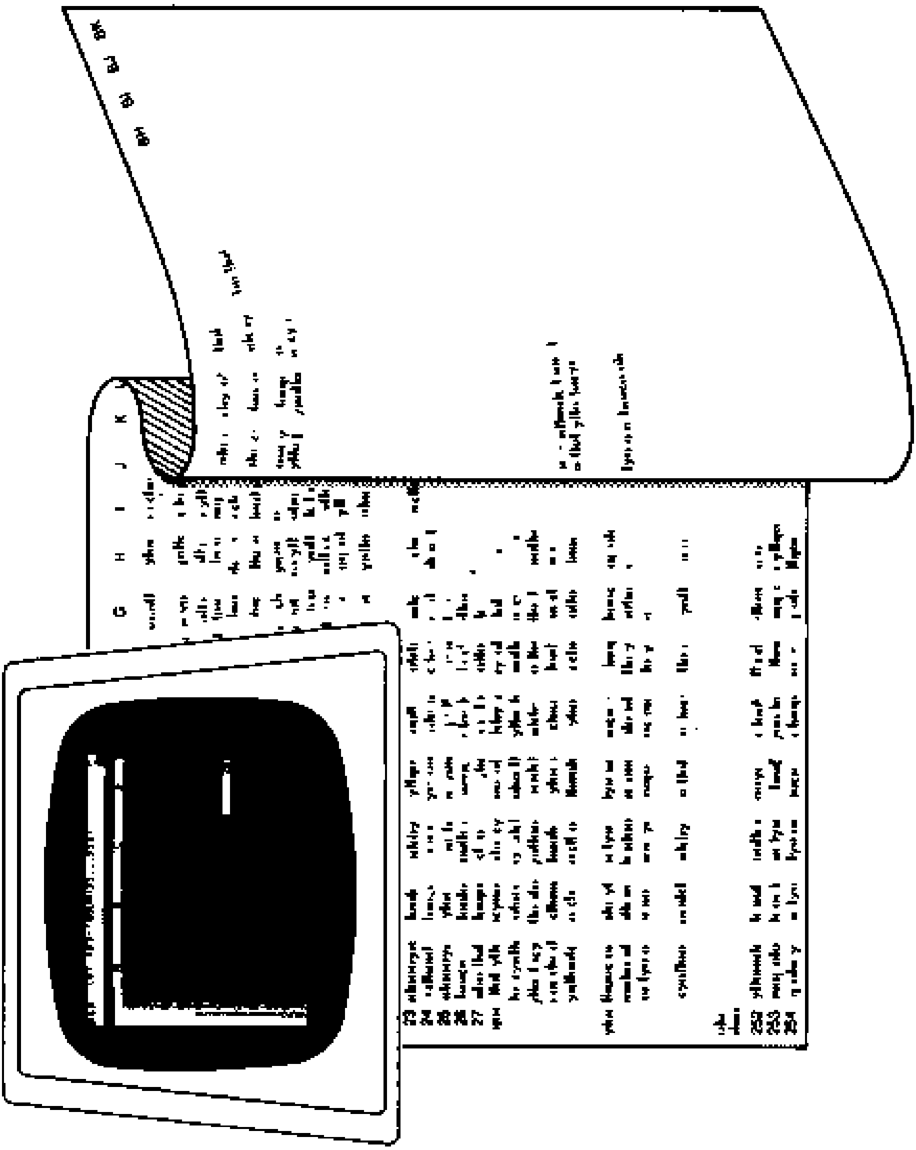
Part IV is the Index for this manual, listing subjects alphabetically and relevant page numbers.

The best way to learn to use VisiCalc is to try it. Don't be afraid to experiment and make mistakes. You cannot hurt either the computer or the VisiCalc program, no matter what you type at the keyboard.

Overview Of VisiCalc: The "Electronic Sheet"

VisiCalc was born out of the observation that many problems are commonly solved with a calculator, a pencil and a sheet of paper — three nearly universal tools. Calculating sales projections, income taxes, financial ratios, your personal budget, engineering changes, cost estimates — even balancing your checkbook is done with a calculator, pencil and paper.

VisiCalc combines the convenience and familiarity of a pocket calculator with the powerful memory and electronic screen capabilities of the personal computer. With VisiCalc, the computer's screen becomes a "window" which looks upon a much larger "electronic sheet." You can move, or "scroll", this window in all four directions to look at any part of the sheet, or you can split the computer screen into two "windows" to see any two parts of the sheet at the same time.



YOUR SCREEN IS A WINDOW INTO THE ELECTRONIC SHEET IN THE COMPUTER'S MEMORY

The sheet is organized as a grid of columns and rows. The intersecting lines of the columns and rows define thousands of entry positions. At each position you can enter an alphabetic title, a number or a formula to be calculated. Just by "writing" on the sheet, you can set up your own charts, tables and records. Formatting commands let you individualize the appearance of each entry, row or column. If you wish, for example, you can make your VisiCalc checkbook record look just like your bank statement.

But the power of VisiCalc is that the computer *remembers* the formulas and calculations you use as you work through a problem. If you change a number you had previously written on the electronic sheet, all other related numbers on the sheet change before your eyes, as VisiCalc automatically recalculates all of the relevant formulas.

Recalculation makes VisiCalc a powerful planning and forecasting tool. Not only can you effortlessly correct mistakes and omissions, you can also examine various alternatives.

For example, imagine that you are doing sales projections using VisiCalc. You may want to know what the impact on your company will be if a specific product doesn't sell as well as you anticipate. What if you sell only 200 "widgets" a month instead of 250? What if you sell 300? What if one of your salesmen quits and it takes his replacement six weeks to come up to speed? Playing "what if" with VisiCalc is simply a matter of changing a single number. Doing the same thing with a calculator, pencil and paper might take hours of erasing and recalculating.

VisiCalc's editing features let you change, insert or delete titles, numbers or formulas. The existing VisiCalc chart or table is instantly restructured, with all of the columns, rows and other formulas edited to reflect your changes.

If you've entered a formula at one position, VisiCalc lets you replicate it at any number of other positions. VisiCalc will also add up, average or otherwise manipulate rows, columns, or other ranges of numbers.

While you can adjust the length of titles and numbers that are displayed on your computer screen, the internal length of titles and formulas is much larger. Decreasing the length of each position on the screen lets you increase the number of positions displayed at once, without affecting their content. To see the complete title or the formula that produced a number, you simply move the screen highlight or "cursor" to rest on that number or title.

Once you've established the format for a particular application, you just enter or change numbers. You can save the entire electronic sheet on your diskette, and you can print all or part of the sheet on a printer.

You can learn the elementary features of VisiCalc in an hour or two, and you'll find that you are immediately able to solve simple problems. As you use VisiCalc for more complicated applications, you'll discover that it has a broad range of features and commands. You learn these features and commands as the need arises.

Important Follow-up Program

Please read the User's Support Plan that comes with this product. Returning the warranty registration card will enable us to keep you informed of new versions of the VisiCalc program.

After you've used VisiCalc, we'd like to know of your comments and suggestions for improvement. We have provided the Reader Critique at the back of this manual for this purpose.

What You Need

To use VisiCalc, you will need the following components:

1. Your Commodore PET or CBM 2001 Series computer (which have 40 characters per line on the screen display and 32K of RAM memory) or the CBM 8032 (which has 80 characters per line on the screen display and 32K of RAM memory.)
2. The Commodore CBM Model 2040 dual drive for floppy diskettes.
3. A set of blank diskettes.
4. The VisiCalc program diskette. This is enclosed in the inside front cover pocket of the binder holding this manual.
5. The special integrated circuit (called an IC or "chip") which must be installed in your computer before you can use VisiCalc. This is located in the pocket in the back cover of the binder holding this manual. It is the small black plastic wafer with metal legs which are inserted into a piece of conductive foam. Do not remove it from the foam until we instruct you to do so.
6. An optional piece of equipment is a Commodore Printer Model 2022 or 2023 for printing the charts and tables you create with VisiCalc. An ASCII printer may also be used — your dealer can help you with the equipment necessary to connect this type of printer to the Commodore computers.

Setting Up Your Equipment

Before you can use VisiCalc, you must install the integrated circuit in your computer. We give you detailed instructions in this section so that you may install it yourself, if you wish. If the instructions are not clear to you, or you are nervous about opening your computer, ask your dealer to help you with the installation.

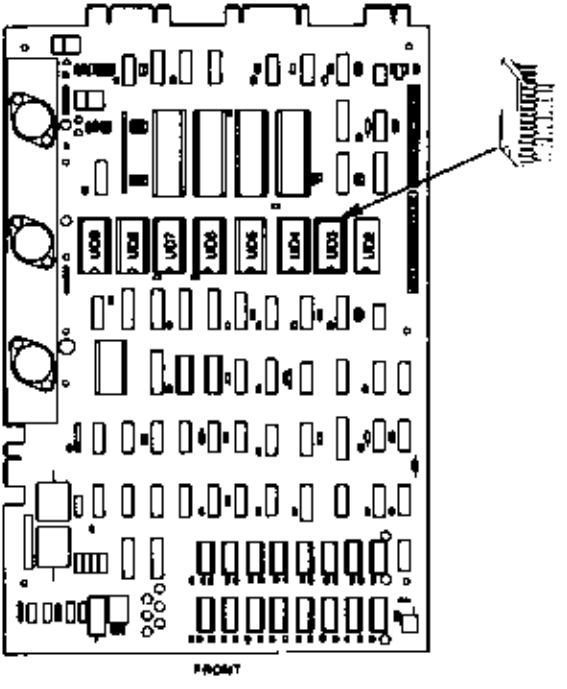
Before doing anything, be sure you **unplug the computer's power cord from the socket.**

The upper (white) section of your PET/CBM computer is connected to the lower (black) chassis by a hinge at the back and some small bolts at the front. To open your machine, you must unscrew these bolts.

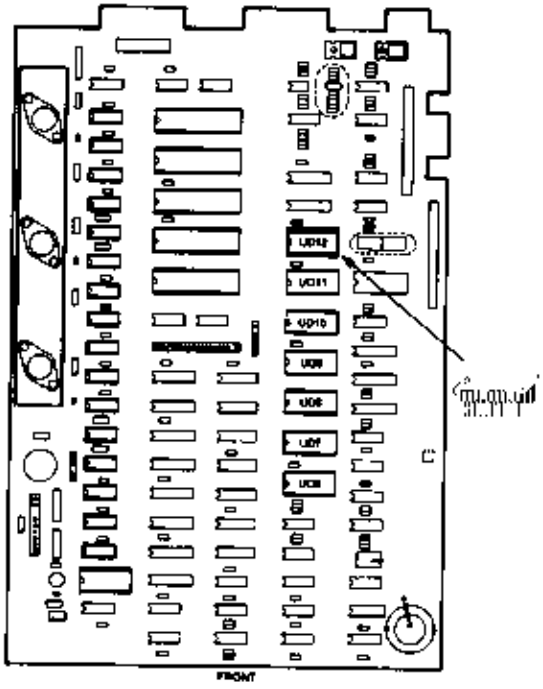
You will find the bolts under the lip of the white cover on either side of the keyboard. To get at them easily, place your machine on a desk or table. Pull the machine forward so that it extends a few inches beyond the edge of the desk. Now kneel on the floor and look under the lip of the white cover. You should see the bolts in their mountings on either side of your machine. There will be two per side on a model 2001, and one per side on a model 8032. Obtain a screwdriver that is the right size for your bolts and unscrew them. Save these bolts so that you can replace them when you are finished.

You may now slide the machine back so that it is fully on your table. Now lift up the light-colored top by grasping the front edge and raising it. The top and underside are hinged at the back, so you simply lift it up. Hold it and look inside—somewhere there is a metal bar along the side or front edge of the computer case. This is a brace for holding the top open so that you can let go. It works on the same principle as the brace used for holding up the hood on many models of cars. It may be jointed to either the top part of the case or to the underside. When you've found it, pull it out and insert the free end into the hole in the metal tab from which you removed a screw. Make sure it is secure, and then let go of the top of the computer.

Inside the computer you'll see many things. What you're interested in is the flat "printed circuit" board fastened to the black underside. It has many electronic components plugged into it, and you're going to plug in one more. Now get the integrated circuit that is in the pocket in the back cover of the binder holding this manual. It is the rectangle with little metal legs, currently embedded in a piece of foam. Look at the illustrations below. The top one is a drawing of the printed circuit board in the CBM 2001 Series computers. The one below it is the board in the Model 8032 computer. Locate the one for your computer and compare it to the actual board.



2001 SERIES PRINTED CIRCUIT BOARD



8032 SERIES PRINTED CIRCUIT BOARD

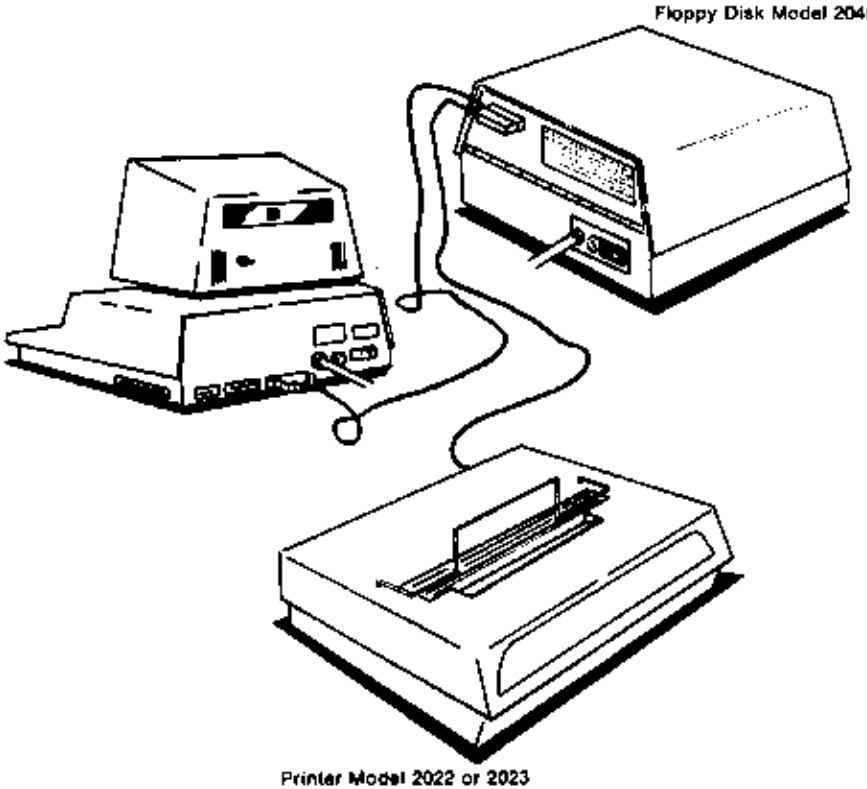
The board in your computer should have little numbers and letters printed on it, to identify every socket into which a component may be plugged. On the CMB 2001 Series, the socket you want is labelled **UD3**. In the 8032, the socket you want is labelled UD12. They are highlighted in the drawings above to help you orient yourself to the board in the computer.

Find the socket with the appropriate label for your computer. Notice that it is in a row of sockets that are the same size, many of which already have integrated circuits (IC's) plugged into them. Study the tops of the IC's that are already there and you'll see that each one has a small semi-circular notch cut into the plastic at one end. All the IC's have been inserted with the notch facing the same direction. Look at the IC that you are going to insert (it should still be in the foam). It, too, has the semi-circular notch in one end.

Having done all this, you are now ready to insert the VisiCalc IC. Before you remove it from the foam, ground yourself to remove any static electricity by touching the black underside of your computer. Make sure you have the right socket, remove the VisiCalc IC from the foam and line up its legs with their respective holes in the socket. You may have to adjust the angle of the legs slightly with a pair of needlenose pliers if they don't line up just right. Make sure that **the notch is facing the same direction** as the IC's that are already inserted. It is critical that the notch be oriented correctly. Check carefully that all the legs have been started in their holes — it is all to easy to miss one and have it bend out of the socket or under the wafer. Then start pushing it down, until it's all the way in.

Double-check that all the legs have gone in and then close up your computer by doing the same steps you did when you opened it, but in reverse. After assembling the rest of the equipment, you'll be ready to use VisiCalc.

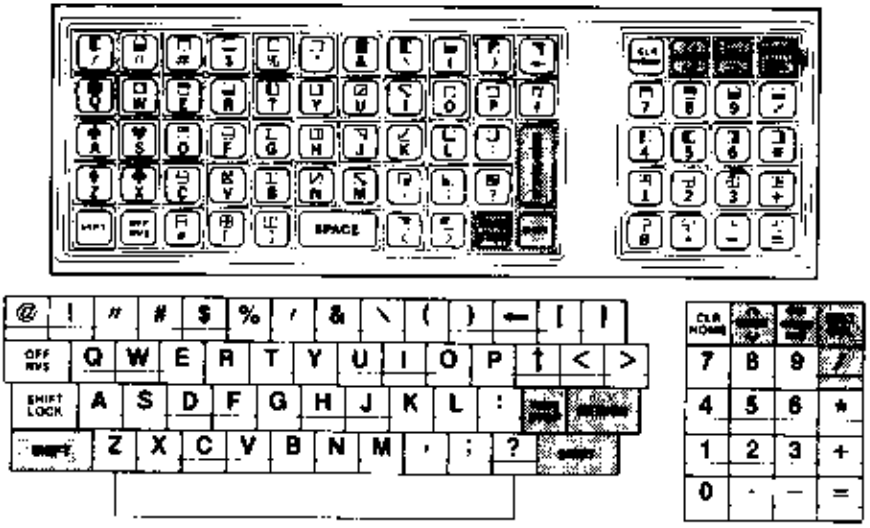
The computer's power cord should be plugged into a wall socket, and the printer and floppy disk drive's cables should be connected as shown in the illustration below. If you are using an ASCII printer, have your dealer show you how to hook it up to the computer.



EQUIPMENT HOOK-UP

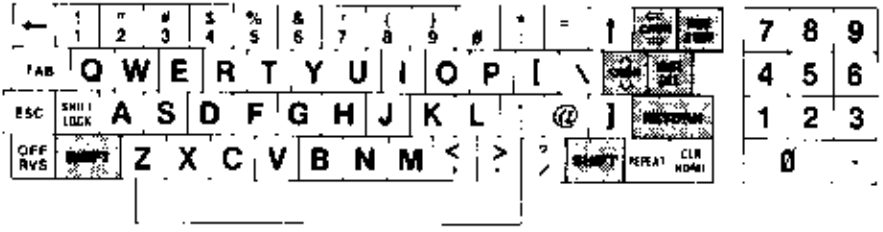
Some Notes On Your Keyboard

This manual describes the use of VisiCalc on several different computers. We tell you how to enter a command keystroke by keystroke, utilizing many illustrative examples. While the use of VisiCalc is identical on each computer, the style of keyboard is different. For example, you may have to use the **SHIFT** key on one keyboard in order to type an asterisk (*) and on another keyboard the asterisk is located on the numberpad and is typed unshifted. In this manual, when we instruct you to type a specific character, we assume you will press the **SHIFT** key if necessary.



2001 SERIES KEYBOARDS

With the keyboard illustrated above, you do not use the **SHIFT** to type the special characters such as the asterisk (*), the double quote ("), the right caret (>), etc. Note that the slash (/), the plus and minus signs, the asterisk, and the period are all located on the numberpad. These are keys that you will be using frequently with VisiCalc.



8032 SERIES KEYBOARD

This keyboard does use the **SHIFT** to generate some of the non-alphabetic characters you'll be using, such as *, ", and >. The instructions in this manual will tell you to type a command, such as >A1. Except for an occasional reminder, we do not instruct you to hold down the **SHIFT** key, although you must do so in order to generate the >.

Also note the positions of the keys that are shaded in the drawing for your keyboard. You will use them a great deal. You will see the key labelled **RETURN** represented by this symbol, ® throughout this manual.

The keys with the word **CRSR** (on the top keyboard illustration above it is spelled CURSOR) and little arrows on them are used in conjunction with the **SHIFT** and indicate direction of movement of the highlight you will see on your VisiCalc sheet. You'll use these keys frequently, too. In this manual, the following symbols represent the use of these keys, and also our notation for the exponentiation character ↑.

Symbol	Keystrokes
•	*Press*
•	*Hold down* **SHIFT** and press
•	*Press*
•	*Hold down* **SHIFT** and press
↑	*Press key with single up-pointing arrow* ↑

Besides the keyboard differences, there is also the availability of the lower case alphabet on some of the Commodore computers. If your computer uses both upper and lower case, use the **SHIFT** to make capital letters, as you would on a typewriter when you are creating titles for your VisiCalc sheet. In the text of this manual, we use only upper case to explain what to type and what you see on the screen. Whether you type a letter in upper or lower case does not matter to VisiCalc — it will automatically capitalize letters where it is necessary for a command, such as >A1, or a formula such as 8+A1. If you use the SHIFT LOCK key at any time, be sure to "unlock" as soon as you've finished typing. While the SHIFT LOCK is on, many of the keys you need, such as the CRSR keys discussed above and the keys that are shaded on the keyboard illustrations, may not work as described here.

