

PERSONAL SOFTWARE
VISICALC™
APPLE II & II PLUS



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VISICALCTM

Computer Software Program

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INTRODUCTION

INTRODUCTION

1. VisiCalc and Your Apple Computer

This manual will show you how to use VisiCalc and your Apple computer to solve problems in your professional work and your everyday life. VisiCalc gives you a way to use a personal computer to solve problems without having to spend your time and energy programming, or your money to buy or have prepared for you a computer program for each new problem. You can use VisiCalc yourself to quickly solve problems, much as you would with a calculator and a sheet of paper. But thanks to VisiCalc's "electronic sheet" and recalculation capability, you can work more rapidly and explore more options than you could before.

VisiCalc is just one of many software systems available for your Apple computer. Some of the others are the "languages" BASIC and PASCAL and the Apple "Disk Operating System." You don't have to know anything about these other systems or read any other manuals in order to use VisiCalc. This manual will guide you step by step from the moment you set up your Apple computer and turn on power. Of course, as you gain familiarity with the capabilities of your Apple, you may wish to learn more about these other software systems — or, if you've owned an Apple before obtaining VisiCalc, you're probably already familiar with them. At appropriate points, this manual will mention how various features of VisiCalc relate to the other languages and systems provided for your Apple.

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. The four lessons in this manual should be read with your Apple computer in front of you. Each lesson will show you exactly what to type, keystroke by keystroke. As you practice, you'll gain familiarity and confidence in using some of the more advanced features of VisiCalc, which you can use to speed your work still further. Before long, you'll need only the VisiCalc reference card which summarizes all of VisiCalc's commands and features. You'll find it in its pocket on the inside back cover of the binder holding this manual.

2. Important Follow-up Program

Please take a moment now to read carefully the VisiCalc warranty statement and proprietary rights notice, and fill out and mail the VisiCalc Users' Group registration card. This will ensure that you know what precautions to take when using VisiCalc, and what to do if your VisiCalc program diskette is accidentally damaged. Returning the registration card will also ensure that you are kept informed of new and improved versions of VisiCalc and of the availability of the VisiCalc Users' Newsletter.

After you've had a chance to read this manual and use VisiCalc for a few of your own applications, we'd appreciate it if you would fill out and mail the Reader's Comment Form at the back of this manual. This will enable us to incorporate corrections and improvements in the next edition of the manual, and to incorporate your suggestions in subsequent versions of VisiCalc.

3. 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 — a better “pencil” and “sheet of paper.” 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.

The sheet is organized as a grid of columns and rows. The intersecting lines of the columns and rows define literally thousands of entry positions. At each of these positions 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 the statement you get from your bank.

But the power of VisiCalc is not that it simply imitates a calculator with pencil and paper. The computer remembers the formulas and calculations you’ve used as you work through a problem. Now, suppose you change a number you had previously written on the electronic sheet. Like magic, all the 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 literally take hours of erasing and recalculating.

VisiCalc’s editing features also let you change, insert or delete titles, numbers or formulas. The existing VisiCalc chart or table is instantly restructured before your eyes. All of the columns, rows and other formulas are 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 as displayed on your computer screen, the internal length of titles and formulas is practically unlimited. 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, all you have to do is enter or change numbers. You can save the entire electronic sheet on your Apple diskette or cassette, and you can print all or part of the sheet on almost any model of line printer.

VisiCalc strikes a delicate balance between simplicity and sophistication. 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.

4. Origins of VisiCalc

VisiCalc was conceived and written by Dan Bricklin and Bob Frankston of Software Arts, Inc., Cambridge, Massachusetts, a software company with extensive experience in computer languages, compilers and word processors. It is distributed exclusively by Personal Software, Inc., Sunnyvale, California, a software publishing and marketing company with a high calibre line of labor-saving and leisure time software. Both Software Arts and Personal Software are committed to maintaining the highest standards of quality and innovation in software for personal computers.

5. Setting Up Your Computer

If you are using your Apple computer for the first time, this section will cover the essential steps needed to set up the computer and start using VisiCalc. Each of these steps has several embellishments, which you may wish to learn about if you intend to use other Apple languages such as Integer BASIC, APPLESOFT or PASCAL, or other features of the Apple Disk Operating System (DOS). To do this, consult the appropriate Apple instruction manuals. If you are already familiar with the basic operation of the Apple computer and the Disk II, you can skip to the section entitled "Loading VisiCalc."

To use VisiCalc, you will need the following components:

1. Your Apple II or Apple II Plus computer. It must have at least 32K bytes of RAM memory, and may have more.
2. A video monitor (preferable), or a TV set and an appropriate cable or device to connect it to your Apple. (A black and white monitor or TV is satisfactory and in some ways preferable for VisiCalc, but a color monitor or TV is useful to take advantage of the color capabilities of your Apple computer.)
3. A Disk II diskette drive. One drive is sufficient, and more than

one drive can be used if desired. You will also need a set of blank diskettes. (One blank diskette is enclosed with your Disk II, but you'll probably want more.)

4. The VisiCalc program diskette. This is enclosed in the inside front cover pocket of the binder holding this manual.

The Apple's power cord should be plugged into the back of the Apple and into a wall socket, and the video monitor or TV power cord should also be plugged in.

If you have a video monitor, the dealer who sold you the monitor should also supply you with a cable to connect it to the Apple and show you how to hook it up. Make sure that the cable runs from the jack marked VIDEO OUT on the back of the Apple to the VIDEO INPUT jack of the monitor.

If you are using a TV set, you will need an "RF Modulator" and cable, which changes the signal put out by the Apple so that it matches what your TV expects. Ask your dealer for an RF Modulator, or consult your Apple BASIC or APPLESOFT manual for information on where to find one.

Your Disk II drive should be connected by its ribbon cable to the set of pins for "Drive 1" on your Disk II controller card, and the controller card should be plugged into "Slot 6" at the back of the Apple main circuit board. This is the most sensitive step in setting up your Apple. Ask your dealer to show you how to install the Disk II drive and controller card properly. Take some time out now to read Chapter 1 ("Installation and Handling") of your Apple Disk Operating System Instructional and Reference Manual. Pay particular attention to Sections 5 and 6 of Chapter 1, which cover care and handling of the Disk II diskettes, and the proper way to insert diskettes into the drive and remove them. The time you spend now learning how to properly care for diskettes will probably save you the catastrophic loss of one of your VisiCalc storage diskette contents later. Whenever you are setting up your Apple, make sure that the Apple's power is turned off when you install the Disk II controller card, and that the ribbon cable and controller card are attached properly.

6. Loading VisiCalc

The next step is to check that your Apple computer is working properly, and load the VisiCalc program from diskette into the Apple's memory. If you are familiar with the Apple Disk Operating System (DOS), you will find that you load VisiCalc by "booting" from the VisiCalc program diskette, in exactly the same way that you "boot the DOS" from an Apple SYSTEM MASTER diskette.

If you have the Language System installed on your Apple, which gives you 64K RAM and enables you to run PASCAL, you must follow a special procedure to prepare the system to run VisiCalc, just as you would to prepare it to run BASIC programs. Just follow the appropriate instructions below.

Turn on your video monitor or TV set, but leave the Apple's power switch (located at the back of the Apple on the left) off for the time being. Open the Disk II drive door or latch by pulling outward at its bottom edge.

If you have a Language System, you must use the BASICS diskette when you first turn on the computer. This diskette is supplied in the box of PASCAL system diskettes which comes with the Language System. If you have an ordinary Apple II or II Plus, you can start right away with the VisiCalc program diskette, which is kept in the pocket on the inside front cover of the binder holding this manual.

Take the diskette you need and carefully insert it into your Disk II drive, exactly as shown in the illustration in Chapter 1, Section 6 of your Apple DOS manual. Insert the diskette with the VisiCalc (or BASICS) label upwards. 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 turn on the power switch at the back of your Apple. One of three things should happen:

1. If you have a Language System and are starting with the BASICS disk, the Disk II drive will start whirring and clicking for a few seconds. Then the message INSERT BASIC DISKETTE AND PRESS RETURN will appear on the screen, and the drive will stop whirring. Once the drive has stopped, open the drive door, carefully remove the BASICS diskette and store it in its box, and then insert the VisiCalc program diskette, exactly as described above. Then press the key marked RETURN, and go on to step 2.
2. If you have an Apple II Plus, or an Apple II with the "Autostart ROM," the Disk II drive will begin whirring and clicking, and the red IN USE light on the drive should come on. The letters VC should appear in the upper left corner of the screen. After a few seconds, the VisiCalc program will be loaded, and the screen display shown in the photo below will appear. You can skip the following paragraphs and continue with the instructions following the screen photo.
3. If you have an Apple II without the Autostart ROM, the Disk II drive will do nothing, but a random pattern of characters will appear on the screen. The Apple will "beep" once, and you will see an asterisk and a blinking square box near the bottom left corner of the screen.

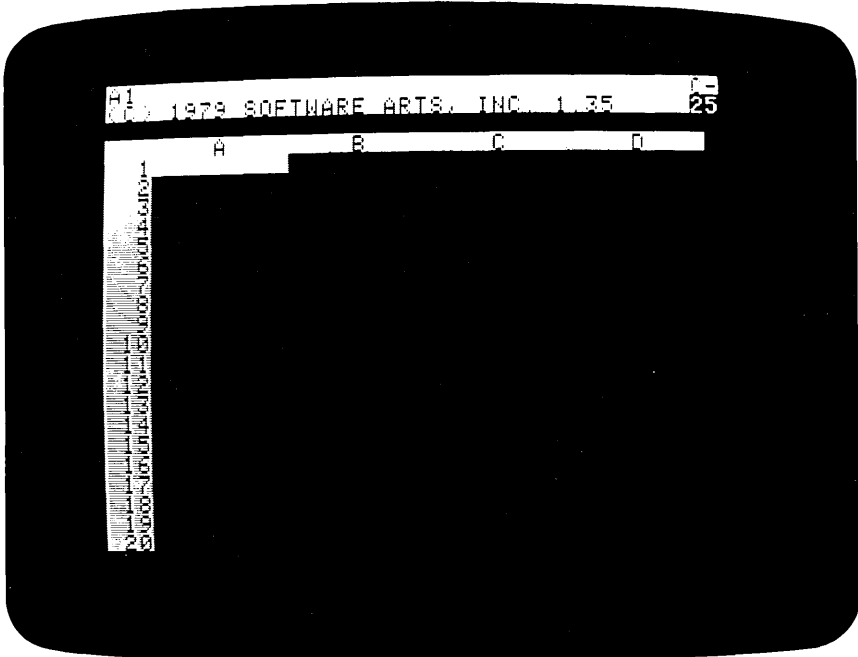
If you get the asterisk and blinking box, you should do the following:

- a. Press the key marked RESET at the upper right corner of the keyboard once. The Apple will beep and another asterisk will appear.
- b. Press the **6** key once.
- c. Hold down the key marked CTRL at the left side of the keyboard, and press the **P** key once. Then release the key marked CTRL.
- d. Press the key marked RETURN at the right side of the keyboard.

This sequence of keystrokes is often abbreviated **RESET 6 CTRL-P RETURN**. After this magic incantation, your Apple should behave exactly as described in step 2 above.

If you still find that nothing happens, do the following: i) Read the instructions again. ii) Check to see that your Disk II drive is connected by its ribbon cable to the pins for Drive 1 on the controller card, and that the card is inserted in Slot 6 on the Apple main circuit board. (If it is inserted in a different slot, say Slot 7, then you must instead type RESET, 7, CTRL-P, RETURN.) iii) Ask your Apple dealer for assistance.

If the Disk II drive starts whirring and clicking, but never stops, wait for about fifteen seconds. Then press the key marked RESET in the upper right corner of the keyboard. After a second or two, the drive should stop and the IN USE light should go off. Open the drive door, remove the diskette, and check to make sure that it was inserted properly. Then turn off your Apple and try the whole procedure again. If, after several tries, you are still unsuccessful, ask your Apple dealer for assistance.



If all has gone well, your screen should now look more or less like the one pictured above. Making sure that the Disk II drive has stopped whirring and the red IN USE light is off, open the drive door or latch, 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 Apple, or unless something goes wrong.

7. Initializing VisiCalc Storage Diskettes

Now take out a blank diskette and carefully insert it into the Disk II drive, just as you did for 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 II 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 II 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.

1. Press the / key, next to the SHIFT key at the bottom right corner of the keyboard. On the prompt line you should see `COMMAND: BCDGIMPRSTVW-`.
2. Press the letter S key. The prompt line should read `STORAGE: L S D I W R.`
3. Press the letter I key. The prompt line should read `INIT DISK: TYPE RETURN TO ERASE DISK.`
4. Press the key marked RETURN. The red IN USE light should come on and the disk should spin for nearly two minutes, making buzzes, clicks and other little noises.

What is happening is that the computer is recording a standardized pattern on the surface of the diskette, so that VisiCalc (or another program) 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 Integer BASIC or APPLESOFT).

After about two minutes, if all goes well, the Disk II drive should quiet down and the red IN USE light should go off. Once the drive has stopped, 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 IN USE 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. If you don't have any adhesive labels, you can write directly on the label on the diskette, but be sure to use a felt tip

pen, not a ballpoint.