Loading VisiCalc

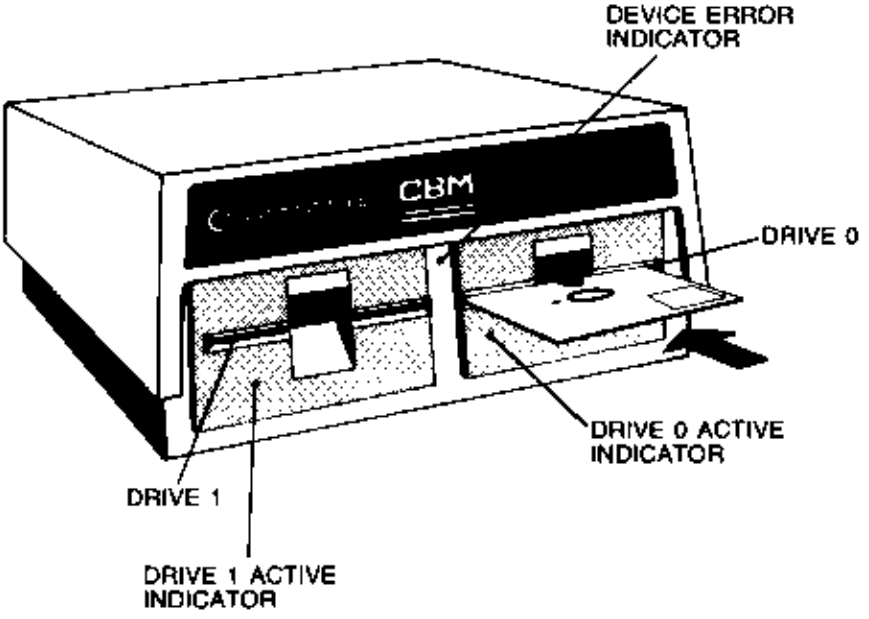
The next step is to turn on your computer and the disk drive. The switches are located on the back of each one. Note that the disk drive lights come on for only a second when you turn the power on, and then go off. There is no indicator on the front of the drive to tell you when the power is on. We recommend that you mark the power switch on the disk drive so that you know the "ON" position; then if you are unsure whether the disk drive is turned on, you can check the position of the power switch at the back. We are emphasizing this because you must **never turn off the disk drive with a diskette in either drive.** To do so may damage the drive or the diskette. It is also good practice not to turn on the disk drive with a diskette inserted.

The word READY will be on the computer's screen with a blinking square under it.

Now you need the VisiCalc program diskette, which is kept in the pocket on the inside front cover of the binder holding this manual. A word of caution about the handling of diskettes is in order here — you can't be too careful with diskettes. Each diskette is a small, magnetically coated plastic disk, sealed in a protective square plastic cover. Through the oval cutout in the square cover, you can see the magnetic surface of the actual diskette. *Never* touch the exposed magnetic

surface. Protect the diskette from dust by storing it in the paper sleeve it comes in. Keep it at least 6 inches from magnetic fields such as those generated by a TV. Extremes of temperature (such as in a car trunk on a warm day) could destroy a diskette, and you would lose your data, or your VisiCalc program. Don't bend, staple, or write on the square plastic cover with a hard pen or pencil (use only the soft felt tip pens).

Open the door on drive 0 (the right hand drive) by pulling gently on its lower edge. Remove the VisiCalc program diskette from the paper sleeve and carefully insert it into drive 0, exactly as shown in the illustration below. The oval cutout in the square diskette jacket should enter the drive first. The label should enter the drive last. Gently push the diskette all the way in, and close the drive door by pushing it down.



Now you're ready to start typing on the keyboard. Remember the symbol ↵ represents the key labelled **RETURN** and also that, depending on the style of keyboard on your computer, you may have to use the **SHIFT** to type the quotation mark ("). The letters you type may appear in lower case on the screen, but this will not affect the instruction you are giving. If you make a typing mistake, use the **INST/DEL** to back up the blinking square to the wrong character and continue typing from that point. Type the following exactly as shown, including the space.

OPEN 1,8,15,"I0"↵ *Note that is the letter I and the number zero, not the letter oh.*

The drive 0 ACTIVE indicator will come on and the drive will make whirring and clicking sounds. The light will go off and on the screen READY will appear again.

If your computer is the CBM 8032, hold down the **SHIFT** and press the key marked **RUN/STOP**. The drive 0 ACTIVE indicator will light up, the screen will display a few characters and the words SEARCHING FOR 0:*, LOADING, READY, and RUN. The drive will whir for about 30 seconds, then the light will go off and the VisiCalc screen will appear. It should look like the photo below.

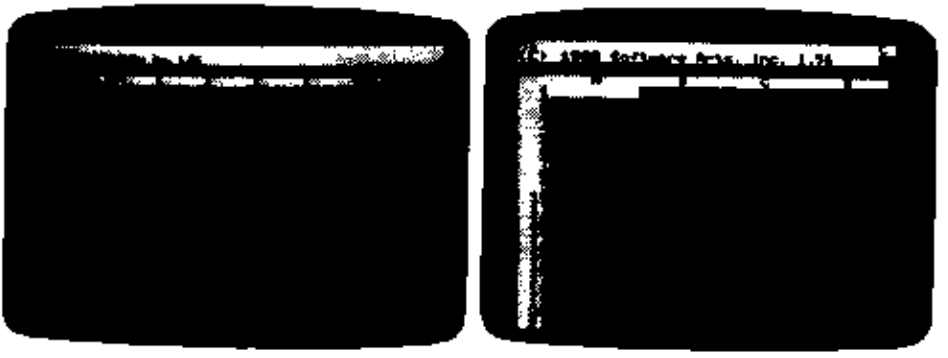
If you have the PET or CBM 2001 Series computer, type the following exactly:

LOAD "*",8↵

The drive will whir and the screen will say SEARCHING FOR *, then LOADING and then READY will appear again. Type:

RUN↵

Now wait for about a minute while the drive whirs and the drive 0 ACTIVE indicator stays on. The drive will quiet down, the light will go off, and the VisiCalc screen will appear, looking like the photo below.



If your screen doesn't look like this or the DRIVE ERROR light on the disk drive comes on, try loading again. **Remove your VisiCalc diskette from the drive** and turn off the disk drive and the computer. Then try the directions above again. If the message ERROR LOADING VISICALC appears on your screen, you probably have not inserted the special VisiCalc integrated circuit properly. Check its position inside your computer: is it in the right slot and are all its legs in their respective sockets? Make sure your computer is turned off before trying to remove the IC. If after several tries you are not successful at loading VisiCalc, see your dealer for help.

Making sure that the disk drive has stopped whirring and the ACTIVE indicator is off, open the drive door, and gently remove your Visicalc program diskette. Put this diskette away in its pocket on the inside front cover of your VisiCalc binder; you won't need it again until the next time you turn on your computer.

Initializing VisiCalc Storage Diskettes

Now you must make a working diskette to use for storing the information you will be creating with VisiCalc. Take out a blank diskette and carefully insert it into drive 0 of the disk drive, just as you did with the VisiCalc program diskette. The label should be up and the oval cutout should go in first. Notice that a blank diskette has a small notch cutout on its left side. This cutout is sensed by your disk drive, and it tells the computer that it is OK to write information on the

diskette surface. For its protection, the VisiCalc program diskette does not have this notch; hence it is said to be "write-protected." Close the disk drive door.

Now follow the instructions below, and watch the second line from the top of the screen. This line is called the VisiCalc **prompt line**, and is described more fully in Lesson One of Part II and in Part III.

1. Press the / key. On the prompt line you should see COMMAND: BCDFGIMPRSTVW-.
2. Press the letter **S** key. The prompt line should read STORAGE: L S D I Q #
3. Press the letter I key. The prompt line should read INIT DISK: HIT RETURN (ERASES DISK) and under it are the characters 0:VC DISK,XX,8. For information on the meaning and use of these characters, see the discussion of The STORAGE Command in Part III.
4. Just press ↵ (the RETURN key). there's no need to hit it. The red ACTIVE indicator light should come on and the disk should whir for nearly a minute.

In the initialization process, the computer is recording a pattern on the surface of the diskette, so that VisiCalc can find a given spot on the diskette surface and "write" information there or "read" it back later. What's more, information "written" by one program (such as VisiCalc) can be located later and "read" by a different program (which could be written in BASIC). Diskettes initialized with an 8032 computer can be used with the CBM 2001 Series computer, and vice versa. If you initialize a diskette that has had data stored on it from some previous use, either by VisiCalc or some other program, that data will be erased by this process.

After the disk drive quiets down and the red ACTIVE light goes off, open the drive door and carefully remove the newly initialized diskette. (Never open the door or insert or remove a diskette while the drive is whirring or the ACTIVE light is on; this will probably damage the diskette, and may also damage the drive.)

Look for the adhesive labels that normally come with a box of blank diskettes. Write a note to yourself, such as "VisiCalc Storage Diskette" and the date, on an adhesive label, and apply this label to the diskette jacket near the manufacturer's label. You can write directly on the label on the diskette, but be sure to use a felt tip pen, not a ballpoint.

At this point, you may wish to initialize some additional diskettes for use with VisiCalc. Simply insert a new blank diskette, close the drive door, and follow the four-step initialization procedure above. When you've finished, you'll be ready to go on to Lesson One of the Tutorial and begin learning to use VisiCalc. Your screen should look like the photo below.

80 COLUMN SCREEN

40 COLUMN SCREEN

PART II. VISICALC TUTORIAL

Lesson One

Lesson One

When you have loaded VisiCalc into your computer, as described in the section entitled "Loading VisiCalc," the image on your screen should resemble the photo shown in that section. The same photo is reproduced below. If your screen is different, type the following keys: / **C Y**. This will clear the sheet and it will look like the photograph. Here we'll examine the components of this screen image more closely.

Your screen has become a **window** into the computer's memory, which VisiCalc has organized like an **electronic sheet**. As you can see, the sheet is divided into rows which are numbered 1, 2, 3, and so on, and columns which are lettered A, B, C, and so on. At each intersection of a row and column there is an **entry position**, with a **coordinate** such as A1, B3, C17, and so forth. At each entry position you can "write" a message or title, a number, or a formula of the kind you might enter, keystroke by keystroke, on a calculator. In a moment we'll demonstrate how you move around and write on this electronic sheet.

Above the white border with the column letters, there are three additional lines which make up VisiCalc's **control panel**. The middle line of this control panel displays the VisiCalc copyright notice and **version number**, for example:

(C) 1980 SOFTWARE ARTS, INC. 1.52

Should you ever need to call or write to Personal Software to ask questions about VisiCalc or to report problems with VisiCalc, please be sure to include this version number and the model of your computer.

Press the key marked **RETURN**. As we mentioned in the section "Notes on Your Keyboard" in Part I, we'll indicate the **RETURN** key with the symbol ®. The copyright notice and version number will disappear. Now press the / key followed by the **V** key. The copyright notice and version number will reappear on the middle line. You can always obtain the version number of your copy of VisiCalc by typing the command /V.

Moving the Cursor

At the upper left corner of the control panel you can see the coordinate A1 displayed. Notice that there is a white bar or highlight over the entry position at column A, row 1. This highlight is called the **cursor**. You always write on the electronic sheet at the position marked by this cursor; you can think of it as the point of your pencil or pen. You move the cursor with the **CRSR** keys and the **SHIFT** key. These keys control the direction of movement of the highlight. Used alone, the **CRSR** keys move the highlight down or to the right (the direction of the arrow printed below the name of the key). Throughout this manual, the symbols ♦ and ♦ will mean to move the highlight down or to the right with these keys. When you hold down the **SHIFT** key and then press the **CRSR** keys, the highlight will move up or to the left (the direction of the arrow printed above the name of the key).

Try pressing the right arrow key ♦ once. Notice that the cursor moves to the position at column B, row 1, and the cursor coordinate in the upper left corner of the control panel changes to B1. (The copyright notice and version number will also disappear with your first keystroke.) Now press the left arrow key ♦ (remember to press **SHIFT** along with the **CRSR** key) and watch the cursor move back to its original position. Try moving the cursor down to row 2 of column A with ♦ and then back to position A1 with ♦. Remember you must use **SHIFT** to move the cursor up or to the left.

Scrolling the Window

When you first load VisiCalc, your screen window is positioned to let you look at the upper left hand corner of VisiCalc's electronic sheet. On the CBM and PET 2001, the window allows you to see the first four columns (A through D) and the first twenty-one rows (1 through 21) of the sheet. On the CBM 8032, the window lets you see the first eight columns (A through H) and the first twenty-one rows (1 through 21). Now, with the cursor at A1, press the right arrow key ♦ several times until the highlight is at the right edge of the window. Now press the right arrow key ♦ again. Notice that the next column to the right comes into view, while column A disappears off the left edge of the window. When this happens, we say that the window has **scrolled** to the right. Try pressing ♦ a few more times, watching more columns appear at the right edge of the window, and disappear at the left.

The screen window will also scroll to the left. (In fact, it will scroll in all four directions.) Press the left arrow key ♦ (don't forget **SHIFT**) until the cursor is at the left edge of the window. Then press ♦ several more times and notice that the columns that had disappeared as you scrolled the window to the right come back into view. Press ♦ until the cursor is back at position A1. Now try pressing ♦ one more time. You should see the highlight cursor and the cursor coordinate in the upper left corner of the screen flash at you. This is VisiCalc's way of telling you that you are bumping into the edge of the sheet.

Just for fun, press the up-pointing arrow key ♦ (you must use **SHIFT** with the **CRSR** key), which would normally move the cursor up. You are bumping into the edge of the sheet again. So far we have encountered the left edge and the top edge of the sheet. Now, we will go looking for the other two edges.

Press the down arrow key ↓ until the cursor has moved down to position A21. Then press ↓ again, and notice that row 22 comes into view, while row 1 disappears off the top of the screen window. Continue pressing the ↓ key until your finger starts to get tired (actually, a few more presses will do). As you can see, the electronic sheet is quite a bit larger than an ordinary sheet of paper.

Automatic Repeat

We can speed our search for the bottom edge of the sheet by using the automatic repeat feature of the computer. To see this in action, press the ↓ key again, and this time *hold it down*. Much better, isn't it? (The cursor and the window should be scrolling downwards automatically.) Continue to hold down the ↓ key until you bump into the bottom edge of the electronic sheet. The cursor will be at position A254.

Now, let's search for the right hand edge of the sheet. Press → and hold it down. The cursor and window will go scrolling off to the right. As the cursor and window scroll to the right, notice how succeeding columns are lettered. After A, B, C, . . ., X, Y, Z comes AA, AB, AC, . . ., AX, AY, AZ, and then BA, BB, BC, ... The cursor finally stops at position BK254, as it bumps into the right hand edge of the sheet. You are now at the lower right hand corner of VisiCalc's electronic sheet.

Direct Cursor Movement

Even with the aid of automatic repeat, it took a while to scroll the cursor and window all the way to the lower right corner of the VisiCalc sheet. There's an easy way to move an arbitrary distance across the sheet with a few keystrokes.

Type the character '. Depending on your keyboard, you may have to hold down the **SHIFT** key to generate this character. If you make a mistake, press the **INST/DEL** to correct what you've typed. The next section "Backing Up the Cursor" explains the use of this key in detail.

Two things will happen: i) The message GO TO: COORD appears on the middle line of the control panel, at the top of the screen. ii) Directly below this message, a small rectangle appears. You have discovered two new components of the VisiCalc control panel: the **prompt line** and the **edit line**.

VisiCalc communicates with you on a keystroke by keystroke basis, just like a pocket calculator. Each time you press a key, VisiCalc tells you, on the prompt line, what you can type next. Right now, the prompt line is telling you that VisiCalc has recognized your keystroke command :> , which means GO TO an arbitrary position on the sheet, and that next, VisiCalc expects you to type the COORDinate of the position to which you want the cursor to move.

Press the **A** key once: The letter A will appear on the edit line (third line from the top of the screen), followed again by the small rectangle. Notice that you get a capital A, whether you press the shift key or not. VisiCalc knows that you are entering a coordinate and so takes care of upper case for you. The **SHIFT** key matters only when you press a key with two symbols on it, or as you will see, when you are entering labels. Now press the number **1** key: we want to move the cursor back to position A1. So far, we have A1 on the edit line, followed by the small rectangle. VisiCalc is still waiting for you to type something: it doesn't know yet whether you want to go to position A1, or position A11, or A121, or some other position. Now press the ↵ key. The information on the prompt and edit lines disappears, and the cursor and window move back to the upper left corner of the sheet.

Try another example. Press the keys :> C 1 0 ↵. Does the cursor move to the expected position?

Backing Up the Cursor

VisiCalc has several error correction features, each of which will be covered in this lesson. The first of these is the key labelled **INST/DEL**.

Press the following keys: :> A 1 1. Then pause for a moment before pressing ↵. Suppose that you intended to move the cursor to position A1, but you accidentally pressed the **1** key twice. You now have A11 on the edit line, followed by the small rectangle.

Press the key marked **INST/DEL** once. Notice that the small rectangle "backs up" one character and erases the extra 1, leaving you with A1. Now press ↵. The cursor will move back to the upper left hand corner of the sheet. In general, VisiCalc will let you correct typing errors by backing up with the **INST/DEL** key. You can back up more than one character. For example, to change A11 to A2, you would press the **INST/DEL** key twice, backing up to leave just the letter A, and then you would press the **2** key to get A2.

Besides backing up, you can "back out" with the **INST/DEL** key. Press the following keys: B 5 Then pause. Suppose that you change your mind and decide that you don't want to move the cursor at all. Press the **INST/DEL** key once, and the number 5 will disappear from the edit line. Now press the **INST/DEL** key again. The letter B on the edit line disappears, and so does the prompt GO TO: COORD. You have backed out of the > or GO TO command completely, and you can now type something else.

There's an even faster way to back out of a command. Press these keys: C 1 2. Suppose you decide you don't want to use the GO TO command. Find the key labelled **RUN/STOP** and press it once, watching the screen as you do so. The screen flashes and the prompt and edit lines are blank. You have backed out of the GO TO command with one key: **RUN/STOP**. No matter what you are typing, you can always back out and leave the sheet unchanged by

pressing the **INST/DEL** key a few times or pressing the **RUN/STOP** once, as long as you notice your error before pressing the last keystroke of the command or other entry.

Before going on, spend a few more minutes moving the cursor around with the arrow keys, and the > or GO TO command. Try moving the cursor to a nonexistent position such as AB525. What happens? Try moving to an invalid coordinate such as 25A instead of A25. What happens?

Now, get back to the upper left hand corner of the sheet with > A 1 <. Next, we're going to learn how to write.

Writing On the Electronic Sheet

As you have seen, moving the cursor and window around is pretty easy, but so far your electronic sheet is (or should be) empty. You'll find that writing on the sheet is even easier. Before proceeding further, type the following keys: / **C Y**. The screen will go blank, then reappear with the copyright on the prompt line. This will make sure that the sheet is clear and that the cursor is at position A1.

Now type the following keys: **S A L E S** (If you mistype a letter, you can back up with the **INST/DEL** key.) Stop and look at the screen. On the prompt line is the word LABEL. This is VisiCalc's term for any type of alphanumeric message that won't be used in calculation which you write on the sheet. On the edit line is the word SALES, followed by the small rectangle. The small rectangle indicates that you can still use the **INST/DEL** key to back up and retype the message, or to back out completely. SALES also appears under the cursor highlight at position A1 on the sheet. If your computer has the lower case alphabet, all letters you type for labels will appear in lower case unless you use the **SHIFT** key for capitals, as you would on a typewriter. Use the **INST/DEL** or the **RUN/STOP** to back up and retype any characters in the SALES label, if necessary. When you are satisfied, press the ↵ key. The information on the prompt and edit lines disappears, and the cursor moves to position B1, leaving the label SALES at A1. (Throughout the rest of this tutorial, all alphabetic characters will be shown upper case in the text. The photographs will show the use of upper and lower case letters. You can use upper and lower case as you prefer for your labels — you won't hurt anything.) Try pressing the **INST/DEL** key and then the **RUN/STOP**. (Nothing happens except for VisiCalc flashing the screen at you.)

Now type the following keys: **1 0 0** Stop and look at the screen. The prompt line says VALUE, which is VisiCalc's term for a number or formula. On the edit line is the number 100, followed by the small rectangle. Press the **INST/DEL** key four times, and watch the number disappear: First 0, then 0, then 1, then finally the prompt VALUE. Position B1 is still blank. You could, of course, have done the same thing by pressing **RUN/STOP**.

Now press the following keys: **7 5 + 2 5** If you make a typing error, watch the edit line carefully and use the **INST/DEL** key to back up.) The word VALUE is again on the prompt line, and the edit line reads 75 + 25, followed by the small rectangle. Now press the ↑ key once (don't forget to **SHIFT** if it is necessary on your keyboard). In place of 75 + 25, you now have 100 (the answer) on the edit line. You can use this "exclamation key" feature to perform quick calculations before writing a number on the sheet. (Much more will be said about formulas and calculations later.)

Notice that, so far, nothing has appeared under the cursor highlight at B1. Everything has been happening on the edit line. Now press ↵. The information on the prompt and edit lines disappears, and the number 100 appears at position B1 on the sheet. Try pressing **INST/DEL**. (The screen flashes and nothing happens.) There is one other change on the screen since you pressed ↵. Can you spot it? The top line of the screen now reads: B1 (V) 100. This line is called the **entry contents line**, because it gives the full explanation of the contents written in the entry position highlighted by the cursor. Right now, the entry contents line says (V), for VALUE, and shows the number 100. Press the ↑ key, and the cursor will move back to position A1. Now the entry contents line reads: A1 (L) SALES. The (L) stands, of course, for LABEL.

Formulas and Recalculation

Now move the cursor to position A2 by pressing the → once. Next, type the letters **C O S T** and then press the → key. The cursor moves to B2, leaving the label COST at A2. Now we are going to write a different kind of formula. We want the entry at position B2, for COST, to be 60% of the number for SALES. Press the following keys: **. 6 * B 1** The '*' symbol is used to indicate multiplication, and depending on your keyboard, you may have to use the **SHIFT** key to make the asterisk. The edit line should now read .6*B1. (If it doesn't, remember **SHIFT** and **INST/DEL**.) Assuming that you are satisfied, press ↵, and watch what happens. The information on the prompt and edit lines disappears. On the entry contents line, you should now see B2 (V) .6*B1. And at position B2 is the number 60, the result of multiplying .6 times 100, the number at B1.

Now for a bit of magic. Press the ↑ key to move the cursor up to position B1. Now press the following keys: **2 0 0** ↵ and watch the screen. The number behind the cursor highlight at B1 changes to 200. What else happens? The number opposite COST, at B2, changes to 120. Notice that COST is still 60% of SALES.

Press the → key, moving the cursor to B2. On the entry contents line at the top of the screen, the formula you had typed earlier, .6*B1, is still there. When you changed the number at B1 to 200, VisiCalc automatically recalculated the formula at B2 as .6*200, or 120. You'll see many more examples of this powerful recalculation feature as we progress.

More on Labels and Values

Let's look more carefully at LABELs and VALUEs, and explore an even simpler way to write formulas.

Press the following keys: ← **A 3** ↵ to move the cursor to position A3. We're about to write a formula to calculate gross profit as sales minus cost.

First, we'll write the label GROSS. Press the **G** key. Notice that the prompt line immediately says: LABEL. When you write at an entry position, VisiCalc looks at the first key you press to determine whether you are typing an alphabetic LABEL or a numeric VALUE. If you start with one of the letters A through Z, as you did here, VisiCalc assumes that you are typing a LABEL. If you start with one of the digits 0 through 9 or a decimal point, '.', or with something that could begin a formula such as plus, '+', minus, '-', parenthesis, '(', or '@' or '#'

(which will be explained later). VisiCalc assumes that you are typing a VALUE. For now, press **RUN/STOP** to back out of LABEL.

What happens if you want to write a message such as -GROSS-or 1ST QTR? Try it. Press the following keys: **- G R O S S** - You may as well stop, because VisiCalc will be flashing the screen at you. VisiCalc took the initial dash or minus sign to mean that you were typing a formula, the letter G as part of an entry position coordinate and then complained as you typed something that couldn't be a formula. Press **RUN/STOP** to back out of this mistake.

To remedy this situation, press the " key (depending on your keyboard, you may have to hold down **SHIFT**. VisiCalc takes the " to mean that you want to type a LABEL, but the quote symbol will not be a part of the message itself. As soon as you press the " key, the prompt line says LABEL. The edit line shows just the small rectangle. Now you can type: **-G R O S S** - As usual, you can use the **INST/DEL** key to back up and correct mistakes. You don't have to type a closing quote symbol. Now press the → key, and the cursor will move to position B3, leaving the message -GROSS- at A3.

Now we're ready to calculate SALES minus COST. The formula you'd expect would be B1-B2. What will happen when you type B1-B2? Try it: Press **B 1 -B 2** No screen flashes so far, so press ↵. What happened? If you've been watching the prompt line, you already realize that VisiCalc took the initial letter B to mean that you were entering a LABEL or message. B1-B2 is a perfectly legitimate message or comment, but it doesn't calculate anything. Under the cursor highlight you have, not the result of calculating SALES minus COST, but the message B1-B2.

Try again. First, we'll eliminate the erroneous message B1-B2. Try pressing **INST/DEL** and then **RUN/STOP**. Nothing happens, since we've already pressed ↵. But we can use a new VisiCalc command to blank out an entry position at any time. Press the following keys: **/ B ↵** The message B1-B2 under the cursor highlight disappears, and the entry contents line goes blank except for the cursor coordinate B3.

Remember that we used the " key to type a LABEL when VisiCalc would otherwise have tried to treat it as a VALUE. We can use a similar trick to type the formula B1-B2 as a VALUE, instead of a LABEL. One way to do this would be to type the formula as 0 + B1-B2. VisiCalc would take the initial digit 0 to signify that we were typing a VALUE. An equivalent formula is +B1-B2; VisiCalc will take the '+' to indicate a VALUE. Press the following keys: **+ B 1 -B 2 ↵** Now we have what we want. The entry contents line reads B3 (V) +B1-B2. Under the cursor highlight is the number 80, the result of calculating +B1-B2, or +200-120.

Cursor Moves in Formulas

So far, you know how to move the cursor to an entry position, and write a message, a number, or a formula which refers to other positions on the electronic sheet, such as +B1-B2 in the previous example. By now you probably also realize that if you change the numbers at B1 or B2, the formula +B1-B2 at entry position B3 will be recalculated, and the new result will be displayed at B3.

As you wrote the formula for SALES minus COST, you probably had to check the screen to see that the number for SALES was at position B1, and the number for COST was at B2. Now, imagine that you have already written a large number of formulas on the sheet. Keeping track of which numbers are at which coordinates would become time-consuming. Columns A and B might have scrolled off the left edge of the window as you moved it to display other parts of the sheet. Then you wouldn't even be able to see the numbers next to SALES and COST, so writing a new formula involving SALES and COST might be a problem.

There's an easy way to solve this problem: you write the formula, but let VisiCalc fill in the coordinates! Let's try it. First, blank out the formula at B3 by typing: / **B** ↵.

Press the + key. The prompt line reads VALUE, and the '+' appears on the edit line, followed by the small rectangle. At this point, we would normally type the coordinate B1, but what we really want is the number next to the label SALES (currently 200). Point at that number on the screen with your finger. We are about to do the same thing electronically, by "pointing" with the cursor.

Watch the edit line, and press the ↑ key once. The cursor moves up to highlight the number 120, and the coordinate of that number, B2, appears on the edit line. Now press ↑ again. Do you see what we mean by "pointing" the cursor? The edit line now reads +B1 followed by the small rectangle. Now press the - key. The cursor jumps back to B3, the entry at which we are writing the formula. The edit line now reads +B1-followed by the ubiquitous rectangle. In general, after pointing the cursor at the position you want to include in the formula, you simply continue the formula by typing an arithmetic operation symbol such as -, +, *, or /.

Watch the edit line again, and press the ↑ key once more. The cursor moves up to 120, the number next to COST, and the edit line now reads +B1-B2. This is the formula we want! To end the formula as it stands on the edit line, press ↵. The information on the prompt and edit lines disappears; the entry contents line reads B3 (V) +B1-B2; and under the cursor highlight is the number 80, the result of calculating B1 minus B2.

To demonstrate VisiCalc's recalculation feature again, press the ↑ key twice to move the cursor up to B1, and change the number there by typing: **1 0 0** ↵. Notice that B2 changes back to 60, or .6 times 100, and B3 changes to 40, or 100-60.

The idea of moving the cursor as you write a formula may seem a little strange at first, and if you wish you can always type the position coordinates yourself. But as you gain experience and familiarity with VisiCalc, you'll probably find that the technique of moving the cursor to the positions you want will become easier and more natural. In time, you'll find that you can almost forget about coordinates entirely, and think in terms of the visual positions of numbers and formulas on the sheet.

To test your understanding of the process of moving the cursor as you write formulas, you may wish to try an example yourself. Move the cursor down to position B5, and write a formula there for gross profit as a percentage of sales. (Hint: The desired formula is +B3/B1*100. Try to obtain this formula by moving the cursor and typing the → and / keys.)

Saving the Electronic Sheet On Diskette

As we wrap up this first lesson, you'll have a chance to use one of the blank diskettes you initialized with the /SI command when you read the section entitled "Initializing VisiCalc Storage Diskettes" in Part I. We'll save the contents of the electronic sheet from this lesson on diskette, and load the sheet back into memory as we begin Lesson Two. If you skipped the discussion of diskette initialization when you read Part I,the Introduction, you can still use the /SI command to initialize a diskette now; it won't disturb the information you have written on the electronic sheet. Take out a blank diskette and carefully follow the instructions under "Initializing VisiCalc Storage Diskettes," then continue with the instructions below. If you don't have any, just skim over the material below and at the beginning of Lesson Two on the /SS and /SL commands. For

insurance. In Lesson Two we'll give brief instructions for setting up the electronic sheet with exactly the same labels, numbers and formulas which you have now.

First, make sure that your disk drive 0 ACTIVE light is off and open the drive door. If your VisiCalc program diskette is still in drive 0, carefully pull the diskette out, and replace it in the pocket on the inside front cover of the binder holding this manual. Now insert the blank diskette into the drive, just as you did before. Gently push the diskette all the way in, and close the drive door by pushing it down.

Now type the VisiCalc STORAGE command / **S** The prompt line reads STORAGE: **L S D I Q** #. VisiCalc is telling you that it recognizes /S as the storage command, and that next it expects you to press one of the keys **L S D I Q** or #. These keys have the following meanings:

- **L** Load the sheet contents into RAM memory from a diskette file.
- **S** Save the sheet in memory by "writing" it into a diskette file.
- **D** Delete a previously saved file from its place on the diskette.
- **I** Initialize, or format, a blank diskette.
- **Q** Quit the VisiCalc program.
- **#** Save or load a sheet in the Data Interchange Format (see Part III, the STORAGE Command).

Press the letter **S**. Now the prompt line reads FILE FOR SAVING, and a small rectangle has appeared on the edit line. There is room on the diskette to hold several electronic sheets. So that you can find the particular sheet you want later, you give each sheet a name when you save it on diskette. The saved information is called a diskette **file**, and the name you give it is called a **filename**. VisiCalc will find an empty area on the diskette and will write the sheet contents there. Then, in a special area on the diskette called its directory or catalog, VisiCalc will save the filename you specified and a note about where on the diskette it saved the sheet contents.

When you are saving a file, the first thing you must tell VisiCalc is which drive the diskette you want to save the file is in. You have two drives: the one on the left is drive 1, and the one on the right (which is the one we have instructed you to use thus far) is drive 0. You indicate the drive by typing its number and a colon, for example, 0:, before the filename. A filename can be up to sixteen characters, including spaces, and must not contain the following characters: " # * ? : ; or , . The last three characters of any VisiCalc filename you give will consist of .VC. This suffix is to allow you to differentiate the VisiCalc files from any others you may save on the diskette. These three characters use up three of the sixteen available, so you can use the other thirteen for the filename of your choice.

Let's name the file we are saving EXAMPLE.VC. Since we instructed you to place the blank initialized diskette in drive 0, we want to tell VisiCalc to save the file on the diskette in that drive. Press the keys **0 : E X A M P L E . V C** As usual, you can correct typing errors with the **INST/DEL** key. When you are satisfied, press **↵**. The disk drive should begin whirring and the ACTIVE light should come on. After a moment, the drive should quiet down, the ACTIVE light will go off, and the prompt and edit lines will go blank. Your work is safely filed away on the storage diskette.

This completes Lesson One. You may wish to experiment for a while, moving the cursor around and writing your own labels, numbers and formulas. Try writing some formulas by pointing the cursor to obtain the coordinates. There are, of course, many more features of VisiCalc which we haven't discussed yet, and you may stumble upon one of them. As you experiment, if something happens that you don't understand, make a note of it, and then continue with the next lesson. Most of your questions will be answered as you go. Already, though, you know enough about VisiCalc to use it for some simple applications. Try it!

Postscript: Protecting Yourself From Disaster

Have you ever worked out a problem or made some notes to yourself on a sheet of paper, only to find out later that the sheet had been lost, or that someone had accidentally thrown it away? Or perhaps you've lost the results of some calculation you were performing on an electronic calculator, because power was turned off, or the battery died. Things can and do go wrong.

As you begin to use VisiCalc, you'll find that at times the results you see on the screen may be quite important to you. Losing that information at the wrong time would be at best a real nuisance, and at worst a minor disaster, if, say, you needed the results for a presentation the next morning. How can you protect yourself?

VisiCalc is designed to be as foolproof as possible. It is quite difficult to mess things up badly by anything you might type at the keyboard. For example, if you give the command to clear the screen (intentionally or accidentally) by typing / C, VisiCalc will display on the prompt line CLEAR; Y TO CONFIRM. Only if you type the letter Y at this point will the contents of the sheet be erased. If you type any other key, the clear command will be aborted, and the sheet will be left unchanged. Similarly, if you type / B to blank out an entry, nothing will happen unless and until you press one of the keys ←, →, ↑, ↓, or ⏎. Any other key will abort the BLANK command.

Save Your Work As You Go

VisiCalc does its best to protect you, but other things can go wrong. What if your building has a power failure? What if someone pulls the plug from the socket? What if you are called away by some emergency and the janitor turns off your computer?

To protect yourself, you should save the electronic sheet periodically on diskette. As you work, think of how long it has been since you last saved the sheet. If you have spent more time than you would wish to lose if something went wrong, or if you have new results which might be difficult to reconstruct, then it's time to save the sheet again. To keep track of several versions of the same information on diskette, you can append a sequential number (such as FORECAST 3.VC) or the date (such as FORCAST 10/26.VC) to the filename you use when you save the sheet. Remember that only sixteen characters are allowed for the filename and spaces count as characters.

Another option is to print out the sheet on a printer. (See the discussion of the /P command at the end of Part II, Lesson Three and in Part III of this manual.)

Although you would not be able to examine the formulas, or change the numbers and recalculate, this "hard copy" would at least survive through most interruptions and emergencies.

Making Backup Copies of Diskettes

Saving your work periodically on diskette is only the first step in protecting yourself. A diskette is a safe and reliable medium for storing information; however, to be used, a diskette must be handled and transported from place to place. Think pessimistically. A diskette may be scratched, or it may pick up grease or dust; it may be damaged by heat, exposed to a magnetic field, or accidentally re-initialized (which erases its contents). And a diskette will eventually wear out: its average lifetime is about 40 hours of use (being read from and written to in the disk drive). Hence, to protect yourself, you should always make extra copies of your important files on separate "backup" diskettes.

To make a backup copy of your files, you can use VisiCalc's STORAGE command. Simply insert the diskette containing the file you want to copy into the disk drive 0, and use the /SL command to load the sheet from the diskette file into memory. (For details on the /SL command, see Lesson Two and the STORAGE Command in Part III.) Then insert a fresh, initialized storage diskette into drive 1, and use the /SS command to save the same information on the new diskette. To tell the computer that the diskette on which you want to save the information is in drive 1 (not drive 0) type 1 : before the filename you give when the prompt line reads FILE FOR SAVING. For instance, you might load the file named EXAMPLE.VC with /SL and then tell VisiCalc to save it on the diskette in drive 1 by using /SS and typing **1 : E X A M P L E . V C** for the filename. Your sheet will be safely stored on the diskette in drive 1 with the filename EXAMPLE.VC, and the original sheet (in this case, also having the name EXAMPLE.VC) will still be on the diskette in drive 0. Notice that the 1: you typed is *not* part of the filename. The time it takes to make backup files will be amply repaid the first time you try to load a file from a diskette, only to get the message that an error occurred while trying to read the disk.

Alternatively, you can copy the entire contents of one diskette to another diskette. To do this, you must use programs that are provided with te Disk Operating System (DOS) for your CBM floppy disk drive. There ae several versions of the CBM disk drive Disk Operating System, each of which requires a slightly different method of duplicating diskette. Read the DOS User's Manual that comes with your disk drive carefully and follow the directions for preparing to use a diskette and the duplication procedure. *Test your understanding of the procedures on a data diskette you make expressly for experimentation.* Until you thoroughly understand the procedures, don't risk using good data diskettes; you may lose the data while learning.

Making backup files is important. It's all too easy to read about these protective measures, use them once or twice, and then when you're in a hurry, skip the backup steps. When disaster strikes, you'll curse your carelessness.

Remember Murphy's Law:

> If anything can possibly go wrong, it will.

Protect yourself.

Lesson Two

Lesson Two

In this lesson, the "fireworks" begin as we show how VisiCalc extends and generalizes the basic principles you have seen so far. We will begin with the example built up in Lesson One, showing a figure for SALES, and formulas to calculate COST of goods sold and GROSS profit.

If you have just finished Lesson One, everything you need should still be present on the electronic sheet. Check your screen against the screen photo below, and continue with the text from that point. If you want to practice loading the sheet you just saved, anyway, type /CY and then follow the instructions in the next section.

If you're tackling Lesson Two in a new session, your first step is to load the VisiCalc program into your computer's memory. The instructions to do this are in Part I in the section entitled "Loading VisiCalc."

If you saved the results of Lesson One on diskette, you can easily reload the same information now by following the instructions below. (If you didn't save the sheet, follow the instructions for setting up the sheet just before the screen photo.)

Loading the Sheet from Diskette

Make sure that your disk drive's ACTIVE light is off, then open the drive door and (if you haven't done so already) carefully remove your VisiCalc program diskette and replace it in the pocket on the inside front cover of the binder holding this manual. Now insert the storage diskette holding the file named EXAMPLE.VC which you saved at the end of Lesson One into drive 0. Be sure that the label on the diskette jacket is up and the oval cutout enters the drive first. Gently push the diskette all the way in, and close the drive door.

Now type the VisiCalc STORAGE command / S. The prompt line reads STORAGE: L S D I Q #. (To review the meanings of the characters L S D I Q #, check the section entitled "Saving the Electronic Sheet on Diskette" at the end of Lesson One.) Press L. The prompt line reads FILE TO LOAD. At this point, you could simply type the name EXAMPLE.VC, ending with the ↵ key. But let's try something else. Press the • key once. Your disk drive will whirr for a moment as VisiCalc looks at the directory and the ACTIVE indicator lights on each drive will come on. (The ACTIVE light on drive 0 will remain on until you have finished the STORAGE command.) Then the name EXAMPLE.VC appears on the edit line! (If a different name appears, press the • key repeatedly until you get the name EXAMPLE.VC.)

When you press the • key, VisiCalc looks in the diskette's directory or catalog for the name of a file which could be a saved VisiCalc sheet. On the edit line, VisiCalc presents the first qualifying filename it finds in the directory for your inspection. If this filename is not the one you want, you would simply press the • key again, and VisiCalc would show you another filename from the diskette

directory. Eventually you will reach the name of the desired file (or else you'll realize that you have the wrong diskette). Assuming that you have the name EXAMPLE.VC on the edit line, press ®. Watch the characters flashing by at the left end of the edit line. These are the same keystrokes you would type from the keyboard to set up the sheet, but they are being "typed" automatically at high speed as they come back from the diskette. After a moment, the disk drive ACTIVE light goes off, the information on the prompt and edit lines will disappear, and the screen should look just like the screen photo below. You can continue with the instructions following the photo.

If you don't have the file EXAMPLE.VC saved on diskette, you can type in the same information from the keyboard. To practice moving the cursor and writing labels, numbers and formulas, you can go through the steps in Lesson One, or, if you're comfortable with these VisiCalc features, you can type exactly the characters you see below. Remember you may have to use the **SHIFT** key to type some of the characters.

```
>A1®
SALES◆100®
>A2®
COST◆.6*B1®
>A3®
"-GROSS-◆+B1-B2®
>B1®
```

Replicating a Formula

Your screen should look exactly like the one pictured above. The cursor should be at B1. If the number under the cursor is not 100, just type **1 0 0** and press ®.

At present, we have figures for sales, cost of goods, and gross profit for only one month (or year, or other period). Now, we'll project these figures out for twelve months. Let's assume that SALES will increase by 10% each month. Press the ◆ key to move the cursor to C1, and type: **1 . 1 * ◆ ®**. Notice that we used a cursor movement to fill in the coordinate **B1** in the formula for the next month's sales. The entry contents line at the top of the screen now reads C1 (V) 1.1*B1, and the number under the cursor highlight at C1 is 110, or 1.1*100.

To calculate sales for the remaining ten months, we would have to move the cursor to D1 and type the formula 1.1*C1, then move on to E1 and type 1.1*D1, and so forth. Since this is such a common operation and it requires so many keystrokes, VisiCalc provides a shortcut way to do it. The shortcut is the REPLICATE command, and it can be used to make copies of, or "replicate" formulas, labels, numbers, blank entries, etc. across columns, down rows and so forth. In this lesson, we'll use the replicate command in just a couple of simple examples. The many uses of this command are covered more fully in Lesson Three.

With the cursor at C1, type / R. The prompt line reads REPLICATE: SOURCE RANGE OR RETURN, and on the edit line is C1, the coordinate of the formula under the cursor, followed by the small rectangle. Press ↵. The prompt line now reads REPLICATE: TARGET RANGE, and the edit line reads C1 . . . C1: followed by the small rectangle. So far, we have indicated that we want to replicate just the formula at C1, and VisiCalc is asking us where we would like to put copies of this formula.

Our intent is to project sales out for twelve months. The first month is shown at B1, the second at C1, and the twelfth month will be at M1. Hence, we want the formula replicated in the range of positions from D1 to M1. Press the → key, then type a period. The edit line now reads C1 . . . C1: D1 . . . As you can see, by moving the cursor, we are indicating where we want copies of the formula to be placed. Now press the → key ten times. Notice that as you move the cursor to D1, E1, F1, and so on, the "target range" on the edit line reads D1 . . . D1, D1 . . . E1, D1 . . . F1, and so on: VisiCalc is "filling in" the ending coordinate of the target range, just as it did when we moved the cursor in the middle of typing a formula.

When you have finished pressing the → key ten times, the cursor will be resting at M1, and the edit line will read C1 . . . C1: D1 . . . M1. (If you moved too far with →, you can move back with ←.) Now press ↵. The cursor jumps back to C1, where the original formula is stored. The edit line reads C1: D1 . . . M1: 1.1*B1, and the small rectangle is highlighting the coordinate B1 on the edit line. The prompt line reads REPLICATE: N - NO CHANGE, R - RELATIVE. VisiCalc is asking whether we want the same formula, 1.1*B1, at each of the positions in the target range D1 . . . M1, or whether the coordinate B1 should be interpreted as *relative* to the position of the formula.