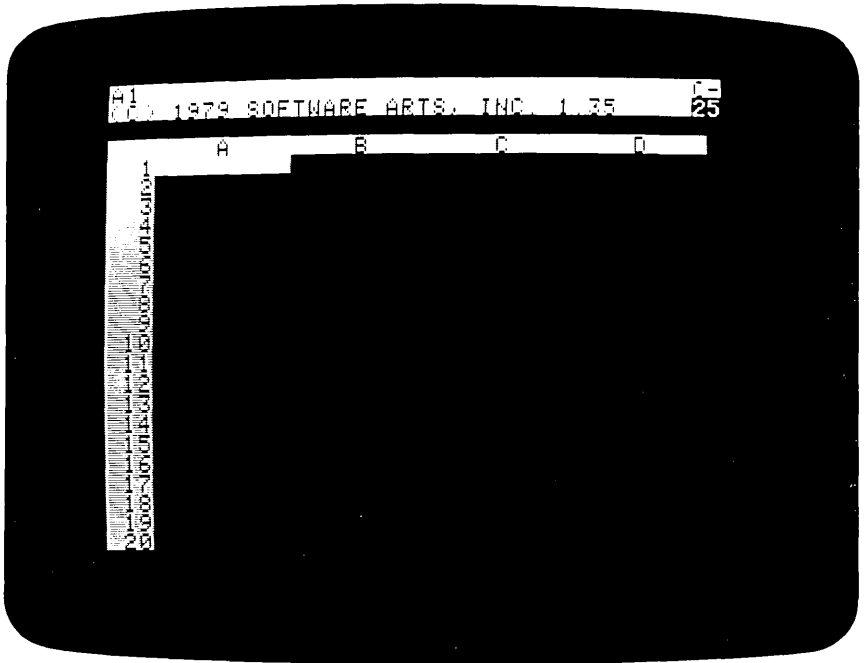
At this point, you may wish to initialize some additional diskettes for use with VisiCalc. Simply insert a new blank diskette, close the drive door, and follow the four-step initialization procedure above. When you've finished, you'll be ready to go on to Lesson One and begin learning to use VisiCalc.

LESSON ONE

LESSON ONE

Lesson One

If you have successfully 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. 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 (currently A B C D), there are three additional lines which make up VisiCalc's **control panel**. Right now, the middle line of this control panel displays the VisiCalc copyright notice and **version number**, for example:

(C) 1979 SOFTWARE ARTS, INC. V1.35

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

Press the key marked RETURN at the right side of your Apple keyboard. (For brevity, from here on we'll indicate the RETURN key with the symbol Ⓜ, and the space bar 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.

1. 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 arrow keys ◀ and ▶ at the right side of the keyboard. 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 ◀ and watch the cursor move back to its original position.

Since the Apple keyboard does not include "up arrow" and "down arrow" keys, VisiCalc uses the space bar, Ⓢ, to "change direction." Look in the upper right corner of the control panel for the letter 'C', which is currently followed by a dash, '—'. The dash is the **direction indicator**, and it currently indicates that the arrow keys will move the cursor horizontally. (The letter 'C' will be explained in Lesson Four). Now press the space bar Ⓢ *once*. Notice that the dash changes into an exclamation point, '!'. This indicates that the arrow keys will move the cursor vertically. Next, press the right arrow key ▶. The cursor will move down to the position at column A, row 2, and the cursor coordinate at the upper left corner of the screen will become A2. Press the left arrow key ◀ to move the cursor back up to position A1. Try pressing the space bar Ⓢ a few more times to see how it changes the direction indicator, but leave the indicator as a dash, '—'.

2. 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. The window allows you to see the first four columns (A through D) and the first twenty rows (1 through 20) of the sheet. Now, with the cursor at A1 and the direction indicator as a dash, '—', press the right arrow key ▶ three times. This takes you to position D1, at the right edge of the window. Now press the right arrow key ▶ again. The cursor moves to position E1, and column

E of the sheet 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 **▶** two more times to bring columns F and G into view.

The screen window will also scroll to the left. (In fact, it will scroll in all four directions.) With the cursor at G1, press the left arrow key **◀** three times to move to F1, E1, and D1. Then press **◀** again and notice that column C comes into view, while column G disappears off to the right. Press **◀** twice more to move back to position A1. Now try pressing **◀** one more time. The sound you hear is VisiCalc's way of telling you that you are bumping into the edge of the sheet.

Next, press the space bar **Ⓢ** once to change the direction indicator to an exclamation point, '!'. Just for fun, press the left arrow key **◀**, which now 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 right arrow key **▶** twenty times to bring the cursor down to position A20. Then press **▶** again, and notice that row 21 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.

3. The REPT Key

To speed our search for the bottom edge of the sheet, we'll use another key on the keyboard. Press the **▶** key again, and this time *hold it down*. While you hold down the **▶** key, press the key marked **REPT** (for REPeaT), and hold *it* down. Much better, isn't it? (If all is going well, the cursor and the window will be scrolling downwards automatically.) Continue to hold down the **▶** and **REPT** keys until you bump into the bottom edge of the electronic sheet. Then release both keys. The cursor should be at position A254.

Now, let's search for the right hand edge of the sheet. Press the space bar **Ⓢ** once, and notice that the direction indicator changes from an exclamation point to a dash, '—'. We're ready to move the cursor horizontally. Next, press the **REPT** key and hold it down. While you are holding down the **REPT** key, press the right arrow key **▶** and hold it down. The cursor and the screen window should start scrolling automatically to the right.

Did something go wrong? Yes, if you followed our instructions exactly. If you first pressed the **REPT** key and then pressed the **▶** key, the cursor and the screen window will be going nowhere quickly, and VisiCalc will be telling you, over and over again, that you are bumping into the bottom edge of the sheet. Why?

We deliberately gave you these instructions to point out a subtle trap. The answer lies in the action of the Apple's **REPT** key. The **REPT** key always repeats *the last key pressed*. It works, not only with the arrow keys, but with the letter keys, the number keys, the punctuation keys, and . . . the

space bar.

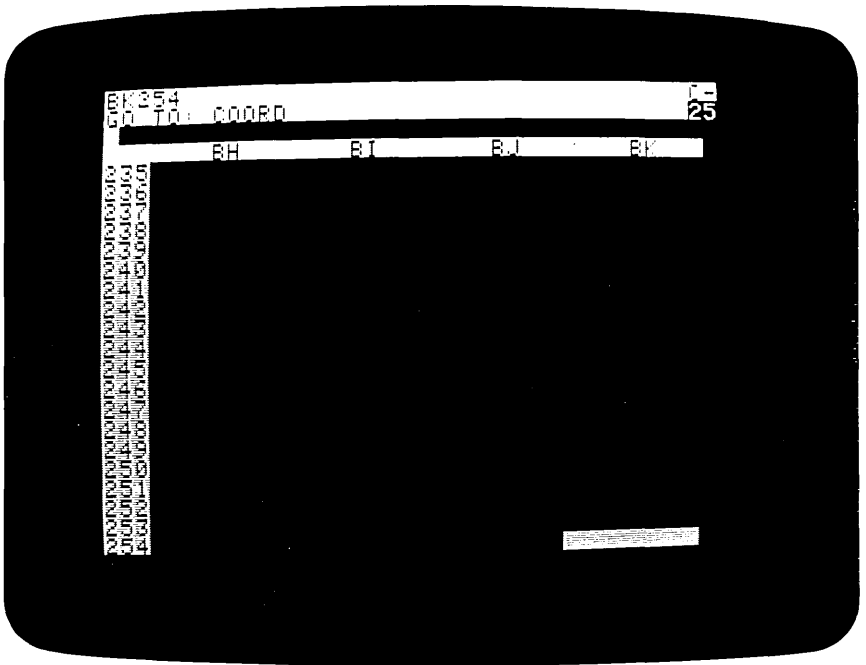
Now, let's search for the right hand edge of the sheet the right way. Press the space bar $\text{\textcircled{S}}$ to set the direction indicator to a dash, '—'. Then press the right arrow key \blacktriangleright and hold it down. Next, press the **REPT** key and hold it down. This time, the cursor and the window will go scrolling off to the right. Moral: always press and hold the arrow key first, then press the **REPT** key. When the cursor reaches the desired destination, release both keys.