We want sales to increase by 10% in each month, so we want the formulas to be 1.1*B1, 1.1*C1, 1.1*D1, etc. In other words, each new sales figure should be 1.1 times the previous month's sales. Press R, and watch the screen. The information on the prompt and edit lines disappears; the cursor remains at C1, where we started; and numbers have appeared in the visible columns.

Use the → key to move the cursor to D1, E1 and F1, and notice what appears on the entry contents line: 1.1*C1, 1.1*D1, and 1.1*E1. Press the → key seven more times to move the cursor over the entries G1 through M1, scrolling the window to bring them into view. VisiCalc has "typed" the formulas for you, and calculated the sales values for all twelve months. At M1, the twelfth month's sales should be shown as 285.3117 (to four decimal places).

Much has happened during the last few keystrokes, and of course there are many more options for the replicate command which we haven't used in this case. But what you must remember to type to replicate a formula is very simple: i) Move the cursor to the formula you want to replicate; ii) Press / **R** ↵ to start the replicate command; iii) Point the cursor at the first entry position in the range of positions where you want the formula replicated, press the period key, and point to the last entry position (or you can type in the entry coordinates); iv) for each coordinate in the formula, press either **N** or **R**, depending on whether that coordinate should be left unchanged, or interpreted as relative to the position of each copy of the formula.

Replicating a Range of Formulas

Type ← **A 2** ↵ to scroll the window all the way back to the left edge of the sheet, and then press → to move the cursor to B2. To complete our twelve month projection, we would like to replicate the formulas for cost of goods sold and gross profit. At the moment, the entry contents line shows the formula for cost of goods, .6*B1. If we were to move the cursor to B3, we would see the formula for gross profit, +B1-B2. We can replicate both of these formulas at once across the sheet.

Press / **R**. The prompt line reads REPLICATE: SOURCE RANGE OR RETURN, and on the edit line is B2, followed by the small rectangle. If you were to press ↵ at this point, as we did before, you would replicate just the formula for cost of goods sold at B2. When you were finished, you would come back to the formula for gross profit at B3, and replicate it into the same range of columns as you did for B2. We can accomplish both of these steps at once: Press . **B 3** ↵. The edit line now reads B2...B3: VisiCalc acknowledges that we want to replicate a "source range" of formulas, B2 through B3. The prompt line reads REPLICATE: TARGET RANGE. Instead of pointing at the first and last positions as we did before, we will simply type the coordinates of the target range. Type **C 2 . M 2** ↵. For a source range of B2...B3, and a target range of C2...M2.

VisiCalc will assume that the formula at B2 (for cost of goods) is to be replicated at positions C2 through M2, and the formula at B3 (for gross profit) is to be replicated at positions C3 through M3.

The prompt line now reads REPLICATE: N = NO CHANGE, R = RELATIVE, and the edit line reads B2: C2 . . . M2: .6*B1, with a highlight over the coordinate B1. How do we want the coordinate B1 to be interpreted? Our intent is that cost of goods sold in any given month will be 60% of that month's sales. Hence we want B1, the coordinate for SALES, to be interpreted as *relative* to the position of each copy of the formula. For the formula at B2, we want the sales figure just above it, or B1. For the formula at C2, we want the sales figure just above *it*, or C1; and so on. Press **R**. Almost instantly, numbers appear in the other columns, and the edit line now reads B3: C3...M3: +B1, with a highlight over B1. VisiCalc is ready to replicate the formula for gross profit, at B3, into positions C3 through M3. The +B1 is the beginning portion of the formula +B1-B2. Again, we want B1 to be interpreted as relative to the position of each copy of the formula. Press **R**. Now the rest of the formula appears on the edit line, as +B1-B2, this time with a highlight over B2. B2, or cost of goods, is also relative in the gross profit formula. Press **R** once more. Numbers will appear in the other columns of row 3, and the prompt and edit lines will go blank. The REPLICATE command has finished its work.

Use the arrow keys to move the cursor to the right and up and down to examine the formulas and calculated results displayed in columns C, D, E and so on. Finally, type / **M 1 R** to display the last month's sales, cost of goods and gross profit, in column M. VisiCalc has saved you a good deal of work already. But these numbers are somewhat hard to read, because they fill the columns and don't always line up. Can we do better than this?

Formatting the Screen Display

Of course. Type / **G F I** (for "global format integer," as explained below), and watch what happens. Is the new display easier to read? If you scroll the window to the left, you will see that all of the numbers which come into view on the screen have been rounded to integers and lined up on the right. However, this does not mean that VisiCalc has actually rounded the numbers that it uses in its calculations. Each number is calculated and maintained with up to eleven significant digits or decimal places (so that, for instance, each new period's sales is based on an accurate rendition of the previous period's sales). The numbers are rounded only as they are displayed on the screen.

Perhaps you'd prefer to see two more decimal places, for "dollars and cents." Press /, the keystroke which starts all commands. The prompt line reads COMMAND: BCDFGIMPRSTVW-. Each of the keys, B, C, D, and so on through '-' is the keystroke for a different command. So far, we have seen the commands /B (for BLANK), /C (for CLEAR), /R (for REPLICATE), and /S (for STORAGE). Now, press G. The prompt line reads GLOBAL: C O R F. VisiCalc has recognized the GLOBAL command, which is used to change something about the entire screen display. Next, VisiCalc expects one of the keystrokes C, O, R or F. Press F. Now the prompt line reads FORMAT: D G I L R $ *. VisiCalc is ready for a change to the "global format," or the way in which numbers and alphabetic labels are displayed on the screen. A moment ago, you used the letter I to change all of the numbers to integer format. Now, press $ (you may need to use the SHIFT key on your keyboard). Remember that you can use the INST/DEL key to quit the command and start over. Notice how the screen display changes to show everything in dollars and cents form.

As you might guess from the FORMAT prompt list D G I L R $ *, there are many other ways to format numbers and alphabetic labels. It is also possible to set the format of each entry position individually. These options will be covered more fully in Lessons Three and Four of this Tutorial.

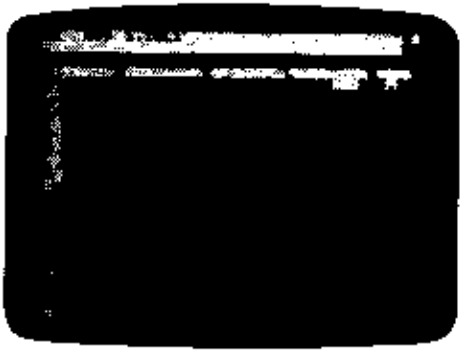
Fixing Titles In Place

If the cursor is not on M1, type > M 1 ®. Only the numbers for each month's sales, cost of goods and gross profit are shown on the screen. The titles SALES, COST and -GROSS- have scrolled off the screen window to the left. Imagine the situation if you were preparing a more complex income projection, with many rows of numbers for selling and administrative costs, taxes, and so on. It would be difficult to remember what each row of figures represented, once the titles had scrolled off the screen. We'd really like the titles to stay visible at the left edge of the screen window.

No more easily said than done. Type > A 1 ® to bring the titles SALES, COST and -GROSS-into view. Now type / T (the TITLES command). The prompt line says TITLES: H V B N. The possible keystrokes are:

H	To fix horizontal titles.
V	To fix vertical titles.
B	For both horizontal and vertical.
N	For neither.

For now, press V. You have asked VisiCalc to fix the vertical column A, where the cursor lies, in its present position, no matter where the cursor is moved subsequently. Press the → key eight times, watching the screen as you do so. Notice that column A stays fixed in place, while the remaining columns scroll to the left, disappearing when they reach column A. Now press the → key nine times. (If you aren't sure of what happened, press the → key again.) You are "bumping" into column A, just as you bumped into the left edge of the sheet once before. Next, type > M 1 ®. Column A is still visible, making it easy to identify each row of numbers.



Now, For a Quick Recalculation

So far, with the aid of the REPLICATE command, you have written one number (the beginning number for SALES at B1), and thirty-five formulas on the electronic sheet. How are these formulas related? Press > B 1 ® to bring the first columns into view, leaving the cursor on the initial SALES figure. The formula for COST at B2 is .6*B1, which depends on the figure for SALES at B1. The formula for gross profit at B3, in turn, depends on both SALES and COST (+B1-B2). What about succeeding columns? At C1, the formula is 1.1*B1, so this entry also depends on the initial SALES figure. And cost of goods at C2 depends on the figure at C1, while C3 depends on both C1 and C2. At D1 we have 1.1*C1, and so on. As you can see, a change to the initial SALES figure at B1 will affect every other number on the sheet. Try it. Just type a new number, such as 123.45, and press ®. How long did it take to recalculate twelve months' worth of sales, cost of goods and gross profit formulas? Type **1 0 0** (and ®) again, and watch the changes ripple through the other figures on the screen. Scroll the screen window to the right to view M1, the ending month's sales.

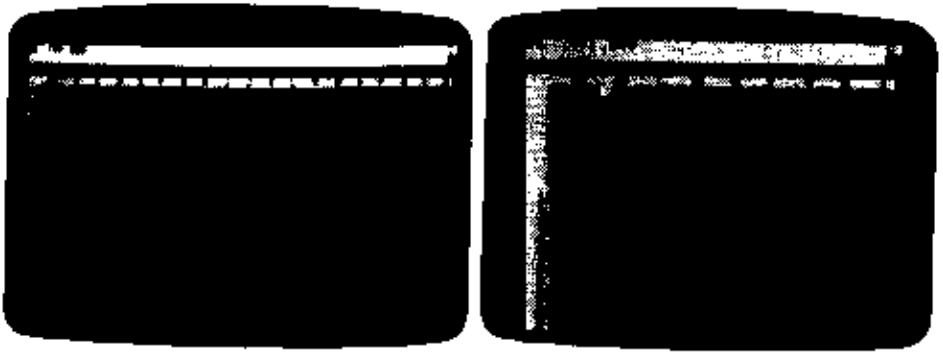
At this point, if you're intrigued by this example, you'd like to know how to change the sales growth figure of 10%, or the cost of goods percentage of 60%, and recalculate gross profit. For simplicity's sake, we've designed this example so that the only changeable figure is the initial SALES. Since the figures 1.1 and .6 are built into each of the twelve formulas for sales and cost of goods, we can't change these percentages without replicating all of the formulas again. A better approach would be to write the factors 1.1 and .6 into separate positions on the sheet, and make the sales and cost of goods formulas refer to these positions. If we did this, changing the sales growth and cost of goods percentages would be as easy as changing the initial sales. We'll make use of techniques like this in Lesson Three. (If you're *not* intrigued by this business-related example, bear with us; Lesson Three deals with personal budgeting.)

Adjusting Column Widths

Type > B 1 ®. For some time now, you've been scrolling the window back and forth across the sheet to view the figures for different months. You might be wishing for a larger screen that would display more columns at once. Well, you *can*.

Type another GLOBAL command: / **G C 7** ®. In an instant, the screen changes to display more columns. Each column has been narrowed from nine characters to seven characters in width. In general, you can use the command / G C to set the "global column width" to anywhere from 3 to 37 characters per column on a 40-character screen display and from 3 to 77 characters on an 80-character display. Given a column width, VisiCalc will fit as many columns as it can across the screen.

Right now, the dollars and cents figures just about fill up the available space in these 7-character columns. But we already know how to round the numbers to integers: Type / **G F I**. Now, we have some extra space, so let's narrow the columns further: Type / **G C 4** ®. That gives us even more columns of figures in the window, each column four characters wide.



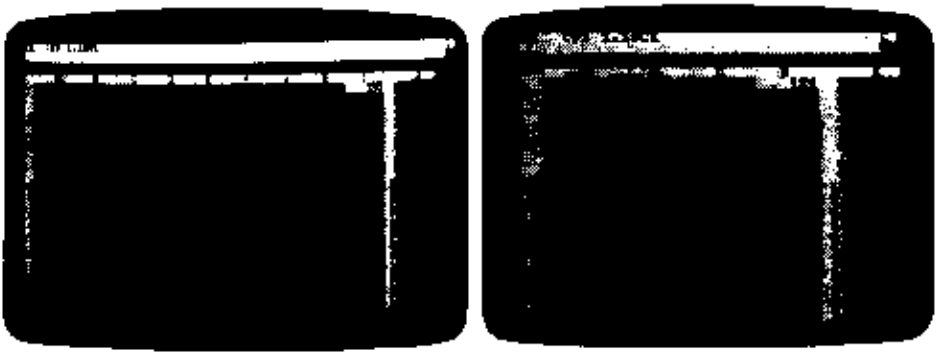
Pause for a moment. Look at the titles, SALES, COST, and -GROSS- in column A. SALES has been shortened to SALE, and -GROSS is now -GRO. Have we lost the rest of the labels SALES and -GROSS-? Move the cursor to position A1 to find out. (If you press the • key, you'll bump into column A, which we fixed in place as a title area. Type > A 1 ®.) The entry contents line reads A1 (L) SALES. Press • twice to reach A3. The entry contents line reads A3 (L) - GROSS-. Even though the columns have been narrowed, the full alphabetic labels are preserved.

Can these labels be more than nine characters long? Of course; in fact, you can type an alphabetic label as long as you like, regardless of the current column width, and the full label will be preserved. Try this: With the cursor still at A3, type **GROSS PROFIT**. Then press the • key to move up to COST, and type **COST OF GOODS SOLD**, followed by ®. Next, type / **G C 1 2** ®. Notice that the entire label GROSS PROFIT comes into view, while the number of columns in the window is reduced. Now, type / **G C 1 8** ®. Notice the prompts GLOBAL: C O R F and COLUMN WIDTH, and the small rectangle on the edit line as you type. As usual, the **INST/DEL** key can be used for corrections as you enter the number 18. The entire label COST OF GOODS SOLD can be seen. Let's go back to / **G C 7** ®.

The ability to fix titles in place and adjust column widths gives us some compensation for the limited size of the screen. But, suppose we'd really like to keep the wider columns and the cursor at B1, the initial sales figure, and change it, while watching what happens to the final sales and gross profit at column M. If only we had two screens. . . .

Splitting the Screen

Type > E 1 ↵ to move the cursor to column E. If your screen is 80 characters wide, type > J 1 ↵ to move the cursor to column J. Now, type the WINDOW command / W. The prompt line reads WINDOW: H V 1 S U. Press V (for vertical). Your screen should look like the photo below.



You have created two screen windows. Each one can be scrolled independently to view any portion of the electronic sheet. At present, the cursor is in the left hand window. Use the ↓ key to move the cursor downwards to row 21 and beyond. The left window will scroll downwards to follow the cursor, but the right window will remain still. Bring the left window back to the top of the sheet with > B 1 ↵.

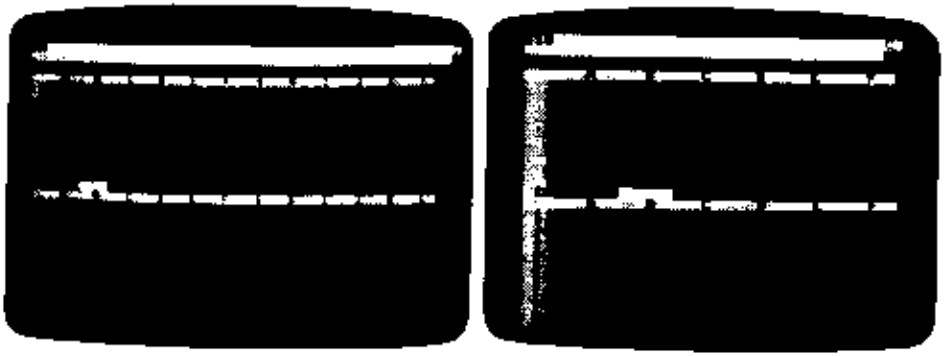
Now press the ; key (you won't need to press the **SHIFT** key). The cursor jumps into the right hand window. Press the → key to scroll the right window across to column M. We now have both the beginning and ending months' sales, cost of goods and gross profit figures visible at the same time. Press ; again. The cursor jumps back to the left window. (Each time you press the ; key, the cursor jumps from one window to the other.) Notice that the cursor has landed at the same position it was on when we last jumped out of the left hand window.

Now we can change the initial sales figure, and watch what happens in the final month. Type 1 2 3 followed by ↵, and let VisiCalc recalculate. SALES in column M should be 351. Try typing a few more numbers with the cursor at B1. See if you can find, by trial and error, the initial sales figure which gives you an ending month's sales of 1000 (rounded to the nearest integer). (Hint: You can type a number with a decimal point, even though it will be displayed in rounded form.)

When you are finished experimenting with recalculation, type the WINDOW command / W again. This time, press 1. The screen returns to normal (1 window). We have seen that the idea of a split screen is useful. Can we get any

more mileage out of this approach? Take a look at the screen, and notice how much of it is empty. Perhaps we can use the lower part of the screen to better advantage.

Type > B 1 1 ® to move the cursor down to the middle row of the screen. Now type / W H (for horizontal). Your screen should look like the photo below.



This time the screen is split horizontally, into a top and bottom window. Press the ; key to move the cursor into the bottom window. Next, hold down ♦ to scroll the window upwards, until the cursor bumps into the top edge of the sheet. Both windows are now displaying the same portion of the electronic sheet! The cursor should be at B1 in the bottom window. Just for fun, change the number at B1 to 100 in the bottom window, and watch what happens. The recalculation affects both windows. Use the ♦ to scroll the bottom window rightwards until column M comes into view. Now we can see the first and the last months at the same time.

Global Commands In Separate Windows

Press ; to move the cursor into the top window, and type / G C 4 ®. Once again, we have more columns on display at the top of the screen, each column four characters wide. As you can see, the column widths can be different in the two screen windows. The global commands /GC and /GF affect only the window in which the cursor rests at the time the command is typed. Press ; once more, moving the cursor to the bottom window, and this time type / G F $. We have dollars and cents displayed in the bottom window, and integers at the top.

Press ; to jump the cursor into the top window, and type > B 1 ® to highlight our original sales figure. At B1, type the number 3 0 0 followed by ®, and watch the changes ripple through all the columns as VisiCalc recalculates all the formulas. Now type the number 6 0 0. What happens? Columns H through M show > symbols in some positions instead of numbers. As you can probably guess, the calculated results are too large to display in integer form in the narrow columns of the top window, or with two decimal places in the bottom window. You can press ; and type / G F I to see the final sales figure at M1 in the bottom window. It should be 1712.

Summary

We have covered a lot of ground in this lesson and, at this point, after the many examples we've shown here, you may be a little hesitant to even touch the keyboard, in view of the radical changes to the appearance of your work which can result from just a few keystrokes. The features and commands you have seen here can be mastered more easily than you might think. Remember the following key points:

1. No matter what you type at the keyboard, you cannot hurt either the computer or the VisiCalc program. Moreover, it's fairly difficult to destroy your own work on the electronic sheet, particularly if you watch the prompt line for keystroke-by-keystroke feedback and save the sheet periodically on diskette.
2. Throughout this lesson, we have introduced only four new commands. They are:

   The **REPLICATE** command /R, which gives you a shortcut way of writing similar formulas in adjacent rows and columns.

   The **GLOBAL** command /G, which lets you change the column width (/GC) and the way numbers are formatted (/GF).

   The **TITLES** command /T, which lets you fix rows or columns of alphabetic titles in place, as part of the top or left hand "border".

   The **WINDOW** command /W, which lets you split the screen, either horizontally or vertically, into two independently scrollable windows.

   Much of the power of VisiCalc is due to the simple and highly consistent way in which these commands interact with one another. In almost any context, a command will do what you would logically expect.

3. Aside from the replicate command, which basically saves you time as you write formulas, all of the commands discussed in this lesson affect only the *appearance* of your work on the screen (generally in an effort to compensate for a small screen size). Nothing you might do with the /G, /T or /W commands can affect the labels, numbers or formulas actually written on the sheet. When in doubt, you can always type **/ W 1 / T N / G F G / G C 9** ↵ to return everything to normal.

Armed with these assurances, you should be ready to *experiment*. Clear the screen and try out these commands with a problem of your own. If you don't understand something, go back through this lesson to see what you might have missed, and check Part III, the VisiCalc Command Reference of this manual and the reference card for more complete explanations. You now know enough about VisiCalc to begin to use it really effectively. Good luck!

Postscript: Memory and the Electronic Sheet

As you may know, your computer contains two kinds of fast semiconductor memory: RAM and ROM. ROM, or "read only memory," is manufactured with a fixed pattern of data or program instructions stored in it, whereas RAM, or "random access memory" is made in such a way that it retains data which is put into it only as long as the memory's electric power is left on, or until new data is put into the memory in place of the old data. Data or program instructions are put into RAM memory either by typing at the keyboard or by loading prerecorded programs or data from cassette or diskette.

The VisiCalc program is loaded into RAM memory from diskette, and it, together with some RAM which the computer itself requires, takes up about 21K bytes. The remainder of RAM memory is devoted to the VisiCalc electronic sheet. VisiCalc manages this area of memory automatically. You never have to concern yourself with the details of how the electronic sheet is maintained. But you will find it useful to have a general idea of how the sheet works, as you begin using VisiCalc to its fullest capacity.

How the Sheet Is Reconfigured

Let's try some experiments. If you have not already done so, load VisiCalc into your computer. (You can refer to the instructions in the section entitled "Loading VisiCalc.") If you already have VisiCalc running, type **/ C Y** to clear the sheet.

Now type **> B K 2 5 4** ↵ to move to the lower right hand corner of the sheet. Let's try to write a number at this position. Type **1** ↵. What happens? As usual, VALUE appears on the prompt line, and 1 appears on the edit line, followed by the small rectangle. But when you press ↵, VisiCalc simply flashes the screen and leaves nothing at position BK254. Why?

Think for a moment. Just how large is this electronic sheet? The columns are lettered A through Z, AA through AZ, and BA through BK, for a total of 63 columns. There are 254 rows, so that makes a total of 63 x 254, or 16,002 entry positions. Right now, each position is nine characters wide. If all 16,002 entry positions were filled with alphabetic labels nine characters long, they

would take up 16,002 x 9 = 144,018 bytes of memory. That's considerably more RAM memory than you can possibly have on your computer! What's more, as you saw in Lesson Two, the columns can be widened and the wider you make them, the more bytes would be needed.

You can conclude that, even though VisiCalc lets you scroll down to position BK254, the electronic sheet is not really this large, because of RAM memory limitations. Just how far does the sheet actually extend? Let's try some experiments to find out.

Type > B K 1 ® to move the cursor to the upper right hand corner of the sheet. Now try typing 1 ®. It works: The number 1 is recorded at position BK1. Apparently, the sheet extends as far as column BK. Now, let's try the lower left hand corner. Type > A 2 5 4 ®, then try typing 1 ®. VisiCalc flashes the screen and refuses to record a number there. So the sheet doesn't seem to extend all the way down to row 254.

Before you draw conclusions from this experiment, let's try another one. Type / C Y again to clear the sheet. Then type > A 2 5 4 ® once more. Let's try writing the number 1 in this position again: Type 1 ®. It works! This time, the sheet seems to extend down to row 254 after all. Now type > B K 1 ® to move to the upper right hand corner of the sheet, where we recorded the number 1 a moment ago, before clearing the sheet. Type 1 ®. What happens? VisiCalc refuses to record the number. Obviously, something unexplained is going on here.

The explanation is that the electronic sheet is dynamically reconfigured: It grows to be the size and shape you need as you use it. You actually start with a 1 by 1 sheet, starting and ending at position A1. Although you can move the cursor to any position up to BK254, no memory is actually allocated for the sheet until you write something on it. Then the sheet grows into a rectangle just large enough to include the rightmost and bottommost positions in which something is written. As you move further downwards and to the right, writing labels, numbers and formulas, this process continues, until the available memory is exhausted.

When you wrote the number 1 at position BK1, the sheet grew to a size of 1 row by 63 columns. Then, when you tried to write in position A254, VisiCalc tried to extend the sheet to be a rectangle of 254 rows by 63 columns, but there was not enough memory available. The reverse happened when you cleared the sheet and wrote the number 1 at position A254: The sheet grew to a rectangle of 254 rows by 1 column. Then it was unable to grow to be 254 by 63.

The Memory Indicator

Type / C Y again to clear the sheet. Look in the upper right corner of the screen on the prompt line. Just below the letter C is a two digit number called the **memory indicator**. This number is the amount of memory still available for additional entries on the sheet, in K bytes. With 32K of memory, this number should be 10 (or close to it). The memory indicator will vary as you write information on the sheet or use commands, such as replicate, to write information. If you finally exhaust all of the available memory, VisiCalc will flash the screen and refuse to write anything more on the sheet, as it did when you tried to write at position BK254.

One question remains unanswered: How many bytes of memory does each entry position take up? You know that labels, numbers and formulas can be of different lengths and that column widths can be adjusted from as few as 3 to as many as the full width of your screen. The answer is not obvious, so let's experiment. The numbers we give in the next paragraphs for the memory indicator may be different on your computer.

Type **> Z 1 0 0 ®**. Since we cleared the sheet a moment ago, we currently have just a 1 by 1 sheet. As soon as we write something at Z100, the sheet will expand to be 26 columns by 100 rows, for a total of 2600 entry positions. If each position takes, say, 9 characters (the current column width), the sheet might use up 2600 x 9 = 23,400 bytes. With 32K of memory, a sheet of 2600 positions of 9 characters each might more than exhaust available memory. Let's try it: Type **1 ®**. What happens? The memory indicator changes from 10 to about 05. The sheet has grown to 2600 entry positions, but only about 5K bytes have been used. Since most of the newly created sheet is blank, VisiCalc reserves a minimum amount of memory — only 2 bytes — for each entry position.

Dynamic Memory Allocation

If you type a long message or formula at a particular entry position, VisiCalc will reserve additional bytes of memory for the position; but all of the other positions on the sheet will remain just large enough to hold the information which you have written in them. This is called "dynamic memory allocation." Let's see how it works. Type **> Z 1 ®**. At Z1, type the label **A LONG MESSAGE TO FILL MEMORY** and press **®**. So far we have used only a few bytes, so the memory indicator is unchanged at 05. Now we'll use up a lot of memory quickly. With the replicate command, we'll create 100 copies of the label A LONG MESSAGE TO FILL MEMORY. Type **/ R ®**, and for the target range of the replicate command type **Z 2 . Z 1 0 0 ®**. Watch the memory indicator: After a few seconds, as the replicate command does its work, the indicator changes from 05 to 02 (or, on some computers, 01). We have used up about 3-4K bytes.

One more experiment: Let's erase all the messages we have written at Z1 through Z100. Once again, we'll enlist the aid of the replicate command. First, type **/ B ®** to blank out position Z1. Then type **/ R ®**. The target range is again **Z 2 . Z 1 0 0 ®**. As the messages disappear, watch the memory indicator: It changes from 02 (or 01) back to 05! As you can see, VisiCalc reclaims the extra memory space used for long labels or formulas when they are erased from the sheet.

To sum up, VisiCalc manages memory efficiently and automatically. Because memory is dynamically allocated and the sheet is reconfigured to suit your needs, you can, for all practical purposes, work on a sheet that is much larger than you could actually fit into the computer's RAM memory. Aside from noticing from time to time how much space is still available for you to write in more entry positions, you need not concern yourself with problems of memory management.

Shrinking the Sheet

One thing VisiCalc does not do automatically, however, is to "shrink" the sheet. Suppose that you have written on various portions of the sheet, causing it to grow to a size of 100 by 100 positions. Later, having finished with this information, you might have erased or blanked out the entry positions near the right and bottom edges of the 100 by 100 sheet. The sheet will remain configured as 100 by 100, although each empty position will require only 2 bytes. If you begin using additional memory by writing lengthy labels and formulas in other positions, you may want to shrink the sheet to the smallest possible configuration for the information still written on it. To do this, you must save the sheet on diskette with the /SS command (as discussed in Lesson One), clear the sheet with / C Y, and reload the saved sheet with the /SL command (as discussed in Lesson Two). As the disk file is loaded, VisiCalc will enter on the sheet only those labels, numbers and formulas actually saved, and in the process the sheet will grow from a 1 by 1 configuration to just the size you need for the information remaining. This will make available more memory space for additional labels and formulas.

Lesson Three

Lesson Three

In Lessons One and Two, we used several examples to illustrate both the simplicity and the power inherent in VisiCalc's concepts and features. Although each individual VisiCalc command is quite simple, the various commands can be used in combination with each other to achieve a wide range of useful effects. As with any tool, there is skill involved in using VisiCalc effectively, and you will gain this skill through experience. In this lesson, we will begin to illustrate some of the techniques you can use to get the most out of VisiCalc's commands. We will also introduce more VisiCalc commands and features in this lesson.

Let's begin with a clean slate. Load the VisiCalc program into your computer as described in the section entitled "Loading VisiCalc," or, if you already have the program running, clear the sheet by typing / C Y.

In this lesson we'll outline a household budget application, with suggestions as to how you might adapt it for your own use. To prepare a budget, we'll first project our income for the next twelve months. We'll also project various necessary expenses such as food, rent or mortgage, telephone, etc. as well as semiannual expenses such as car insurance. Then we'll use VisiCalc to find out how much of our income is left for leisure and for savings and what percentage of our income is going for each category of expense. Finally, we'll consider various enhancements such as calculating the interest on our savings account.

Typeahead

First, we'll lay out twelve months or periods across the sheet. Type the word **PERIOD** and press the → key to move on to position B1. Now, as fast as you can, type the following keys: 1 → 2 → 3 → 4 →and watch what happens on the screen. Were you typing faster than VisiCalc could move the cursor and write the numbers on the sheet? If so, you noticed a feature called **typeahead**: VisiCalc remembers the keystrokes you type, no matter how fast you go, and it catches up with you as soon as it can. (If you are wondering why VisiCalc was so slow in the first place, read the section in Lesson Two entitled "Memory and the Electronic Sheet" and you'll realize that the sheet was actually "growing" as you typed.)

Before going on to type the numbers 5 through 12, let's ask ourselves: Is there a better way? Let's use the replicate command and let VisiCalc *calculate* the numbers 1 through 12. Use > A 1 ® → → to scroll the window and move the cursor back to C1, where the number 2 is written. Can you obtain the number 2 from a formula? It's simple: Type 1 + ← ®. The entry contents line should read C1 (V) 1+B1, and the value 2, now the result of 1+B1 or 1+1, should still be present at C1. Now, let's replicate. Type / R ®. The prompt line reads REPLICATE: TARGET RANGE, and the edit line reads C1...C1: followed by the small rectangle. Press → to obtain the starting position, D1; then press . ;

and finally, hold down the → key to move the cursor to column M, which will be period 12. (If you overshoot, back up with the ← key.) The edit line should read C1...C1: D1...M1. Now press ®. The prompt line reads REPLICATE: N=NO CHANGE, R=RELATIVE, and the edit line reads C1: D1...M1: 1+B1, with a highlight on B1 as in the photo below.

Press R to make the coordinate relative: This will give us 1+C1, 1+D1, etc. The prompt and edit lines should go blank. Move the cursor out to column M to check your work: Position M1 should show the number 12.

Replicating Numbers and Labels

Type the following characters, ending with the ® key as shown:

>A2® INCOME→1800®

We'll assume that $1800 is your monthly "take-home pay" after taxes and other deductions. Now, let's fill in the figure 1800 for all twelve months. Press / R ®. Can you replicate a single number as well as a formula? Of course: A number is actually the simplest case of a formula. For the target range, type C 2 . M 2 ®. You aren't asked whether the new formula is relative or not, because there are no coordinates in the "formula" 1800. The number 1800 should now appear in all twelve columns, in positions B2 through M2.

Next, we'll draw a line across the sheet. Move the cursor with > A 3 ® and then type / - . The prompt line reads LABEL: REPEATING, and a small rectangle appears on the edit line. Whatever character or characters we type next will be repeated to fill the entry position A3. Type - followed by ®. You should now have a line of nine hyphens at A3. Is this any different from simply typing the hyphens manually? Type / G C 1 2 ®. As you can see, the repeating label expands to fill the widened entry position. Now, go back to / G C 9 ®.

How can we easily extend the line across all twelve columns? The ever-useful replicate command will also replicate labels. Type / R ®. For the target range, type B 3 . M 3 ®. It's that simple. You should now have a line of hyphens extending all the way to column M.

Using Formulas For Flexibility

Before we go any further, let's think about what we've done. To save ourselves the trouble of typing the number 1800 twelve times, we replicated this number. That's fine as far as it goes, but is it the best way to handle our income? It would be better if we could change the income figure for all twelve months by simply typing a new figure for the first month and taking advantage of VisiCalc's recalculation feature. Let's replicate a formula instead of a number. Type:

```
>C2®
+B2®
```

We have defined the second month's income to be the same as the income for the first month. Next, let's replicate: Type / R ®. The target range is D 2 . M 2 ®. Now the prompt line reads REPLICATE: N=NO CHANGE, R=RELATIVE. Do we want the same formula, +B2, in all of the remaining positions, or would we prefer +B2, +C2, +D2, etc.? Either way we can change the income for all twelve months simply by typing a new number at B2. Think further: What if we should get a raise in the sixth month? If the formulas refer to the previous month, we can simply type a new number in month 6 and "propagate" the change through months 7-12. Let's try it. Type R to make the coordinate B2 relative. When the replicate command has finished, use the → key to move to month 6 (position G2). Now type **2000** ®. Press → a few more times to verify that each succeeding month's income has changed to 2000. Were you able to foresee the way in which the change would be propagated? If you weren't sure, move the cursor over all twelve income figures and imagine what would have happened if all of the formulas were +B2.

Our next task is to list our expense categories and estimate monthly amounts for each category. (Some expenses will vary from month to month, and other expenses will occur perhaps only every six months. We will leave these blank for the moment.) You can either type the following exactly as shown, or you can use the arrow keys to move the cursor and save yourself some keystrokes. (Hint: To take full advantage of the arrow keys, type all the alphabetic labels first.)

```
>A4®
MORTGAGE→600→
>A5®
UTILITIES→
>A6®
TELEPHONE→75→
>A7®
FOOD→350→
>A8®
CLOTHING→100→
>A9®
CAR EXPENSE→80→
>A10®
CAR INSURANCE→
>A11®
SAVINGS→150→
>C2®
```

At this point your screen should look like the screen photo below:

Next, we would like to replicate the monthly expense figures in column B across for the remaining eleven months. Remember our discussion of the merits of replicating a number versus a formula for our monthly income? To give ourselves maximum flexibility, we should also replicate formulas for the monthly expenses. At C4 we want the formula +B4; at C6 we want the formula +B6; at C7 we want +B7; and so on. (We'll fill in figures for UTILITIES and CAR INSURANCE later.) These formulas are so similar to each other and to the income formula +B2 that it's tempting to look for a shortcut way of typing them. Once again, the replicate command comes to our aid. This time, we'll replicate a formula down a column instead of across a row.

Replicating Down a Column

Make sure that the cursor is at C2. The entry contents line reads C2 (V) +B2. In a relative sense, C2 is to B2 as C4 is to B4, and so on: We want to treat the coordinate B2 as *relative*. Type /R®. The prompt line reads REPLICATE: TARGET RANGE, and on the edit line is C2. . .C2:, followed by the small rectangle. Press the ♦ key twice. Now the edit line reads C2. . .C2:C4. Type a period. The cursor jumps back to C2; VisiCalc acknowledges that the target range will start at C4. Next, press the ♦ key nine times (or hold it down to utilize the auto repeat ability) to reach position C11, opposite the figure for SAVINGS. The edit line now reads C2. . .C2:C4. . .C11, so the target range will be C4 through C11. Press ®. The cursor jumps back to C2, and the prompt line reads REPLICATE: NO=NO CHANGE, R=RELATIVE. The edit line reads C2:C4. . .C11: +B2, with the highlight over the coordinate B2. We want this coordinte to be relative: Press R. A column of numbers, from 600 to 150, appears in column C. Use the ♦ key to move the cursor downwards, pausing to look at the formulas we've replicated. We have what we wanted: At C4 is +B4, at C6 is +B6, and so on. We also have formulas at C5 and C10, but we can easily eliminate them. You can use ♦ and /B to do this, or you can type exactly the following:

```
>C5®
/B♦
>C10®
/B♦
>C4®
```

Replicating a Column Several Times

We now have the formulas we want for each expense category. The next step is to replicate these formulas across the rows through month 12. Do you remember how we replicated a source range of formulas, for both COST of goods sold and GROSS profit, across the rows in Lesson Two? We can do the same thing here. Press / R The prompt line reads REPLICATE: SOURCE RANGE OR RETURN, and on the edit line is C4 followed by the small rectangle. Press the ♦ key seven times to move the cursor down to C11. The edit line reads C4. . .C11, followed by the small rectangle. Now press ®. The cursor jumps back to C4, and the prompt line asks us for a TARGET RANGE. Type D 4 . M 4 ®. We have asked VisiCalc to replicate the formula at C4 into positions D4 through M4; the formula at C5 into positions D5 through M5; the formula at C6 into positions D6 through M6; and so on, through the formula at C11. Notice that we gave only the first coordinate in each column in the target range. Now the prompt line reads REPLICATE: N=NO CHANGE, R=RELATIVE. On the edit line is C4: D4. . .M4: +B4, with a highlight on B4. This is the formula for the first expense, MORTGAGE. As was the case for B2 (INCOME), B4 should be relative. Press R, and watch the screen. Several things happen: i) The cursor disappears (don't worry); ii) The number 600 appears at position D4; iii) The edit line now reads C6: D6. . .M6: +B6. VisiCalc has finished replicating the formulas +B4, +C4, +D4, etc. in row 4, and has also replicated the blank entry at B5 into C5, D5, E5, etc. Next, VisiCalc wants to know how to handle the formula +B6 on row 6. All of these formulas will be relative; press R five more times, and then sit back and relax. You have written a total of 96 numbers and formulas on the electronic sheet, with the aid of the replicate command.

Think about the technique we used to replicate the expense formulas: Starting with the prototype formula +B2 at position C2, we created six more prototype formulas by replicating down a column: +B4 at C4, +B6 at C6, etc. Then, we used these formulas as our source range to replicate similar formulas across on rows 4 through 11. Each of the resulting monthly expenses can be changed for all twelve months simply by typing a new number for the first month. For example, type > B 8 ® and change the number there to 120 ®. Your CLOTHING budget is raised to $120 for all twelve months.

To complete our projection of expenses, we'll fill in figures for those expenses which cannot be replicated across because they vary from month to month. Our UTILITIES bill will vary depending on the season and the need for heating or air conditioning. Our CAR INSURANCE premiums are due every six months; we'll pay a premium in month 1 and month 7. Type the following exactly as shown:

```
>B5®
140♦140♦80♦80♦40♦40♦85♦85♦50♦50♦100♦140♦
>B10®
160♦
>H10®
160♦
```

We do not have to fill in zeros for the other ten months in the row for CAR INSURANCE, because VisiCalc treats any blank entry as equivalent to zero. (In fact, any entry containing an alphabetic label will have a "value" of zero if it is referenced elsewhere in a formula.)

Now is a good time to save your work on diskette, if you have not already done so. Make sure that your disk drive's ACTIVE light is off, then remove your VisiCalc program diskette and replace it in the pocket on the inside front cover of the binder holding this manual. Now insert an initialized storage diskette into drive 0; the label should be up, and the oval cutout should enter the drive first. Close the drive door, and type /S S in response to the prompt FILE FOR SAVING, type **LESSON 3–1.VC®**. The disk drive should whir for a few seconds, and, if all is well, the drive will quiet down and the prompt and edit lines will go blank. You should also, at this time, make a backup copy of this file on another diskette which you do not use except for storing the backup files. If you should decide to end this session at this point, *be sure to remove any diskettes from the disk drive before you turn off the disk drive.*

Fixing Titles In Both Directions

We again have a situation where, if we scroll the window to look at the later months, we will lose the descriptive titles INCOME, MORTGAGE, etc. Let's fix them in place. This time, we'll create a border of titles along both the left and top edges of the sheet.

Move the cursor with > A 3 ®. Now type / T. The prompt line reads TITLES: H V B N. (The meanings of the keystrokes H, V, B and N are described in Lesson Two and in Part III, The VisiCalc Command Reference.) Press ® to fix titles in *both* directions. The position of the cursor has a dual significance for this command. If you type /TV to fix titles vertically, VisiCalc will fix in place the *column* in which the cursor rests, and all columns currently on the screen to the left of the cursor. If you type /TH to fix titles horizontally, VisiCalc will fix in place the *row* in which the cursor rests, and all rows currently on the screen above the cursor. Typing /TB is equivalent to typing both /TV and /TH, so the exact position of the cursor is important. In this case, we have created a border consisting of column A along the left edge of the screen window, and another border consisting of rows 1, 2 and 3 along the top edge of the window. To check this, hold down the • key to scroll the window downwards past row 21. Notice how rows 1, 2 and 3 remain in place. Now, type > B 4 ® and press the • key to see how the window scrolls horizontally, leaving column A in place. (Since all other numbers are the same from column to column, only the PERIOD and INCOME figures in rows 1 and 2 will change.) Continue pressing the • key until columns A, M, N and O are in the window. We'll use columns N and O to obtain totals and percentages for our income and expenses.

The Built-in Function @SUM

Type the following:

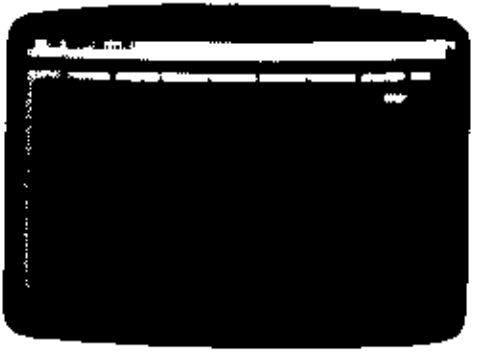
```
>N1®
TOTAL •
```

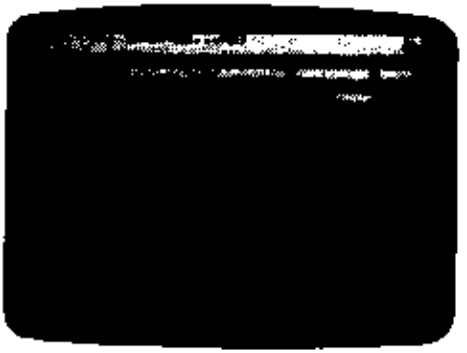
The cursor should be at N2. How can we find our total income for twelve months? You could always type

```
+B2+C2+D2+E2+F2+G2+H2+I2+J2+K2+L2+M2
```

but there's a simpler way. Press @, watching the prompt line as you do so. As soon as you type the @ symbol, the prompt line says VALUE. Now type SUM(and the edit line reads @SUM(followed by the small rectangle.