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.

4. Direct Cursor Movement

Even with the aid of the **REPT** key, it took longer than we would like to scroll the cursor and window all the way to the lower right hand corner of the VisiCalc sheet. Fortunately, there's an easy way to move an arbitrary distance across the sheet with a few keystrokes.

Type the character > . To do this, press and hold down either one of the **SHIFT** keys at the bottom corners of the keyboard, just as you would on an ordinary typewriter. While you are holding down one of the shift keys, press the key marked > once (it's just above the right edge of the space bar). Then release the shift key. Two things will happen: 1) The message GO TO: COORD appears on the middle line of the control panel, at the top of the screen. 2) Directly below this message, a blinking box 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 blinking box. Notice that you get a capital **A**, whether you press the shift key or not. The Apple keyboard and screen allow for only upper case letters. The shift key matters only when you press a key with two symbols on it. 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 blinking box. 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 hand corner of the sheet.

Try another example. Press the keys **> C 1 0 @**. (Be sure to use the shift key to type **>**.) Does the cursor move to the expected position?

5. Backing Up and Out with the ESC Key

If you have made any typing errors up to this point, you've had no way to undo them. VisiCalc has several error correction features, each of which will be covered in this lesson. The first of these is the **ESC** key.

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 blinking box.

Press the key marked **ESC**, near the upper left corner of the keyboard. Notice that the blinking box "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 **ESC** key. You can back up more than one character. For example, to change A11 to A2, you would press the **ESC** 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 **ESC** 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 **ESC** key once, and the number 5 will disappear from the edit line. Now press the **ESC** 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. No matter what you are typing, you can always back out and leave the sheet unchanged by pressing the **ESC** key a few times, 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 space bar, 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.

6. 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**. 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 **ESC** key.) Stop and look at the screen. On the prompt line is the word LABEL. This is VisiCalc's term for any type of alphabetic

message which you write on the sheet. On the edit line is the word SALES, followed by the blinking box. The blinking box indicates that you can still use the **ESC** 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. Now 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. Try pressing the **ESC** key. (Nothing happens.)

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 blinking box. Press the **ESC** key four times, and watch the number disappear: First 0, then 0, then 1, then finally the prompt VALUE. Position B1 is still blank.

Now press the following keys: **7 5 + 2 5** (Remember to use **SHIFT** to type the +. If you make a typing error, watch the edit line carefully and use the **ESC** key to back up.) The word VALUE is again on the prompt line, and the edit line reads 75+25, followed by the blinking box. Now hold down the **SHIFT** key and press the **!** key once. 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 **ESC**. (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.

7. Formulas and Recalculation

Now press the following keys: **Ⓢ ▶ Ⓢ**. This will leave the cursor at position A2, with the direction indicator as a dash, '—'. Next, type the letters **C O S T** and then press the **▶** key. The cursor should move 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.) The edit line should now read .6*B1. (If it doesn't, remember **SHIFT** and **ESC**.) 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 **Ⓢ** to set the direction indicator to '!', and 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.

8. More on Labels and Values

So far, you've seen how easy it is to write alphabetic messages, numbers and simple formulas on the electronic sheet, and how VisiCalc will recalculate formulas when you change a number. Next, we'll 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, and **@** to set the direction indicator to a dash, '—'. 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 **ESC** twice to erase the G and back out of the 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 beeping at you. VisiCalc took the initial dash or minus sign to mean that you were typing a formula, and then complained as you typed something that couldn't be a formula. Press the **ESC** key three times to back out of this mistake.

To remedy this situation, hold down **SHIFT** and press the **"** key. 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 blinking box. Now you can type: **- G R O S S -** As usual, you can use the **ESC** key to back up and correct mistakes. You don't have to type a closing quote symbol. Now press the **►** key, and the cursor should 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 $B1-B2$. But before we type this formula, look back at the explanation of how VisiCalc determines whether you are typing a LABEL or a VALUE. What will happen when you type $B1-B2$? Try it: Press **B 1 - B 2** No beeps 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.

Let's try again. First, we'll eliminate the erroneous message B1-B2. Try pressing ESC. 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.

9. 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 quite time-consuming. You might be working in columns F and G, and columns A and B would have scrolled off the left edge of the window as it moved to display F and G. Now, 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 blinking box. 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. 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 blinking box. 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 blinking box. 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 \blacktriangleleft 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 \textcircled{R} . 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 \blacktriangleleft key twice to move the cursor up to B1, and change the number there by typing: 1 0 0 \textcircled{R} . 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. Try to obtain this formula by moving the cursor and typing the + and / keys.)

10. 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 which you initialized with the /SI command when you read the earlier section entitled “Initializing VisiCalc Storage Diskettes.” 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 the introductory sections, 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 blank diskettes, don't worry. Just skim over the material below and at the beginning of Lesson Two on the /SS and /SL commands. 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.

If you do have an initialized diskette you can practice using the VisiCalc storage commands, and save yourself some time in Lesson Two. First, make sure that your Disk II drive's IN USE light is off, and open the

drive door by pulling outward at its bottom edge. If your VisiCalc program diskette is still in the drive slot, 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 slot with the diskette label upwards. The oval cutout in the square diskette jacket should enter the drive first. 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 W R. VisiCalc is telling you that it recognizes /S as the STORAGE command, and that next it expects you to press one of the letter keys L S D I W or R. 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.
- W Write the contents of the sheet on a cassette tape.
- R "Read" the sheet contents from a cassette tape into RAM memory.

Press the letter S. Now the prompt line reads FILE FOR SAVING, and a blinking box 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.

A filename can be up to thirty characters long, and can consist of any letters, digits or punctuation characters except the comma. Let's name this file EXAMPLE: Press the keys **E X A M P L E** As usual, you can correct typing errors with the **ESC** key. When you are satisfied, press **@**. The Disk II drive should begin whirring and making scratching noises, and the **IN USE** light should come on. After a moment, the Disk II drive should quiet down, the **IN USE** 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!

11. 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. Despite your best efforts, things can and do go wrong.

As you begin to use VisiCalc in your work, 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.

12. The RESET Key

However, there is one key which you should never press while using VisiCalc: the **RESET** key in the upper right corner of the keyboard. This key is the "panic button" on the Apple: It sends a special signal to the computer, causing it to stop whatever it was doing and "reset" itself to a startup condition similar to the one it was in when power was first turned on. Depending on exactly what VisiCalc was doing at the moment when the **RESET** key was pressed, it is possible that the VisiCalc program might not be able to continue normal operation. To be safe, you must boot again from the Visicalc program diskette, and in the process the contents of the sheet in memory will be erased.

Even in this case, however, there is a way out. VisiCalc has a special "reset recovery" program, which lets you save the sheet contents on diskette or cassette just before "bailing out." To try out this recovery procedure, you should have VisiCalc running with something written on the sheet (such as the results of Lesson One). A VisiCalc storage diskette should be in place in your Disk II drive. Now press **RESET**.