Our next step is to indicate what numbers we want to sum up. Hold down the ◆ until you begin "bumping into" the left hand border. The cursor should be at B2, and the edit line should read @SUM(B2 followed by the small rectangle. Press . . . The cursor jumps back to N2, where we started, and the edit line now reads @SUM(B2. . . . As you can see, we are specifying a range of entries, just as we have done several times for the replicate command. To finish this range, press ◆) ®. The entry contents line now reads N2 (V) @SUM(B2. . .M2), and under the cursor highlight is the number 23000, our total income for the year.





The @ symbol is used to begin the name of a VisiCalc built-in function. When you began the entry at N2 with the symbol @, VisiCalc immediately knew that: i) the entry was going to be a numeric VALUE; and ii) the next few letters you typed would be the name of a built-in function. Each built-in function, such as @SUM, performs some sort of calculation on the list of values given to it, and yields a numeric result. Other examples of built-in functions are @MIN, @MAX and @AVERAGE; see the reference card and Part III, The VisiCalc Command Reference for a complete description of all the funtions. Functions such as @SUM will operate over a range such as @SUM(B2. . .M2); a list of particular values such as @SUM(B2, B7, C3, D8); or a list of ranges, values, numbers or formulas, such as @SUM(B2. . .B7, C3. . .C6, 25, D8, 4*C8). And the numeric result of the function can be used wherever an ordinary number could be used: for example, in a function or another formula.

For our personal budget, we would like to obtain totals for each of our expense categories, just as we did for INCOME. Once again, a replication is called for. With the highlight on N2, which is our prototype formula, press / R ®. The target range is N 4 . N 1 1 ®. Now the prompt line reads REPLICATE: N=NO CHANGE, R=RELATIVE. The edit line reads N2: N4. . .N11: @SUM(B2, with the small rectangle highlighting B2. Think for a moment about what will happen if we make B2. . .M2 relative. Since we are replicating down a column, the replicated formulas will be in positions N4, N5, N6, etc. We want N4 to be the sum of B4. . .M4; N5 to be the sum of B5. . .M5 and so on, which is what will happen if the replicated formulas are relative. Press R twice. In an instant, the expense totals, from 7200 to 1800, appear in column N.

Let's find out what percentage of our income is accounted for by each expense total. Type the following:

>O1®
PERCENT♦♦♦

What formula will give MORTGAGE as a percentage of INCOME? Type: + N 4 / N 2 ®. We are dividing the MORTGAGE total at N4, or 7200, by the INCOME total at N2, or 23000. The result is .3130435, or approximately 31%.

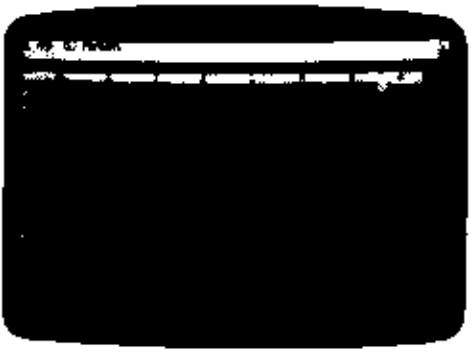
Formatting a Single Entry

The number .3130435 is unnecessarily messy. This is the general format (showing as many significant digits as the column width will allow), which VisiCalc uses in all cases unless we ask for something else. For our purposes, two decimal places should be enough. The global format command /GF, which we used in Lesson Two, displays everything to two decimal places. Type / G F $. Our mortgage percentage at position O4 now appears as 0.31, but every other number on the screen is also displayed in dollars and cents form. Even the month number 12 at M1 appears as 12.00. This is still messy. Change the global format back to "general" by typing / G F G. What we really want is to display just the number at O4 in dollars and cents form. With the cursor still at O4, type / F $. That's it! Just as the command /GF$ affects everything in the screen window, the command /F$ affects only the entry highlighted by the cursor.

Now that the percentage 0.31 is pretty, look at the label TOTAL at the top of column N. It is hard to read, because it's too close to the number 12 in column M, and it doesn't line up with the numbers below it. Move the cursor to the label TOTAL with > N 1 ®. VisiCalc normally starts alphabetic labels from the left side of an entry position (the *general* format for labels, which currently applies *globally* to all entries including PERIOD, INCOME, etc.), whereas numbers have their last digits lined up on the right. To change the format of TOTAL, type / F. The prompt line reads FORMAT: D G I L R $ * . The possible keystrokes are:

- D The format *defaults* to be the same as the global format. In other words, there is no special format for this entry.
- G Use the *general* format for this entry. You can use this, for example, to display a particular number with several decimal places even if the global format is I (integer).
- I Display this entry in *integer* format.
- L Start this entry (either a label or a number) at the *left* side of the entry position.
- R Make the last letter or digit of the entry line up at the *right* end of the position.
- $ Display this entry in *dollars and cents* format.
- * Display this entry in *graph* format. For examples, see Part II, Lesson Four, Part III, The FORMAT Command and the reference card.

For TOTAL, type R. Now TOTAL is lined up with the column of figures below it. Now press ♦ to move the cursor to O1, and press / F R to "right-justify" the label PERCENT.



Replicating a Format Specification

Type > O 4 ⊛ to move to the formula for MORTGAGE expense as a percentage of INCOME. We'll replicate this formula down column O to obtain percentages for all of the other expenses. Type / R ⊛. The target range is O 5 . O 1 1 ⊛. Now the prompt line reads REPLICATE: N=NO CHANGE, R=RELATIVE, and the edit line reads O4: O5. . .O11: +N4. How should we handle the formula +N4/N2, which is MORTGAGE as a percentage of INCOME? For UTILITIES at O5, we want +N5/N2. The first coordinate changes, but the second, N2 or INCOME, does not. Press R to make N4 relative; then, with the highlight over N2 on the edit line, press N to indicate "no change." After a second or two, we have all of our expense percentages, from 0.31 for MORTGAGE to 0.08 for SAVINGS. Notice that all of the percentages are displayed to two decimal places. Press ◆ a few times, looking at the entry contents line. At O5, for instance, the line reads O5 /F$ (V) +N5/N2. The format specification /F$ has been replicated along with the formula. In fact, it's possible to replicate a format specification even if the entry being replicated is blank! We'll use this trick a little later.

Using Replicate To Copy a Row or Column

Type > A 1 2 ⊛. Now we'll draw a line under our list of expenses; then calculate how much money we have left for LEISURE. You already know one relatively easy way to draw a line of hyphens, by using the /-command at A12 and replicating the hyphens across. But let's try using the replicate command a little differently. Type / R. The prompt line reads REPLICATE: SOURCE RANGE OR RETURN, and on the edit line is the cursor coordinate, A12, followed by the small rectangle. Now press INST/DEL. The A12 disappears, leaving only the small rectangle on the edit line. Let's type a new source range: A 3 . M 3 ⊛. As usual, the prompt line reads REPLICATE: TARGET RANGE. Type A 1 2 . A 1 2. Just what are we doing? The source range, A3. . .M3, is the line of hyphens already written on the sheet. We're asking VisiCalc to replicate the entry at A3 into position A12; the entry at B3 into position B12; and so on. Press ⊛. There's your line. (Incidentally, it would have been sufficient to type A 1 2 ⊛ for the TARGET RANGE; VisiCalc will take this to mean A12. . .A12.)

Finally, let's add LEISURE to our budget. The money we have available for leisure will simply be our income minus the sum of our expenses. Type the following:

```
>A13®
LEISURE® + B2-@SUM(B4.B11)®
```

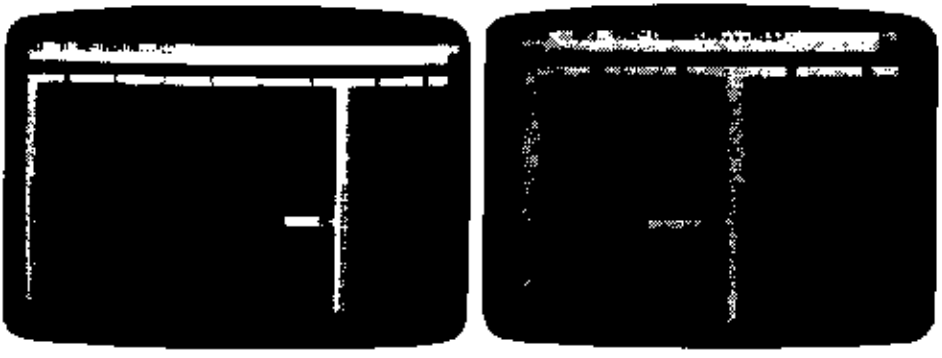
The figure for LEISURE, 125, appears at B13. Then replicate this formula across with / R ® C 1 3 . M 1 3 ®, and press R three times to make the formula coordinates relative. Now start pressing the ® key to scroll the window rightwards, and examine the encouraging results VisiCalc has calculated for us. Our LEISURE money starts small, at $125 in the first month, but it increases fairly steadily thereafter. After the first month, we don't have a car insurance premium, and in months 3, 4 and 5 our utilities bill goes down. In month 6, we get our raise, which increases our INCOME and LEISURE money. Continue pressing ® until you have brought columns M, N and O into view, showing TOTAL and PERCENT, and then press ® to leave the cursor at N13. To obtain a total and percentage of income for LEISURE, we can use the same method we used earlier to copy the line of hyphens. Press the following keys, and watch what happens on the prompt and edit lines (here, we'll use : in place of ®):

```
/R INST/DEL N11.O11:N13®RRRN
```

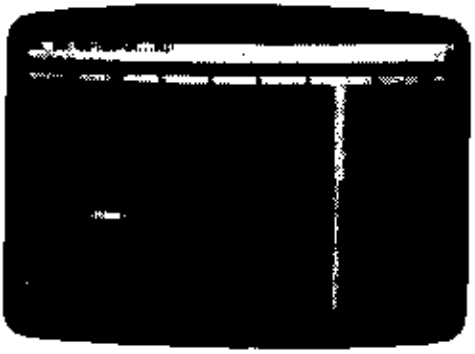
You should have a total of 5150 and a percentage of 0.22 for LEISURE.

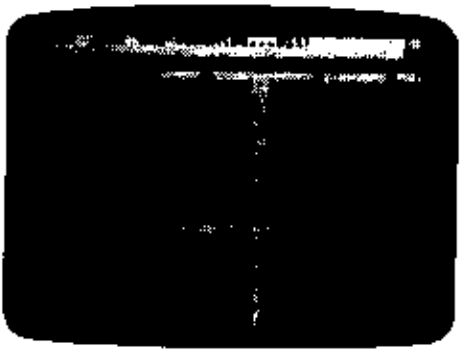
Changing Windows and Titles

As we found in Lesson Two, the screen is too small to display both our starting expense figures in month 1 and our calculated totals and percentages in columns N and O. We can solve this problem by splitting the screen into two windows. With the cursor still at N13, press / W V. Your screen should look like the photo below. The titles in column A and rows 1-3 are fixed in place in both windows.



Press ; to jump the cursor over to the right window, bringing columns A and N into view. Then press / T N to eliminate the fixed titles from this window. The title or "border" column A disappears, exposing column M. Finally, press ® once to bring the TOTAL and PERCENT columns N and O into view, and press ; to jump the cursor back to the left window. Press and hold down ® to scroll this window back to the first month. (Notice that you bump into column A. The fixed titles are still in effect in this window.) Your screen should look like the screen photo below.





Let's try changing one of our expenses to see how VisiCalc recalculates the expense totals and income percentages. Type > B 9 ↵ 1 0 0 ↵. What happens? Your available LEISURE money decreases by $20 each month; the CAR EXPENSE total goes from $960, or 4% of your income, to $1200, or 5% of income; and your LEISURE total for the year goes from $5150, or 22% of income, to $4910, or 21%.

The @NA and @ERROR Functions

Press ↓ to move to position B10. Let's suppose that you were about to change your car insurance policy, and the new premium was not yet known. How would you deal with this in your budget? VisiCalc has a special way: Replace the number 160 at B10 by typing @ N A ↵, and watch the screen. As you might have guessed, @NA stands for "Not Available." When you write this function at an entry position, that entry takes on the special value NA. When VisiCalc recalculates, any formula which refers to an entry containing NA will itself have a value of NA. In this case, your car insurance premium for month 1 at B10 became Not Available. Because of this, there was no way to calculate your leisure money (income minus the sum of expenses) for month 1, and so position B13 (for LEISURE) became Not Available. Moreover, your total car insurance expense for the year could not be calculated and also became NA, which meant that the corresponding percentage of income became NA. And, since one month's LEISURE expense was NA, the total was NA, and so was LEISURE as a percentage of income. Change B10 back to 160 ↵, and all of the calculated values will be restored.

Here's a related issue: Suppose that, instead of typing a number, you were trying to calculate your own car insurance premium as the insurance company does, but you made a mistake and tried to divide by zero. Type 1 / 0 ↵. As the screen shows, when VisiCalc evaluates the formula 1/0, the result is the special value ERROR. Like NA, the value ERROR "propagates:" Any formula which refers to an entry with the value ERROR will itself have the value ERROR. There are several ways to obtain a value of ERROR: dividing by zero, taking the logarithm of a negative number, calculating a value that is simply too large for the computer to represent, etc. You can also deliberately obtain the value ERROR, just as you did for @NA, by typing the function name @ERROR. For now, change the value at B10 back to 160 ↵ so that the totals and percentages can be calculated.

To make sure that we can continue from this point if something goes wrong, let's save the sheet on diskette again. The storage diskette which you used earlier in this lesson should still be in place in your disk drive. Type / S S and, in response to the prompt FILE FOR SAVING, press the ⊕ key. The disk drive should whirr, and a filename should appear on the edit line. Continue pressing the ⊕ key, if necessary, until you have the name LESSON 3-1.VC on the edit line. Then press the **INST/DEL** four times until the small rectangle is sitting where the 1 was. Now type **2.VC®**, watching the edit line as you type the characters. You are saving the sheet under the revised name LESSON 3-2.VC. Once you've started, all it takes is a few keystrokes to protect yourself from disaster.

Now, press : to jump the cursor into the right hand window. There are no fixed titles in effect in this window, and if you look closely, you'll notice that the columns are slightly narrower here than in the left hand window. (VisiCalc automatically adjusted the column widths to make room for the extra vertical border of row numbers which runs down the center of the screen.) Next, press / W 1. This leaves the narrowed columns on the screen. When you type /W1 to return to one screen window, the global column, format, and title settings for the full screen are obtained from the window where the cursor lies at the time you type the /W1 command. If you had typed /W1 with the cursor in the left hand window, the screen would now have fixed titles and columns nine characters wide. For now, type / G C 9 ® and > A 7 ® to adjust the column widths and scroll the screen back to the left edge of the sheet. The cursor should highlight the label FOOD.

The Insert and Delete Commands

Let's say you decide to take on a life insurance policy which has monthly premiums of $115, and you want to incorporate this expense into your budget. If you were working on an ordinary sheet of paper with the same arrangement of figures which we have on the screen, you'd have to erase something, or write in tiny letters or off to the side to make room. But VisiCalc's electronic sheet is more flexible. Type / I R, for "insert row," and watch the screen. Everything at or below the cursor moves down to make room, leaving you with a blank line at row 7 where you can enter the life insurance figures. Notice that, for example, the amounts for SAVINGS, which used to be on row 11, are now on row 12. This may remind you of the formula you wrote for LEISURE, which was income minus the sum of expenses: +B2-@SUM(B4. . .B11). Now SAVINGS at B12 is outside this range. But the figures for LEISURE haven't changed. Type > B 1 4 ® and look at the entry contents line. The formula has changed to be +B2-@SUM(B4. . .B12)! Whenever you insert (or delete, or move) a row or column, VisiCalc automatically adjusts all of the formulas on the sheet so that they refer to the same entry positions as before, even though the coordinates have changed.

Now type the following to fill in the life insurance expense figures. Since all we have is a blank line at row 7, we will also have to add the formulas to calculate TOTAL and PERCENT for this new expense.

```
>A7®
LIFE INS⊕115⊕+⊕®
/R®D7.M7:R
>N6®
/R⊕:N7:RRRN
>A10®
```

Notice that our LEISURE money has decreased by the amount of the life insurance premiums each month. Position B14 is now -10, meaning that we're overspending our income in month 1. Perhaps we should ride the bus to work, and in that way all but eliminate our CAR EXPENSE. Type > B 1 0 ® and then press / D, watching the screen as you do so. The prompt line reads DELETE: R C. (With the cursor at B10, you could delete row 10 by pressing R, or column B by pressing C.) Press R. The title and figures for CAR EXPENSE disappear completely from the screen, and everything below the cursor moves up one row to take up the slack. CAR INSURANCE is now at row 10, and SAVINGS is back at row 11. Our LEISURE money has increased, back to $90, for example, at position B13. (If you were to check the formula at B13, you'd find that it has been adjusted back to +B2-@SUM(B4. . .B11).)

You can also insert columns. Say, for example, that you wanted to obtain six month totals for your income and expenses. Type > H 4 ®. The formula there is +G4, and you know the formula at I4 is +H4. Now press / I C. A new, blank column appears in place of column H. (Notice that the insert command always inserts a row or column before, meaning "closer to row 1 or column A than," the row or column where the cursor lies.) Press → to bring into view the old column H, now relettered column I. The formula at I4 is still +G4, so the propagation of the income and expense amounts skips over the newly created blank column. Press → twice more, and notice that the next formulas are +I4 and +J4. Now move back with > H 4 ® and type / D C. Now the blank column has been deleted, all of the other columns to the right have moved back to eliminate the empty space, and everything has returned to normal. (If you've made any mistakes in this section, you can clear the screen, reload the diskette file named LESSON 3-2.VC, and try each step again.)

To test your understanding of the insert and replicate commands, try the following on your own, then compare your approach with the instructions below: Insert the names of the months, such as JAN, FEB, MAR, etc. just below the month numbers 1 through 12.

Have you succeeded? Here's one way to do it. Type exactly the following:

```
>A2®
/RMONTH→/FR/R:C2.M2:      (This replicates the format /FR)
JAN→FEB→MAR→APR→MAY→JUN→JUL→AUG→
SEP→OCT→NOV→DEC®
>A2®
```

Calculating Interest On a Savings Account

According to our present budget, we are setting aside $150 each month for savings. Part of the motivation for doing this, of course, is that we would like to earn interest on this money. Let's use VisiCalc to project the interest and the accumulated balance we would have if we put this money into a savings or other investment account.

We'll assume that interest on a savings account is paid at the rate of 5% per year, compounded monthly. But, to give ourselves flexibility, we'll write this interest rate into a separate position on the sheet, so that we can change it later and let VisiCalc recalculate the interest and accumulated balance. Type > A 1 5 ® SAV ACCT → . 0 5 ® .

On the first day of each month, our account will be credited with interest for the balance in the account during the previous month, and then we'll deposit our monthly $150. Type the following:

```
>A17®
/F$100®
>A16®
INTEREST®
```

The $100 at A17 is the previous balance in the savings account before our budget begins. The interest paid for one month will be one twelfth of the yearly rate (e.g. .05 divided by 12) times this previous balance. Type:

```
/F$+B15/12*A17®
```

The calculated result of this formula should be 0.42, shown at B16. Does this figure make sense? A year's simple interest at 5% on $100 would be $5.00. One twelfth of this would be $5.00/12, or $0.41666 (which rounds to $0.42).

Press ↓ to move to B17. Our new savings account balance will be the previous month's balance, plus the interest, plus the savings deposit for this month. Type:

```
/F$+A17+↓+B12®
```

(If you like, you can point with the cursor to fill in all three coordinates in this formula.) The result, as expected, is $250.42.

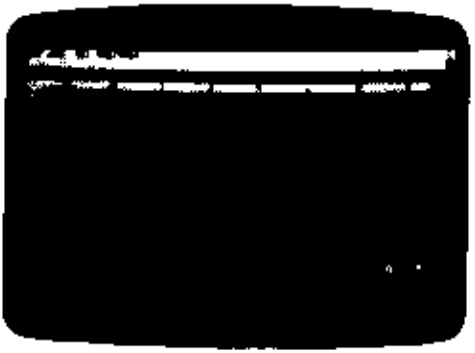
Now, we can replicate both the interest and account balance formulas across for twelve months. Type:

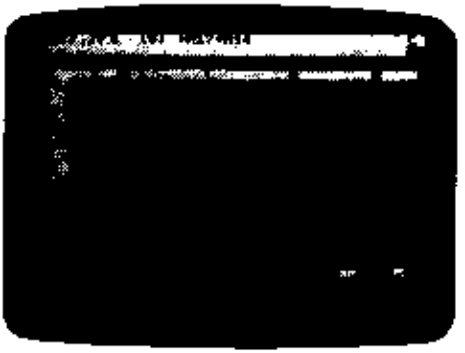
```
>B16®
/R↓:C16.M16:NRRRR
```

As you type the N and R's to determine whether each coordinate should be unchanged or relative, think about what each one means. The interest rate at B15 is clearly N. The R for A17 means "use the value of the entry one position down and to the left of each copy of the formula," and so on for the other coordinates. Press ↓ to examine the calculated results. The interest paid each month increases, since both our monthly deposits and the accumulated interest are added into the balance on which the interest is based. Continue scrolling the window rightward until column N comes into view, and then type the following:

```
>N17®
/F$+M17+N14®
```

This is the combined total of our savings and leisure money, or our "discretionary income." It should currently be 6676.94.





The Move Command

Type > A 1 1 ®. The cursor should highlight the label CAR INSURANCE. Paying that insurance premium in month 1 is taking a big bite out of our available LEISURE money in month 1 (which is $90, as opposed to $250 in month 2). Perhaps we can pay the insurance premiums by taking money out of the savings account.