If your Apple beeped and gave you an asterisk and a blinking box at the bottom of the screen when you first turned power on, it should do the same thing now. If your Disk II drive started up automatically when you turned power on, you should be able to go on to the instructions in the next paragraph. If you have the asterisk and blinking box, you should do the following: i) Hold down the **CTRL** key at the left side of the keyboard, and

press the **Y** key once. ii) Release the **CTRL** key. iii) Press the **Ⓢ** key.

If all is well, the VisiCalc screen will be back to normal, except that the prompt line now reads **STORAGE: L S D I W R**. As you may recall, this is the same prompt you saw when you used the storage command **/S** to save the file **EXAMPLE** on diskette at the end of Lesson One. The VisiCalc reset recovery program has executed a special **/S** command, which you cannot "back out of" by pressing **ESC**. (To review the meanings of the letters **L S D I W R**, consult the section entitled "Saving the Electronic Sheet on Diskette.") You must now: i) Save the sheet on diskette or cassette; ii) Re-boot VisiCalc from the VisiCalc program diskette; and iii) Reload the sheet from diskette or cassette into memory, so that you can continue your work.

If you press **L** or **R** at this point, VisiCalc will beep, insisting that you save the sheet in memory using either **S** or **W**. You can press the **I** key to initialize a new diskette prior to saving the sheet, or the **D** key to delete files from a storage diskette, if you must free up space on that diskette to make room to save the sheet in memory (see the reference card for further information). For now, press **S**. The prompt line reads **FILE FOR SAVING**, and a blinking box appears on the edit line. Type a filename, such as **EMERGENCY SAVE**, and press **Ⓢ**. The Disk II drive's **IN USE** light should come on while the sheet is saved. Then the prompt **STORAGE: L S D I W R** will reappear. At this point, you can turn off the power on your Apple. Remove your storage diskette from the drive and set it aside, then insert your VisiCalc program diskette and re-boot the VisiCalc program as described in the section entitled "Loading VisiCalc." Finally, remove your VisiCalc program diskette, re-insert the storage diskette, and type **/ S L**. Answer the prompt **FILE TO LOAD** with the name of the file you just saved, such as **EMERGENCY SAVE**, and press **Ⓢ**. VisiCalc will load the sheet from the disk file into memory, and the screen display should reappear just as it was before you pressed **RESET**. Now, you can safely continue your work.

13. Save Your Work As You Go

Although you can recover from an accidental **RESET**, other things can go wrong. What if your building has a power failure? What if someone stumbles over the Apple's power cord and pulls it out of the wall 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 you might have difficulty reconstructing later, then it's time to save the sheet again. To keep track of several similar copies of the same information on diskette, you can append a sequential number (such as **FORECAST 3**) or the date and time (such as **FORECAST OF 10/26 17:30**) to the filename you use when you save the sheet.

Another option is to print out the sheet display on a line printer. (See

the discussion of the /P command at the end of Lesson Three.) 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.

14. 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, as long as it is kept away from magnetic fields and extremes of heat and cold. However, to be used, a diskette must be handled, and transported from place to place. Think pessimistically. A diskette may be scratched accidentally, or it may pick up grease or dust; it may be damaged by heat, or accidentally re-initialized (which erases its contents). If you work at home, there are the additional hazards of children and pets. And a diskette will eventually wear out: Its average lifetime is about 40 hours of use. Hence, to protect yourself, you should always make extra copies of your important files on separate diskettes.

To make a backup copy of a single diskette file or a small number of files, you can use VisiCalc's storage command. Simply insert the storage diskette containing the file which you want to copy into your Disk II drive, and use the /SL command to load the sheet from the diskette file into memory. (For details on the /SL command, see Lesson Two.) Then insert a fresh, initialized storage diskette into your drive, and use the /SS command to save the same information on the new diskette. The time it takes to do this will be amply repaid the first time you try to load a file from a diskette, only to get the message "DISK I/O ERROR."

If you have two disk drives, there is an even faster way to copy the entire contents of one diskette to another diskette. What's more, the new diskette does not have to be initialized beforehand. You can do this with the COPY program provided by the Apple Disk Operating System, as described in Chapter 4, Section 6 of your Apple DOS manual. Simply boot from the Apple SYSTEM MASTER diskette, just as you would boot from the VisiCalc program diskette, as described in the section of this manual entitled "Loading VisiCalc." When you see a right caret or a right bracket prompt followed by the blinking box, type **R U N © C O P Y ©**. Insert the original diskette, containing the files which you want to "back up" in Drive 1, and insert a blank, uninitialized diskette in Drive 2. Then answer the questions displayed by the COPY program by pressing © three times. When all of the files on the diskette have been copied from Drive 1 to Drive 2, the COPY program will ask **DO YOU WISH TO MAKE ANOTHER COPY?** Type **Y** for yes, **N** for no, and press ©. For more details, consult your Apple DOS manual.

These procedures are important. Don't assume that accidentally pressing the **RESET** key, losing electric power, or having a diskette wear out are unlikely occurrences. They *will* happen. It is all too easy to read about these protective measures, use them once or twice, and then, when you're in a hurry or under pressure to get something done, skip the backup steps. When

Lesson One

Making Backup Copies

disaster strikes, you will curse your carelessness. Remember Murphy's Law: If anything can possibly go wrong, it will. Protect yourself.

LESSON TWO

LESSON TWO

Lesson Two

In Lesson One, you saw that VisiCalc is based on a few simple principles: moving the cursor, "writing" on the electronic sheet at any of its entry positions, and writing formulas which can be recalculated automatically. You probably also appreciated VisiCalc's analogies with a calculator, pencil and sheet of paper. But so far, you haven't seen any major improvements over the old-fashioned tools, in terms of speeding up your work or saving you time and trouble. In this lesson, the "fireworks" will 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're tackling Lesson Two in a new session, your first step is to load the VisiCalc program into your computer's memory. If you aren't sure of exactly how to do this, follow the instructions in the earlier section entitled "Loading VisiCalc."

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

1. Loading the Sheet from Diskette

Make sure that your Disk II drive's IN USE 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 which you saved at the end of Lesson One. 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.