On an ordinary sheet of paper, more erasures and writing in the margins would be necessary. Not so on VisiCalc's electronic sheet. Type / M. The prompt line reads MOVE: FROM. . .TO, and on the edit line is A11, the cursor coordinate, followed by the small rectangle. Now press ♦. The cursor moves down to highlight SAVINGS, and the edit line reads A11. . .A12. Press the ♦ key four more times, watching the edit line change from A11. . .A12 to A11. . .A16, much as it did for the @SUM function and the replicate command. The cursor highlights INTEREST at A16. Now press ®, and watch the screen. The following things happen: i) The entire row for CAR INSURANCE moves down from row 11, reappearing just above INTEREST at row 16. ii) The rows for SAVINGS, LEISURE and SAV ACCT move up, taking up the space vacated by the old CAR INSURANCE row, and making a new space just above INTEREST for the new CAR INSURANCE row. iii) The cursor remains where it was when we started the /M command: at A11, which is now SAVINGS.

Now look at the figure for LEISURE in month 1. It has increased from 90 to 250. The car insurance premium has been taken out of the sum of expenses used to calculate LEISURE (the formula at B13 now reads +B3-@SUM(B5. . .B11)). Hence, the CAR INSURANCE expense is currently unaccounted for. We must revise the formulas in row 17 to take the car insurance premium out of the savings account balance. Type > B 1 7 ® and look at the entry contents line. The formula reads +A17+B16+B11, meaning the previous account balance, plus a month's interest on that balance, plus this month's savings deposit. To this we must add "minus the car insurance premium (if any)." Type the following:

```
+A17+B16+B11-♦♦®
/R:C17.M17:RRRR
```

This will replicate the new account balance formulas +A17+B16+B11-B15, +B17+C16+C11-C15, etc. across the row.

Now type > N 1 7 ® to examine our total discretionary income: It has declined from 6676.94, before we took the insurance premiums out of savings, to 6666.10. We are now saving less and spending more on leisure, so we have lost about $10 interest on our savings account. (Notice that our LEISURE total at N14 has increased from 4730 to 5050.) Perhaps we should save a little more each month to replenish the funds taken out to pay the insurance premiums.

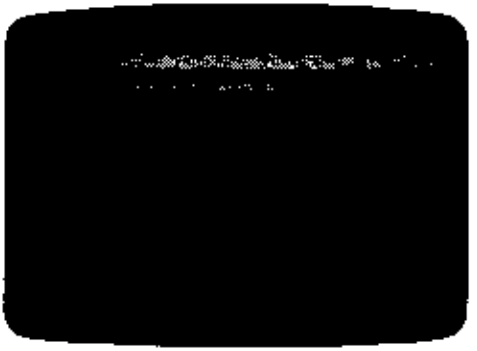
Type > A 1 1 ® ✱ to bring the titles back on the screen and highlight our initial SAVINGS figure at B11. Since the $160 expense for CAR INSURANCE at B15 covers our premiums for six months, we should save one sixth of this amount each month, in addition to our usual savings deposit. Type 1 5 0 + (B 1 5 / 6) ®. (The parentheses in the formula tell VisiCalc to calculate that portion of the formula first. See the section entitled "The VALUE Command" in Part III for a full discussion of precedence.) Thanks to our earlier use of formulas, VisiCalc automatically propagates the adjusted SAVINGS figure across all twelve months, and also recalculates LEISURE and our new savings account balance. This recalculation has made the screen display somewhat messy, because the global format for numbers is still the standard format, or "general." We can clean up the display by typing / G F I. The interest and savings account figures still show dollars and cents, because each of these entries has the "local format" /F$. Now, type > N 1 7 ® to reexamine our total discretionary income. It has increased to 6673.53. By saving about $27 more each month, we have reduced our LEISURE total back to 4730, but we have regained most of the interest we had lost before. VisiCalc can really help you budget in ways that you wouldn't have contemplated before!

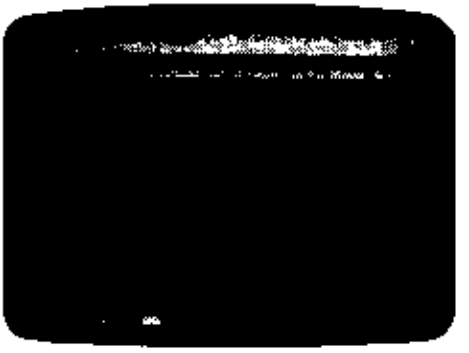
Obtaining Monthly Expense Percentages

This lesson has given you a lot of practice in techniques for using commands such as replicate effectively. Here's a challenge to test your mastery of the replicate command: Give yourself monthly percentages for each of your expenses, from MORTGAGE through SAVINGS. It's possible to accomplish this by typing just one formula and using the replicate command twice. Before trying, save your work by typing / S S and using ✱ as necessary to bring the filename LESSON 3-2.VC onto the edit line, and press INST/DEL four times, then type 3 . V C ®. (If you need them, here are some hints: Use the area of the sheet directly below your list of monthly expenses. Remember that you can replicate format specifications. If you want to get fancy, you can label each row of percentages with one more use of the replicate command.)

If you've succeeded, congratulations. You can probably do anything you want with VisiCalc from now on. Whether you've succeeded or not, let's make sure that your budget matches the one in this lesson: Clear the sheet with / C Y and reload the file you just saved by typing / S L, pressing ✱ until the filename LESSON 3-3.VC appears, and then pressing ®. Now type exactly the following:

```
>A20®
/R INST/DEL A5.A11:A20:
✱/F$+B5/B3®
/R:B21.B26:RN
/R.B26:✱.M20:RRRRRRRRRRRRR      (Type R fourteen times)
>A26®
```





The first replication in this sequence illustrates another use of the replicate command: You can copy a range of entries into another part of the same column (in fact, to any other area on the sheet) simply by specifying the destination starting coordinate for the target range. Check row 21, for UTILITIES, to verify that the percentages may change from month to month.

Synchronized Scrolling

As you can see, the area of the sheet which we have used extends beyond the screen window in both the horizontal and vertical directions. The window has begun scrolling downwards, and our month labels, INCOME, and our first few expenses have disappeared from view. Let's split the screen so that we can see both the expense amounts and the percentages at the same time. Move the cursor up to A19, just above MORTGAGE. Now type / W H. The screen splits horizontally, leaving just enough room for the expense percentages in the bottom window (which we'll attend to in a moment). Now type > A 2 ⊛ ↓ ↓. This should leave rows 2 (MONTH) through 14 (LEISURE) on display in the top window, with the cursor at A4. Next, type / T B to fix the horizontal and vertical borders in place. (Notice that the columns and rows forming the borders do not have to start from the edges of the sheet.) Finally, type ; > A 2 6 ⊛ to bring all of the expense percentages into view, and / T V to fix the labels MORTGAGE through SAVINGS in place.

Now press → until the bottom window begins scrolling rightward. The problem is that we can't easily tell which months these expense percentages refer to. The month labels, such as JAN, FEB and MAR, are visible only in the top window, which isn't scrolling. We'd really like the two windows to scroll together horizontally, but remain independent vertically so that we can view different areas of the sheet through the two windows, as we are now (with rows 2-14 in the top window and rows 20-26 in the bottom). Press / W again, and look at the prompt line. The possible keystrokes are:

H To split the screen horizontally.
V To split the screen vertically.
1 To return to one screen window.
S To synchronize the two windows.
U To unsynchronize the windows.

Press S, and watch what happens in the *top* window. Notice that this window scrolls over so that portions of the same columns are visible through the top and bottom windows. Now press ↵ a few times: The two windows move together "in sync." Type ; to jump the cursor into the top window, and then type > B 7 ↵. Try changing the TELEPHONE expense to something else, say $100 per month, and watch the line of percentages opposite TELEPHONE in the bottom window. Notice that LEISURE in the top window also changes. Now, let's use the two windows for a different purpose. Type / W U to unsynchronize the windows. Then move to the bottom window with ; and type > A 1 ↵ / T B > O 1 7 ↵ to bring your LEISURE total and percentage, your final savings account balance, and your combined discretionary income into view. Then press ; to jump back to the top window, landing at B7, and change the TELEPHONE expense back to 75, watching how this effects the LEISURE percentage in the bottom window. You can also experiment with the budget in other ways. At this point, you may wish to save the results of this lesson by typing, for example, / S S MY BUDGET.VC ↵.

The Order Of Recalculation

So far, we've simply noticed that VisiCalc recalculates the values of all the formulas on the sheet, but we haven't looked closely at how this is done. There are some subtleties to the process of recalculation which can affect your results when you set up a complex problem with many interdependencies. We'll consider these issues here.

VisiCalc recalculates by starting at the upper left hand corner of the sheet and working its way downward and to the right until it reaches the lower right hand corner of the sheet. Each formula is evaluated only **once**, unless you ask for an extra recalculation by pressing !. This means, for example, that the entry at position A1 cannot be a formula which references other positions, and that in general, formulas which reference other entries must be located below and/or to the right of these entries.

VisiCalc will evaluate the formulas on the sheet in either of two possible orders: "down the columns" or "across the rows." Look again at the letter C just to the left of the direction indicator at the upper right corner of the screen. This is the **recalculation order indicator**, and it can be either C, for columnwise recalculation, or R, for rowwise recalculation. When you load the VisiCalc program or clear the sheet, VisiCalc is set to recalculate "columns first:" It will evaluate first

A1, then A2, A3, . . ., etc., then B1, B2, B3, . . ., etc., then C1, and so on. If you change the recalculation order to "rows first," VisiCalc will evaluate first A1, then B1, C1, . . ., etc., then A2, B2, C2, . . ., etc., then A3, and so on.

For many problems, the choice of row versus column first recalculation has no effect on the results displayed on the screen. But there are cases where you must use the right recalculation order to obtain correct results, and it's important to recognize these cases when they arise. So let's consider an example. Clear the sheet with / C Y and type the following:

```
1↵–A2↵
>A2↵
1+A1↵2*B1↵
>C5↵
+A1↵1+C5↵
>C6↵
–D5↵2*C6↵
>A1↵
```

As you type the formulas, think about how each entry depends on the other entries. As you can probably see, the matrix of entries starting at A1 must be recalculated in the order A1, A2, B1, B2 (since B1 depends on A2). The matrix of entries at C5, however, must be recalculated in the order C5, D5, C6, D6 (since C6 depends on D5). With the cursor at A1, type 2 ↵ and watch what happens. A2 becomes 3, B1 becomes –3, and B2 becomes –6, as expected; but while C5 becomes 2 and D5 becomes 3, C6 remains at –2, and D6 at –4. The formula at D5 *was* recalculated, but this occurred *too late* to affect the recalculation of C6 and D6. Now press ! to trigger an extra recalculation: This time C6 becomes –3 and D6 becomes –6.

Now we'll change the order of recalculation from "columns first" to "rows first:" Press / G. The prompt line again reads GLOBAL: C O R F. Press O. Now the prompt line reads REEVAL ORDER: R C. Press R. Notice that the recalculation order indicator at the upper right corner of the screen changes from C to R. Now type 1 ↵ and watch the screen. This time, D5 becomes 2, C6 becomes –2, and D6 becomes –4; but while A2 becomes 2, B1 stays at –3, and B2 at –6. Our problem with B1 and B2 is, of course, symmetrical to our earlier problem with C6 and D6.

The moral of this example is that you should lay out your calculations with either columnwise or rowwise recalculation in mind, but not both. If possible, you should arrange things so that the results will be correct with *either* columnwise or rowwise recalculation. Then, if you decide to calculate something new that requires a particular order of recalculation, you won't be constrained by other dependencies on the recalculation order. For example, the personal budget outlined in Lesson Three is independent of the order of recalculation. Now, suppose that you want to adjust your life insurance policy and premiums to provide a benefit of three times your total annual income. You could do this by switching to "row first" recalculation, so that the life insurance premium in month 1 could be based on the total income calculated in column N.

If you find yourself with a problem of conflicting requirements for "row first" and "column first" recalculation, you can deal with these requirements, albeit awkwardly, by pressing ! for an extra recalculation each time you change a

value and look for recalculated results. But first make certain that your row and column conflict is not actually due to a "forward reference" or a "circular reference," as discussed below.

Forward and Circular References

Clear the sheet with / C Y and type the following: 1 ↓ – ↓ ↵. The entry contents line reads B1 (V) –C1, and the value displayed at B1 is 0, as expected. Now type ↓ 1 + ↓ ↓ ↵. The entry contents line reads C1 (V) 1+A1, and the value at C1 is 2, while the value at B1 has been updated to –2. Next, press > ↵ 2 ↵ – C 1 ↵. We now have the same formula, –C1, at both B1 and B2, and both positions display the value –2. Is there any difference between these two formulas? Indeed there is. One of these formulas will recalculate and display the correct value only if the order of recalculation is "row first." The other will never display the correct value after an automatic recalculation! To see this, type > A 1 ↵ 2 ↵ and watch the screen. A1 becomes 2 and C1 becomes 3, but both B1 and B2 remain at –2. Press ! and both B1 and B2 will be updated to –3. Now, type / G O R and note that the recalculation order indicator changes from C to R. Then type 3 ↵ and watch the screen. A1 becomes 3, C1 becomes 4, and now B2 becomes –4, but B1 remains at –3. You'll have to press ! again before B1 will change to –4. And if you change A1 again, B1 will display a value based on the previous contents of C1 and A1. The formula at B1 is an example of a **forward reference**: It contains a reference to an entry which will be recalculated after B1 is recalculated, regardless of whether rowwise or columnwise recalculation is used.

In pathological cases, forward references may refer to other forward references, so that correct results can be obtained only with several recalculations. For example, press ↓ / I C – ↓ ↵. At the moment, A1 is 3, the new B1 is 4, C1 is –4, and D1 is 4. Now press ↓ 1 ↵. A1 becomes 1, D1 becomes 2, but B1 and C1 are unchanged. Press !. Now C1 is –2, but B1 is still 4. Only after you press ! again will B1 be updated to 2.

An effect even more startling is caused by a **circular reference**. The value of such a formula cannot be settled with any number of recalculations! Clear the sheet with / C Y and type the following: 1 + ↓ ↵. The entry contents line reads A1 (V) 1+B1, and the value under the cursor is 1, as expected. Now type ↓ 1 + ↓ ↵ and watch carefully. What happened? The numbers at A1 and B1 actually changed *twice*. When the formula 1+A1 was completed at B1, it was evaluated, yielding 1+1 or 2 at B1. Then, since the value of B1 had been changed, an automatic recalculation occurred. A1, or 1+B1, became 1+2 or 3, and B1, or 1+A1, became 1+3 or 4. Now press !. A1 increases to 5, and B1 becomes 6. These values will change every time you press !.

The foregoing examples have been somewhat artificial: You probably recognized the forward and circular references as soon as you typed them. If you are planning your work carefully, you should never write such a formula. But some forward or circular references are not so obvious. For example, suppose that you are projecting future profits, taking into account various revenues and expenses. One of the expenses is employee salaries, and one part of salaries consists of profit-sharing. Unless you are careful, you may create a circular reference: Salaries with profit-sharing depend on profits, but profits depend on expenses including salaries. (To resolve this circularity, you must calculate a figure for profits before profit-sharing is taken out.)

Summary

Once again, we have covered a great deal of ground in this lesson. We concentrated on a variety of techniques for using VisiCalc's flexible replicate command as effectively as possible. We also discussed a number of new VisiCalc features, including the formatting of individual numbers and labels, and the relationship between global and local formats; the order in which VisiCalc calculates and recalculates; built-in functions such as @SUM, and the special cases @NA and @ERROR; the insert, delete and move commands, which let you "stretch" the sheet and manipulate entire rows or columns; and synchronized scrolling of the two screen windows. By this time we have covered most of the important concepts and features of VisiCalc, and you should be able to use VisiCalc to considerable advantage. In Lesson Four we will cover a number of other features and fine points of VisiCalc, including scientific notation for numbers and the transcendental functions such as @EXP, @LN, @SIN, and @COS; more about the formatting of numbers, and the move command. You can go on to Lesson Four as soon as you are ready. But now is an excellent time to try out what you have learned on a problem of your own. In this way, you will consolidate your knowledge of VisiCalc's commands and features, and develop a measure of intuition about how they can be used. This will enable you to approach new problems and solve them even more rapidly with VisiCalc.

Postscript: The Print Command

Sometimes it's convenient to have a "hard copy" of the contents of the electronic sheet on a real sheet of paper. VisiCalc's print command lets you print all or any part of the electronic sheet on a printer. If you have a printer connected to your computer, you can try it out by printing a copy of the personal budget we've just created. The instructions for printing files you have made with VisiCalc are in Part III of this manual, in the section entitled "The PRINT Command".

Lesson Four

Lesson Four

Lessons One, Two and Three have covered most of the essential features of VisiCalc. In this lesson, we'll be primarily concerned with features which extend VisiCalc's usefulness in applications where complex or lengthy formulas, numbers with very large or small magnitudes, or arithmetic operations other than simple addition, subtraction, multiplication and division are required. If you intend to use VisiCalc for business or financial applications, you can skim much of this material, concentrating on topics of interest such as the @NPV (Net Present Value) and @LOOKUP functions and the ability to create bar graphs using the /F* formatting option. If you have scientific or engineering applications in mind, you'll find this lesson particularly relevant to your needs.

More On Numbers and Formats

In Lessons Two and Three we illustrated some of the ways you can control the display of numbers on the screen with formatting commands such as /GFI and /F$. In this lesson we'll examine the formatting options more closely.

Load the VisiCalc program into your computer (as described in Part I in the section entitled "Loading VisiCalc") or, if you already have the program running, clear the sheet with / **C Y**. When you clear the sheet, the "global format" is set to *general*: This is the effect you obtain when you type the command / **G F G**. Each individual entry is set to *default* to the global format, just as it would if you had typed / **F D** with the cursor at that entry. Now type the following:

1 2 3 . 4 5 6 ⏎
/ R : ➧ . ➧ ➧ :

We now have the same number, 123.456, on display in three entry positions, A1, B1 and C1. Since we have not yet set any explicit formats, all three entries default to the global format. The global format, *general*, displays numbers in whatever form will show the value of the entry with the greatest precision. As you have seen, however, this may not be the most readable way to display a column of numbers.

Now press the following keys: / **F I ➧** / **F $ ➧**. We have set the "local format" of entries A1 and B1 to be *integer* and *dollars and cents*, respectively. The local format setting at the entry where the cursor lies, A1, is visible on the entry contents line, which reads A1 /FI (V) 123.456. Each entry is displayed in rounded form. At A1, for example, 123.456 is rounded to 123, since .456 is less than .5; but at B1, 123.456 is rounded to 123.46, since the last digit .006 is greater than .005. At C1, we still have 123.456.

Now type / **G F I** to change the global format from *general* to *integer*. Entries A1 and B1 are unaffected, because they have explicit local formats; but C1 now displays 123. With the cursor still at A1, change the local format there by typing / **F G**. The number at A1 now appears as 123.456, and the entry contents line reads A1 /FG (V) 123.456. The local format overrides the global format integer. Next, press ➧ to move to B1, and "erase" the local format there by typing / **F D**.

This causes the display format of B1 to default to the global format, which is currently *integer*; so the entry at B1 appears as 123. The entry contents line reads B1 (V) 123.456; the explicit format setting /F$ has disappeared. Finally, type / G F G to set the global format back to general. Now all three entries display the number as 123.456. Position A1 has a local format which overrides the global setting, but the local format is also general. Positions B1 and C1 have no explicit format, so they default to the general format.

The way in which numbers are displayed in the general format depends on the column width. Type / G C 7 ⏎. Now the number appears as 123.46 at all three entry positions. VisiCalc always allows for one blank at the left end of the entry position, and then displays as many significant digits as it can. To compare the flexibility of the general format to an explicit local format, try the following: > B 1 and then type / F $ to set dollars and cents format at position B1. Then type / G C 5 ⏎. Positions A1 and C1 now display the number as 123.5, but B1 now shows >>>>> (an effect which we saw before in Lesson Two). VisiCalc is telling us that it cannot display a number as large as 123.456 with two decimal places in a column six characters wide. If you type 1 2 . 3 4 ⏎, VisiCalc will be able to display this number at B1.

Scientific Notation

Type / C Y to clear the sheet. At position A1, type **99999999** (that's eight times) followed by ⏎. This is the largest number that we can display, with a leading blank, in a nine-character column. At B1, type 1 + ⏎ ® followed by ⏎. The calculated result, 1 + 99999999 or 100000000, is too large to display in ordinary form at B1, so VisiCalc has switched to **scientific notation**: The number appears as 1E8, meaning "1 times 10 to the 8th power" or "1 followed by 8 zeros." Scientific notation can also be used to display very small numbers. At C1, type .000000001 followed by ⏎. The number appears as 1.E–9, meaning "1 times 10 to the –9th power," or "1 with the decimal point moved left 9 places." (Take a moment to convince yourself that this is correct.) Now at D1 type – ⏎ ®. The result is displayed as –1.E–9.

When a number is displayed in the general format, VisiCalc will automatically shift between conventional and scientific notation as required to display the calculated value with the greatest precision. Type / G C 1 2 ®. Notice that all of the values revert to conventional notation in the widened columns: at D1, for example, the number appears as –.000000001. Next, type / G C 7 ® and > A 1 ®. The number 99999999 at A1 has been rounded up and displayed as 10.0E7, or "9.9999999 (rounded to 10.0) times 10 to the 7th power." Finally, type / G C 5 ® and look at the screen. In order to fit the numbers in these narrow columns, VisiCalc has eliminated decimal points, displaying A1 as 10E7 and C1 as 1E–9; but D1 shows >>>>, since there's not enough room in a five-character column to display –1E–9 (with a leading blank).