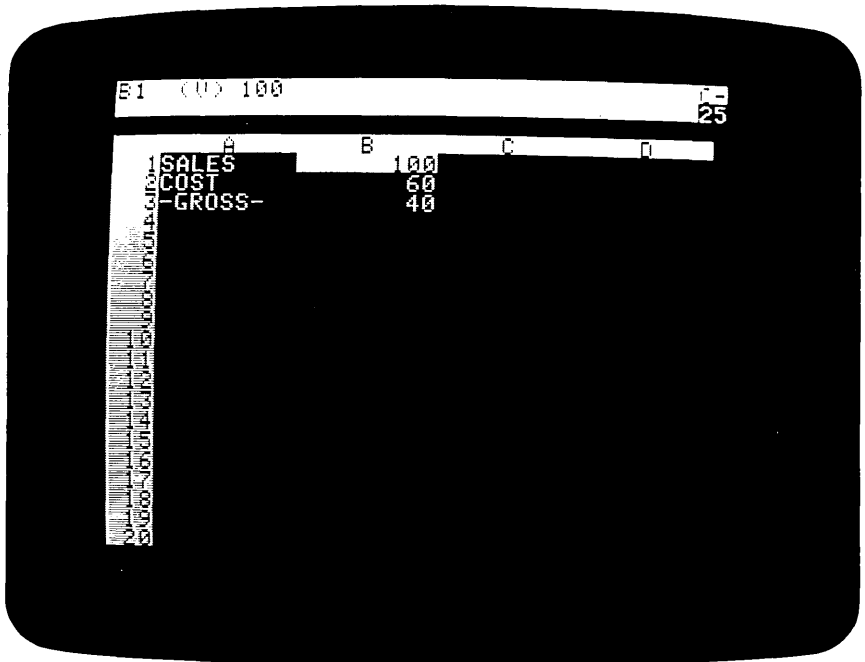
Now type the VisiCalc storage command / S. The prompt line reads STORAGE: L S D I W R. (To review the meanings of the letters L S D I W R, check the section entitled "Saving the Electronic Sheet on Diskette" at the end of Lesson One.) Press L. The prompt line reads FILE TO LOAD. At this point, you could simply type the name EXAMPLE, ending with the @ key. But let's try something else. Press the **▶** key. Your Disk II drive should whirr for a moment and then stop, as the name EXAMPLE appears on the edit line! (If a different name appears, press the **▶** key repeatedly until you get the name EXAMPLE.)

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. (You might also have files which are saved programs in BASIC or machine language on the same diskette. VisiCalc will skip the names of these files.) VisiCalc presents the first qualifying filename which it finds in the directory on the edit line for your inspection. If this filename is not the one you want, you would simply press the **▶** key again, and VisiCalc would go back to the diskette directory for another filename. 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** on the edit line, just press **Ⓞ**. Your Disk II drive should start up again, and the **IN USE** light should come on. 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 II drive will quiet down, 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** 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 to use the **SHIFT** key to type characters such as **>**, ***** and **+**. In the following, you are asked to type the **:** key instead of the **Ⓞ** key, which is an equivalent way of ending the coordinate in a **>** or **GO TO** command.

```
>A1:SALES▶100▶  
>A2:COST▶.6*B1▶  
>A3:“-GROSS-▶ + B1-B2▶  
>B1:
```



Your screen should look exactly like the one pictured above. The direction indicator in the upper right hand corner should be a dash, '—'. 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 \blacktriangleright key to move the cursor to C1, and type: 1 . 1 * \blacktriangleleft @. 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.

2. Replicating a Formula

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 blinking box. Press @. The prompt line now reads REPLICATE: TARGET RANGE, and the edit line reads C1 . . . C1: followed by the blinking box. 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 \blacktriangleright 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 \blacktriangleright 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 \blacktriangleright key ten times, the cursor will be resting at M1, and the edit line will read (in its entirety) C1 . . . C1: D1 . . . M1. (If you moved too far with \blacktriangleright , you can move back with \blacktriangleleft .) 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 coordinate B1 is highlighted 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 at D1, E1, and F1, the numbers 121, 133.1, and 146.41 have appeared. Use the \blacktriangleright 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 \blacktriangleright key seven more times to move the cursor over the entries G1 through M1, scrolling the window to bring columns J, K, L and M 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) Press / R @ to start the replicate command; ii) Point the

cursor at the first and last entries in the range of positions where you want the formula replicated; and iii) 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.

3. 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 blinking box. 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. Press **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 would like 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 at C2 and D2, 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 at C3 and D3, and the prompt and edit lines will go blank. The replicate command has finished its work.

Use the arrow keys and the space bar 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 I** to display the last four months' sales, cost of goods and gross profit, in columns J, K, L and M. VisiCalc obviously 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't we do better than this?

4. 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: B C D F G I M P R S T V W**-. Each of the keys, B, C, D, and so on through 'V' 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 \$ (be sure to use the **SHIFT** key). 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.

5. Fixing Titles In Place

Type > **M I**, so that the screen window once again displays columns J, K, L and M. 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 \triangleright **A 1** $\textcircled{\text{R}}$ to bring the titles SALES, COST and -GROSS- into view. Now type $/$ **T** (the command for "titles"). 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. Set the direction indicator to a dash, —, and press the \blacktriangleright key five 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 \blacktriangleleft key five times. (If you aren't sure of what happened, press the \blacktriangleleft key again.) You are "bumping into" column A, just as you bumped into the left edge of the sheet once before. Next, type \triangleright **M 1** $\textcircled{\text{R}}$. This should bring columns A, K, L and M into view. Now it is easy to identify each row of numbers.

6. 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 \triangleright **B 1** $\textcircled{\text{R}}$ to bring columns A, B, C and D 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 $\textcircled{\text{R}}$. How long did it take to recalculate twelve months' worth of sales, cost of goods and gross profit formulas? Type **1 0 0** (and $\textcircled{\text{R}}$) 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.)

7. Adjusting Column Widths

Press > **B 1** Ⓢ to bring columns A through D back into view. 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, so that you could display more than four columns of figures at once. Well, as you may have guessed, you *can*. Type another "global" command: / **G C 7** Ⓢ. In an instant, the screen changes to display five columns, A through E. 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. 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 nine columns of figures, A through I, with each column four characters wide.

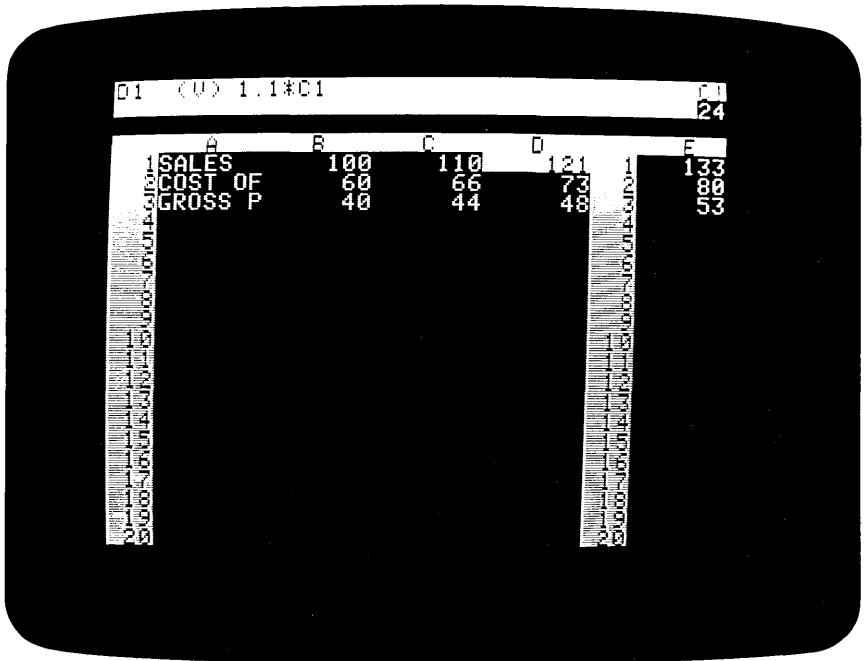
Let's pause for a moment. Look at the titles, SALES, COST, and -GROSS- in column A. SALES has been shortened to SALE, and -GROSS is now -GRO. Have we lost the rest of the labels SALES and -GROSS-? Move the cursor to position A1 to find out. (If you press the ◀ key, you'll bump into column A, which we fixed in place as a title area. Type > **A 1** Ⓢ.) The entry contents line reads A1 (L) SALES. Now, set the direction indicator to an exclamation point, !, and 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.

This should give you an idea. 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 it: 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 is reduced to three. Now, type / **G C 1 8** Ⓢ. Notice the prompts GLOBAL: C O R F and COLUMN WIDTH, and the blinking box on the edit line as you type. As usual, the ESC key can be used for corrections as you enter the number 18. With only two columns on the screen, the entire label COST OF GOODS SOLD can be seen. So much for wide columns. 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, even with narrow columns, we could display only the first or last eight columns out of our twelve columns of sales figures. What we'd really like to do is to keep 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. . . .

8. Splitting the Screen

Type > E 1 @ to move the cursor to column E. 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.



What you have done is to create 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, at position D1. With the direction indicator still at !, use the **↓** key and **REPT** keys to move the cursor downwards to row 20 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 (it's just to the left of the **◀** key). The cursor jumps into the right hand window, coming to rest on position E1. Press **Ⓢ** to set the direction indicator to **—**, and 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. (If you look carefully, you'll see that the direction indicator is now **!**, the same as it was when we last jumped out of this 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), with columns A through E on display. So far so good. 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 roughly the middle row of the screen. Now type **/ W H** (for horizontal). Your screen should look like the photo below.

	A	B	C	D	E
1 SALES		351	386	424	467
2 COST OF		210	231	254	280
3 GROSS P		140	154	170	187

	A	B	C	D	E
1 SALES		100			
2 COST OF					
3 GROSS P					

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, use the ◀ and REPT keys 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. Next, press Ⓢ to set the direction indicator to —, and use the ▶ key to scroll the bottom window rightwards until column M comes into view. (You'll need to press ▶ eleven times, or use the REPT key.) Now we can see the first four months and the last four months at the same time.

9. Global Commands in Separate Windows

Can we do any better than this? Press ; to move the cursor into the top window, and type / G C 4 Ⓢ. Once again, we have nine columns, A through I, 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.

Notice, too, that we have attained one more somewhat quixotic goal: All twelve months are now on display at the same time! Columns A through I are visible through the top window, and columns J through M can be seen through the bottom one. 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 twelve columns as VisiCalc recalculates all the formulas. Now type the number 6 0 0 @. What happens? Columns H and I in the top window, and all the columns in the bottom window, 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.

10. Summary

We have covered a lot of ground in this lesson, and have shown you some of the promised fireworks on the screen. At this point, with your memory of 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. Don't worry. 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:
 - i) The **replicate** command /R, which gives you a shortcut way of writing similar formulas in adjacent rows and columns.
 - ii) The **global** command /G, which lets you change the column width (/GC) and the way numbers are formatted (/GF).
 - iii) 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".
 - iv) 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, or check the reference card for more complete explanations. You now know enough about VisiCalc to begin to use it really effectively. Good luck!

11. Postscript: Memory and the Electronic Sheet

As you probably know, your Apple 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.

If you have ever looked under the cover of your Apple computer, you have probably seen the integrated circuit chips which make up the RAM and ROM memory. The RAM chips, which are mounted near the front of the Apple's main circuit board, are organized into rows of eight chips each. Each IC chip contains 16,384 "bits" of information. The computer accesses a whole row of eight chips at one time, taking one bit from each chip. The eight bits thus obtained are called a "byte." A byte is sufficient to hold the binary code for a single letter, digit or other character. An alphabetic label such as SALES or a number such as 123.45 would take up several bytes. (The exact number depends upon the design of the program which manipulates them.)

Hence, a row of RAM chips on the Apple gives you 16,384 bytes of memory. This is often abbreviated as 16K bytes. The K denotes 1024 bytes. A 32K Apple would have 32 x 1024, or 32,768 bytes; a 48K system would have 49,152 bytes; and a 64K system would have 65,536 bytes.

The VisiCalc program is loaded into RAM memory from diskette, and it, together with some RAM which the Apple itself requires, takes up about 23K 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.

12. 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 blinking box. But when you press @, VisiCalc simply beeps, leaving 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 Apple computer! What's more, as you saw in Lesson Two, the columns can be widened to as much as 37 characters (the width of the screen). If each entry position were this large, you would need 16,002 x 37 = 592,074 bytes of RAM.

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 beeps 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 beeps, refusing 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.

13. 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 and the direction indicator 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. If you have a 32K Apple, this number should be 09 (or close to it). If you have a 48K computer, the number should be 25. On a 64K Language System, the number should be 35, since only 10K of the 16K RAM on the Language Card is actually available to extend the electronic sheet. The memory indicator will vary as you write information on the sheet or use commands, such as replicate, which do the same thing. If you use up so much memory for entries that only a few bytes of memory remain, the number will change into a flashing letter M as a warning signal. If you finally exhaust all of the available memory, VisiCalc will beep at you 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 37 characters. The answer is not obvious, so let's experiment. 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 $2600 \times 9 = 23,400$ bytes. On a 48K system, the number of K bytes available might decline from 25 to 1 or 2. On a 32K system, 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 25 to about 20 on a 48K system (or from 09 to about 04 on a 32K system). 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.

14. 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 20 (or 4). 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 20 to 16 (or from 04 to 00). We have used up about 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 16 back to 20 (or from 00 to 04)! 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.

15. 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

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. You will undoubtedly discover more useful techniques on your own, and you can write about these techniques, or read about the approaches used by others, in the VisiCalc Users' Newsletter. We will also introduce more VisiCalc commands and features in this lesson. These include the built-in functions such as @SUM, and the "insert," "delete" and "move" commands, which let you stretch the sheet to make room for something new or move whole columns and rows. Finally, we hope to demonstrate how VisiCalc might be useful in your personal life, by outlining a household budgeting application and suggesting how you might adapt it for your own use.

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.

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.

1. Typeahead

First, we'll lay out twelve months or periods across the sheet. Type the word **PERIOD** and press the \blacktriangleright key to move on to position B1. Now, as fast as you can, type the following keys: 1 \blacktriangleright 2 \blacktriangleright 3 \blacktriangleright 4 \blacktriangleright 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 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 \blacktriangleright A 1 : \blacktriangleright \blacktriangleright 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 + \blacktriangleleft @. 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 blinking box. Press **▶** to obtain the starting position, D1; then press **.**; and finally, hold down first the **▶** key and then the **REPT** 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. 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.

2. Replicating Numbers and Labels

Type the following characters, ending with the **Ⓢ** key as shown:

>A2:INCOME▶1800 Ⓢ

(As in Lesson Two, we are using the **:** key instead of the **Ⓢ** key as an equivalent way of completing the coordinate in a **>** or **GO TO** command.) 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 Ⓢ**. There's no need to type **N** or **R**, 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 blinking box appears on the edit line. Whatever character or characters we type next will be repeated over and over again in 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.