More On Value References

Clear the sheet with / C Y and type the following:

1 ⏎ 2 ⏎ + A 1 / B 1 ®

The entry contents line reads C1 (V) +A1/B1, and the value displayed is .5. We know that if the number at either A1 or B1 were changed, the formula at C1 would be recalculated. Now press ↓ to move to D1. Here we'll try something different. Press + A 1 / B 1 #, watching the edit line as you do so. As soon as you press the # after the coordinate B1, the reference to B1 is replaced by its current value. The edit line now reads +A1/2. Press ®. The entry contents line reads D1 (V) +A1/2, and the value displayed is again .5. The difference is that the current value of B1 is "fixed" into the formula at D1, whereas the value of B1 is changeable at C1. To verify this, type ↑ ↑ 4 ® and notice that C1 changes to .25, but D1 does not.

The effect of # after a value reference on the edit line is similar to the effect of typing ! after a formula, as described in Lesson One. The difference is that the ! key evaluates the entire formula on the edit line, replacing it with a single number, while the # key fixes the value of a single coordinate, so that the rest of the formula can contain changeable elements. If the # is not preceded by a coordinate such as B1, it is replaced by the current value of the entry where the cursor lies (*i.e.* the entry you are changing). You can use this feature to take a look at the precise value of a formatted entry on the edit line. For example, set the global format with / G F $ and then type 6 ®. The value at C1 is now displayed as .17. Press ↓ to move to C1, then press #. The # is immediately replaced on the edit line with the current value of C1 (1/6) to maximum precision: .166666666666.

A word on precision is in order here. VisiCalc maintains numbers internally in decimal form. Certain fractions (such as 1/6) cannot be expressed exactly with any fixed number of significant digits. VisiCalc uses decimal based arithmetic so that it can maintain accuracy in calculations involving dollars and cents. To accommodate large financial figures as well as high-precision engineering or scientific quantities, VisiCalc maintains numbers (where necessary) to a precision of eleven significant digits. The last 6 on the edit line at the moment is a "guard digit," which allows VisiCalc to determine which way to round the eleventh digit when a calculation is completed. After examining the number, you can press INST/DEL a few times to "abort" the VALUE entry you have started on the edit line.

More On Formulas

In the examples from previous lessons, we have used only simple formulas (or *expressions*) whose meanings have been clear. As you begin to write more complex expressions involving several arithmetic operations, the way in which such expressions should be evaluated may not be so obvious. For example, to evaluate the expression 9+6/3, should we first add 9 to 6 giving 15 and then divide by 3 to obtain 5; or should we first divide 6 by 3 giving 2, and then add 9 to obtain 11? Try it: First type / C Y to clear the screen and then type 9 + 6 / 3 ®. The answer displayed at position A1 is 5. Evidently VisiCalc chose the first option. In this way, VisiCalc is similar to many keystroke calculators in that it always evaluates expressions strictly **from left to right**.

You can change the order of evaluation of arithmetic operations in an expression by using parentheses. For example, press ↓ to move to A2 and then type 9 + (8 / 3) ®. The answer highlighted by the cursor is 11. Parentheses may be nested to any depth. Type

↓ – (↑ ↑ + ((A 2 – 1) / A 1)) ®

The answer displayed at A3 should be –7.

More generally, an expression consists of a series of *operands* separated by arithmetic *operators*. Each operand can be one of the following:

i.) A number, optionally with a decimal point and/or an E exponent.
ii.) A value reference, obtained either with cursor movements or by typing the coordinate.
iii.) A function reference, with zero or more arguments in parentheses.
iv.) An expression surrounded by parentheses. (Such a subexpression is evaluated first.)
v.) Any of the above, preceded by a – or + sign.

Each operator can be one of the following:

+ For addition.
– For subtraction.
* For multiplication.
/ For division.
^ For exponentiation.

On your keyboard, the key with the single, up-pointing arrow is the exponentiation key. The exponentiation operator ^ lets you calculate "powers." For example, type ↓ 2 ^ 3 ® to calculate "2 to the 3rd power," or 8. Try another example: Type ↓ 2 ^ . 5 ® to calculate "2 to the power 1/2," or the square root of 2. The result displayed at A5 should be 1.414214. To find the cube root of 5, type ↓ 5 ^ (1 / 3) ®. VisiCalc will calculate and display the value 1.709976.

More On Built-In Functions

We first encountered built-in functions in Lesson Three, where we used the @SUM function to find yearly totals for our income and expenses and to calculate our available LEISURE money as +B2–@SUM(B4.B11), or income minus the sum of expenses. The LEISURE money example illustrated several points about built-in functions: i) As mentioned above, a function reference can appear in an expression wherever a number or coordinate could appear. Moreover, as we shall see shortly, an expression may also occur as an argument in a function reference. ii) VisiCalc will "spell out" the names of built-in functions if you type just the first few letters and a left parenthesis. iii) One type of function argument is a range of entries, such as B4. . .B11 in the LEISURE example. You need only type one period; Visicalc will fill in the other two.

In general, a built-in function name is followed by a parenthesized *list* of *arguments* separated by commas. Each argument can be:

i) An *expression*, *i.e.* a series of numbers, value references, and/or function references separated by arithmetic operators and/or parentheses; or

ii) A *range* of entries, *i.e.* a series of entries that are next to each other in a row or column, such as B2, B3 and B4, or B2, C2, D2 and E2. A range is specified by typing (or obtaining with cursor movements) the first and last entry separated by an ellipsis. For example, the ranges just mentioned would be specified as B2. . .B4 and B2. . .E2, respectively.

The exact number and type of argument(s) required varies from function to function. For example, the @NA and @ERROR functions which we saw in Lesson Three required no arguments. Some functions require exactly one or two arguments, while others, such as @SUM, take a variable number of arguments.

Let's try an example of the @SUM function using the general form for a list of arguments. Notice that as soon as you type the left parenthesis, VisiCalc finishes spelling out the function name on the edit line. Use the ← key to move to position A7, and type:

@ S (A 1 . A 4 , A 5 * A 6 , A 6 - 3) ®

The result should be 5+11–7+8+2+5 or 24. Let's experiment further with some other built-in functions:

@MIN and @MAX. These functions accept a list of arguments just like the @SUM function. The result is the minimum and maximum value in the list, respectively. Remember that the minimum value will be the negative number (if any) with the greatest absolute magnitude. To try out these functions, type the following:

↑ @ M (A 1 . A 7) ®
↑ @ M A (A 7 , @ S (A 1 , A 2 , A 4 . A 6)) ®

The results should be –7 for @MIN at A8, and 27.12419 for @MAX at A9.

@COUNT and @AVERAGE. These functions also accept a list of arguments, which may be expressions or entry ranges. @COUNT determines the number of nonblank entries occurring in the range or ranges of the argument(s). (Note that arguments which are expressions rather than ranges always count as 1. This can be puzzling if the "expression" is a single coordinate such as B1; it will add 1 to the count *even if B1 is blank*. To avoid this, write B1. . .B1.) @AVERAGE finds the arithmetic mean of the entries making up the argument(s); it is equivalent to @SUM(*arguments*)/@COUNT(*arguments*). To try out these functions, clear the sheet with / C Y and type the following:

1 ↑ ↑ 3 ↑ 4 ↑ ↑ 6 ↑ ↑ 8 ↑ / – – ↑

The cursor should now be at A10. Type @ C (A 1 . A 8) ®. The count of nonblank entries displayed at A10 should be 5. Now type ↑ @ A (A 1 . A 8) ®. The average of 1, 3, 4, 6 and 8 should be 4.4 at A11. To check the equivalence mentioned above, type ↑ @ S (A 1 . A 8) / A 1 0 ®. The result should again be 4.4. Finally, let's change one of the currently blank entries in the argument range to a number: Type > A 5 ® 5 ®. The @COUNT at A10 should change to 6, and the @AVERAGE at A11 and A12 should increase to 4.5.

The @NPV (Net Present Value) Function. This function accepts two arguments. The first is a single expression specifying a discount rate, such as .15 for 15% per period. The second argument is a range of entries; the first entry is the cash flow at the end of the first period, the second entry is the cash flow at the end of the second period, etc. The result of the function is the net present value of the cash flows in the range, discounted at the rate specified by the first argument. If we represent the function reference by @NPV(dr,entry1...entry*n*) and let DR = 1 + dr, the result of the function is (entry1/DR) + (entry2/(DR^2)) + (entry3/(DR^3)) + ... + (entryN/(DR N)). To illustrate the use of this function, type / **C Y** / **G C** ↵ to clear the sheet and make narrower columns. Suppose that we have a project which requires an investment or cash expenditure of $5000 up front, and which is expected to generate cash over a period of five years. Type the following to lay out the cash flows:

"1"1 + " ↵
/R:D1.F1:R
>A2 ↵
-5000"1000"1500"2500"2000"1000 ↵
>A3 ↵
.15"

At position A4, type **+ A 2 + @ N P V (A 3 , B 2 . F 2)** ↵. This causes the $1000 cash flow in the first year to be discounted by 15%, the $1500 cash flow in the second year to be discounted twice, etc. The result at A4 should be 288.3. Now press ♠ and change the discount rate to 10% by typing **. 1** ↵. The net present value at the lower discount rate (which makes the future cash flows worth more today) is 1014. You can find the internal rate of return of this project by trial and error: Try higher and lower discount rates at A3 until the net present value of the cash flows is near zero. When A3 is .17, A4 will be 34.81. (If you are persistent, you can verify that the net present value is .0000005 when the discount rate is .1728674256.)

The @LOOKUP Function. This function also accepts two arguments. The first or "search" argument, an expression, is looked up in the table specified by the second argument, an entry range, and matched against one of the entries in this range. A table of function result values must be present in the column or row immediately to the right of or below the column or row range specified in the @LOOKUP function. The function result is taken from the entry corresponding to the matched entry in the table of result values. The values in the function argument range are ordinarily in ascending order. The search argument is compared against succeeding entries in the second argument range, until an entry greater than the search argument is found. The search argument is "matched" against the entry just before this one (*i.e.* one which is still less than or equal to the search argument), and the function result is selected from the corresponding entry in the table of result values. If the *first* entry in the argument range is greater than the search argument (*i.e.* if the search argument cannot be matched against any entry in the range), the result of the function is NA or Not Available. To illustrate the use of this function, we'll list the first ten entries in the periodic table of the chemical elements, with their atomic weights and atomic numbers. Clear the sheet with **/ C Y / G F L** and type the following:

```
ELEMENT ◆ WEIGHT ◆ NUMBER ®

>A2®
H◆HE◆LI◆BE◆B◆C◆N◆O◆F◆NE®
>B2®
1◆4◆7◆9◆11◆12◆14◆16◆19◆20®
>C2®
1◆1+ ◆®/R:C4.C11:R
>A13®
10.9◆@L(◆,B2.B11)®
```

The result of the @LOOKUP function at B13 should be 4. Given an experimental atomic weight of 10.9, the @LOOKUP function compared this value against successive values in column B, stopping at the value 11 at B6 which was greater than 10.9. Thus, the atomic weight of 9 at B5 is the matching value, and the corresponding entry, the atomic number in column C, is 4. If you change the value to be looked up with ◆ 1 2 . 1 ®, the function result will become 6. If you then type an "atomic weight" of 0 ®, the result of the @LOOKUP function will be NA.

The @ABS and @INT Functions. Both of these functions accept a single argument, an expression. @ABS finds the "absolute value" of its argument: For example, @ABS(1) = 1, @ABS(−1) = 1, and @ABS(0) = 0. @INT finds the "integer portion" of its argument, without any rounding. You can think of the @INT function as setting every digit to the right of the decimal point to zero. For example, type / C Y / F I 1 . 7 ◆ @ I (◆) ®. At A1, the value 1.7 is rounded up to 2 by the local format integer; but at B1, @INT finds the integer portion of 1.7, *i.e.* 1.0 or 1.

Transcendental Functions and Graphing

So far, we've covered all of the built-in functions except for the transcendentals such as @EXP, @LN and @SIN, and all of the formatting options except for the "graph" format /F*. We'll illustrate these two features together with a more complete example. Our goal is to produce graphs of the transcendental functions. We'll have to do this within the limits of the /F* formatting option, which is really designed to draw simple bar graphs in a column alongside other columns of numbers.

Clear the sheet with / C Y and type 1 ◆ 3 ◆ 6 ◆ 20 ®, then > A 1 ®. The "star" format /F* simply displays the number of asterisks equal to the integer portion of the value of the entry where the format is set. Type / F * at A1: In place of the (right-justified) number 1, a single (left-justified) asterisk appears, after the usual leading blank. Now press ◆ / F *. The value 3 is replaced by three asterisks. Continue with ◆ / F * ◆ / F *. Position C1 shows six asterisks, while position D1 shows eight (the maximum for a nine-character column). Type / GC 1 2 ® and notice that position D1 now displays 11 asterisks.

Now clear the sheet again with / C Y. To graph a function, we must first supply a series of argument values for the function and calculate the function result for each argument value. For simplicity's sake, we'll begin with a linear function, e.g. *f(x) = 2.5 * x*. Type the following:

```
>A20~
.1~.1~
>A1~
+A20~+~+B20~
/R:~.A17:RN
```

On row 20, we have defined a "start" value and "step" value for our list of function arguments. Then, using formulas and the replicate command, we calculated the argument values, from .1 to 1.7 in positions A1 to A17. Next, we'll calculate the corresponding function results for our linear function. Type the following:

```
>B1~
2.5*A1~
/R:~.B17:R
```

The function results are .25, .5, .75, etc. up to 4.25. To see how this looks in the star format, we'll set the format specification and replicate again: Type /F*/R:~.B17:R. How does the "graph" look? It's probably not the kind of graph you had in mind. The problem is that the function results do not fall conveniently in the range 1, 2, 3, etc. which would yield one, two, or three asterisks. Let's go back to a numeric display with /FD/R:~.B17:R. How can we create a better star format display?

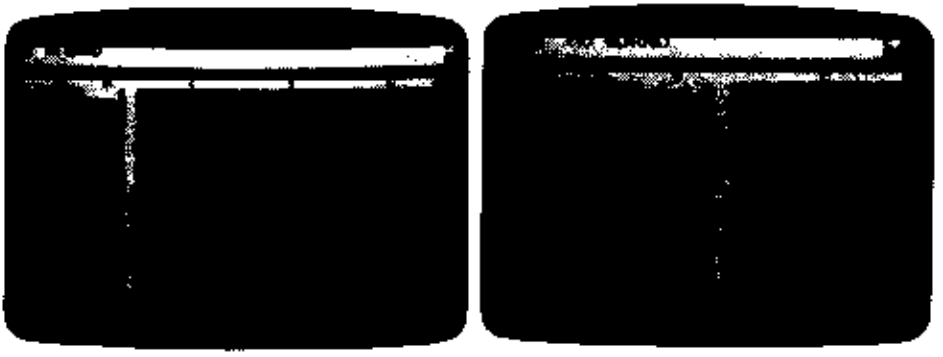
First, we'll set up a wider column in which the asterisks may appear, so that we can represent a wider range of function results with the best possible resolution. This will allow us to display a "bar" of up to 17 asterisks. Then we'll "scale" the function results, from .25 to 4.25, into the range 0 to 17. Type the following:

```
>B18~
/--~@MAX(B1.B17)~
/GC8~
>C1~
/WV;/GC18~
17/B19*@ABS(B1)~
```

At B19, we've used the @MAX function to find the upper limit on the range of function results. (For simplicity's sake, we'll work with the absolute magnitudes of the function results, so the lower limit will be zero. You may wish to work out an approach to scaling which uses both @MAX and @MIN.) We've also set up a wide column in the right hand screen window for the asterisks. The formula at C1 is used to multiply each function result, such as B1, by the factor 17 (the maximum number of asterisks) divided by B19 (the maximum function result). The value of this formula will lie in the range from 0 to 17/B19*B19, or 17. Now type /F* to set the display format at C1, and type /R:~.C17:N R and watch the screen. Now we have a reasonable approximation to a straight line. Moreover, if we've done our job properly, we should be able to graph any set of function results in column B, not just the linear function *f(x) = 2.5 * x*. (We will want to adjust the argument range so that we can graph an interesting portion of the function result range.) Your screen should look like the photo below.

Now type the following:

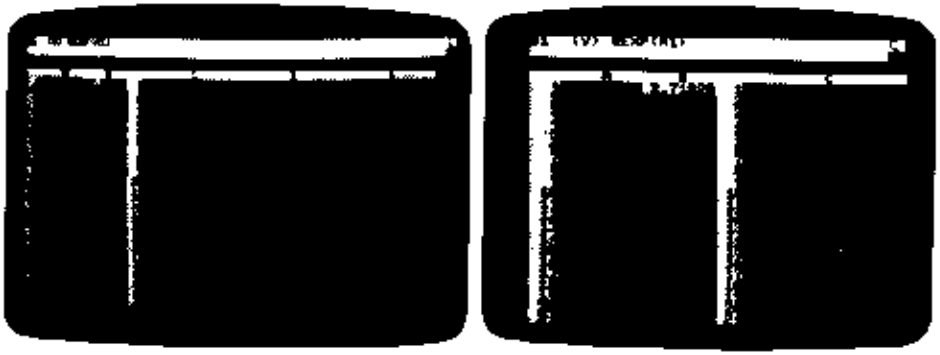
```
;>A20®
1®.25®
>B1®
@LN(A1)®
/R:B2.B17:R
```



Notice that the value of @MAX(B1...B17) at B19 changes to 1.60944. This value affects the formulas in column C so that the results still come out in the range 0 to 17. If the graph of the natural log function doesn't look completely familiar, tilt your head sideways and imagine the X axis on the column and the Y axis on the row.

Now, let's try the exponential function: Type

```
@EXP(A1)®
/R:B2.B17:R.
```



The maximum function result value is now 148.413, and each result is scaled into the range 0 to 17 in column C. Is the graph close to what you expected? Finally, we'll graph the sine function. Since the trigonometric calculations are done in radians, we'll use @SIN(@PI*A1) and a different argument range so that we can obtain a full sine curve in column C. Type the following:

```
>A20®
.03®.06®
>B1®
@SIN(@PI*A1)®
/R:B2.B17:R
```

If all has gone well, you'll have a reasonable graph of the sine function in column C, looking like the photo below.

At this point, you may wish to experiment with different argument values and functions. When you're finished, you can go on with the next section.

Manual and Automatic Recalculation

If you've just worked through the example above at your keyboard, graphing the transcendental functions, you've probably noticed some significant delays as VisiCalc repeatedly recalculated the results of functions such as @EXP, @LN and @SIN. Because the function results are calculated to nearly eleven significant digits, each one takes a fraction of a second to evaluate, and a sheet

full of function references can take several seconds to recalculate. This problem gets worse, of course, as the amount of information on the electronic sheet increases.

In many cases, you don't actually need to have all of the values recalculated every time you change an entry. It would be convenient if you could change several entries and then trigger a recalculation when you're ready to look at the results. VisiCalc lets you do this with the /GR command.

If you still have the graph of the sine function from the previous section on your screen, we'll try changing the argument range start and step sizes. (If you no longer have this graph on the screen, just read along.) Type > A 2 0 ® to move the cursor to the starting value, which is currently .03. When you load the VisiCalc program or when you clear the sheet, you are in *automatic recalculation* mode: As soon as you change the value at A20, VisiCalc will automatically recalculate the values of all the formulas on the sheet. Before doing this, however, type / G. The prompt line reads GLOBAL: C O R F. Press R. Now the prompt line reads RECALC: A M. The possible keystrokes are M, to switch to manual recalculation mode, and A, to return to automatic mode. Press M: You have "turned off" automatic recalculation. Now you can change the values at A20 and B20 without waiting for a lengthy intervening recalculation. Type . 0 6 • . 1 2 ®. Now we're ready for a recalculation — but how do we make it happen? Press the exclamation key !. As you've probably noticed before, an exclamation point appears in the upper right corner of the screen and blinks while the recalculation takes place. Whether you're in manual or automatic mode, pressing ! triggers a recalculation of all formulas on the screen (unless ! is pressed while you're entering a LABEL or VALUE on the edit line). Notice how the graph changes to display the positive–going portion and the reflection of the negative–going portion of the sine curve.

Now, type . 0 6 • . 5 4 ®, then return to automatic mode by typing / G R A. The first thing that happens as you return to automatic mode is, of course, a recalculation to update all the figures on the screen.

Summary

This lesson has introduced you to the full power of VisiCalc's calculation capability. Besides simple addition, subtraction, multiplication and division, VisiCalc provides exponentiation, transcendental functions, and scientific notation for numbers. You can use functions such as @SUM, @MIN and @MAX to manipulate entire rows, columns or other ranges of numbers at once. Functions like @COUNT, @AVERAGE, @NPV and @LOOKUP allow you to quickly

handle common problems such as test score averaging, evaluating the terms of a loan, or looking up figures in the income tax tables. You can control the format of calculated results in a variety of ways — even creating simple graphs with the /F* format. With practice, you'll be able to use the features described in this lesson in combination with VisiCalc's screen and window control and formula replication capabilities to solve complex problems quickly and easily.

Lesson Four concludes Part II, the Tutorial for VisiCalc. Look up commands, as you use them, in Part III, the VisiCalc Command Reference. You will discover still more fine points of VisiCalc not discussed here, and many straightforward examples which illustrate how to use each command. As you use VisiCalc, you will discover countless techniques and application ideas that may be useful in your work. After you've had a chance to read this manual and use VisiCalc for some of your own applications, we'd appreciate it if you would fill out and send in the Reader Critique at the back. We're interested in corrections and suggestions for the manual as well as suggestions for improvements to VisiCalc itself. In the meantime, we hope you find VisiCalc to be an enjoyable and useful tool.