3. 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:

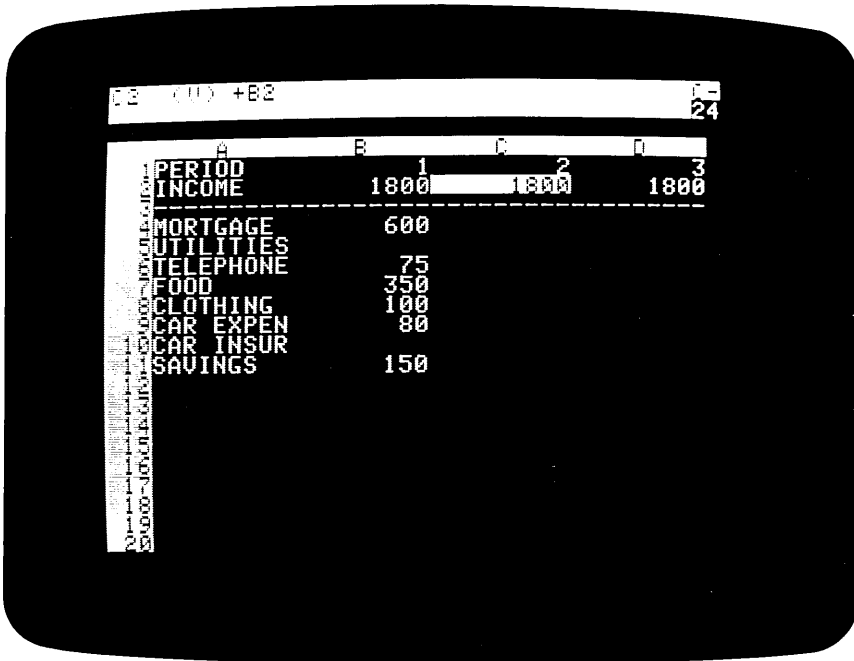
>C2: +B2 ®

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 and space bar 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.

4. Replicating Down a Column

Make sure that the cursor is at C2, and the direction indicator is a !. 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 blinking box. Press the ► key

twice. Now the edit line reads C2. . .C2: C4. Press . . The cursor jumps back to C2; VisiCalc acknowledges that the target range will start at C4. Next, press the **►** key nine times (or use the **REPT** key) 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: N=NO CHANGE, R=RELATIVE. The edit line reads C2: C4. . .C11: +B2, with a highlight over the coordinate B2. We want this coordinate 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:
```

5. Replicating a Column Across Rows

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 together 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 C2 followed by the blinking box. Press the **►** key seven times to move the cursor down to C11. The edit line reads C4. . .C11, followed by the blinking box. 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. 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. If you have gotten this far, 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 could not be replicated across because they were not the same 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. Set the direction indicator to a dash, —, and 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. (Read the admonitions in the section entitled "Protecting Yourself from Disaster." You wouldn't want to be forced to start this lesson over again, just because somebody pulled the Apple's plug out of the wall.) Make sure that your Disk II drive's IN USE 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; 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 THREE #1 ®. The Disk II drive should whirr for a few seconds, and, if all is well, the drive will quiet down and the prompt and edit lines will go blank.

6. Fixing Titles In Both Directions

We again have a situation analogous to one in Lesson Two: With numbers extending out for twelve months, 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 were described in Lesson Two.) For now, press B 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 matters. 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, set the direction indicator to ! and use the **►** and **REPT** keys to scroll the window downwards past row 20. Notice how rows 1, 2 and 3 remain in place. Now, type **> B 4 : Ⓢ** and press the **►** key a few times 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 the screen window shows columns A, M, N and O. We'll use columns N and O to obtain totals and percentages for our income and expenses.

7. The Built-in Function @SUM

Set the direction indicator to a ! and 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 **@ S (**, watching the prompt and edit lines as you do so. As soon as you type the **@** symbol, the prompt line says VALUE. After you press **S (**, the edit line reads **@SUM(** followed by the blinking box.

We'll postpone for a moment the question of how **@S(** became **@SUM(** until we complete the entry at N2. Our next step is to indicate what numbers we want to sum up. Press **Ⓢ** to set the direction indicator to a dash, —, and then press and hold down first **◄** and then **REPT**. When you begin "bumping into" the left hand border, release both keys. The cursor should be at B2, and the edit line should read **@SUM(B2**, followed by the blinking box. 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. 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 for a complete description of all the functions. 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.

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. As you type the letters of a function name, VisiCalc tries to guess which name you are going to spell out by the time you are finished; and if you ask it to, by

typing the (, VisiCalc will finish spelling out the name for you. That's how @S(became @SUM(. If you type something ambiguous such as @M(, which could be either @MIN or @MAX, VisiCalc will simply pick one alternative (in this case, @MIN). If VisiCalc doesn't give you the name of the function you want, you can always back up with ESC and type a more complete version of the name, such as @MA(.

So much for built-in functions. 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. Press / R @. The target range is N 4 . N 1 1 @. Now the prompt line, as usual, reads REPLICATE: N=NO CHANGE, R=RELATIVE. The edit line reads N2: N4. .N11: @SUM(B2, with a highlight over B2. Think for a moment about what will happen if we make B2. .M2 relative. Since we are replicating down a column, the positions of the newly replicated formulas will be N4, N5, N6, etc. Hence, B2. .M2 will become B4. .M4, B5. .M5, B6. .M6, etc., which is what we want. Press R twice. In an instant, the expense totals, from 7200 to 1800, appear in column N.

Next we would like to know what percentage of our income is accounted for by each expense total. Set the direction indicator to !, and type the following:

>O1:PERCENT▶▶▶

What formula will give us MORTGAGE as a percentage of INCOME? Type the following: + 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%.

8. Formatting a Single Entry

The number .3130435 is unnecessarily messy. This is the general format for numbers, which VisiCalc uses in all cases unless we ask for something else. For our purposes, two decimal places should be enough. This reminds us of the global format command /GF, which we used in Lesson Two to display 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 unnecessarily messy. Change the global format back to "general" by typing / G F G. Now we're back where we started. 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. See the reference card or Lesson Four for examples.

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.

9. Replicating a Format Specification

Type > O 4 : to move back 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, or 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. Set the direction indicator to ! and 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.

10. Using Replicate To Copy a Row or Column

Type **> A 1 2 :** to scroll the window leftwards. Our next task is to draw a line under our list of expenses; then we'll 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 blinking box. Now press **ESC**. The A12 disappears, leaving only the blinking box 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 positions A12 through A12; the entry at B3 into positions B12 through 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 a figure to our budget for LEISURE. The money we have available for leisure will simply be our income minus the sum of our expenses. Set the direction indicator to **—**, and type the following:

>A13:LEISURE◆ + B2-@S(B4.B11)®

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 sort of trick we used earlier to copy the line of hyphens. Press the following keys, and watch what happens on the prompt and edit lines (here, again, we'll use **:** in place of **®**):

/R ESC N11.O11:N13:RRRN

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

11. 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**. The left window should display columns A and M, while the right window displays columns A and O. The cursor is in the left window. 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 first ◀ and then REPT 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.

A	C	N	O
		TOTAL	PERCENT
PERIOD	1		
INCOME	1800	23000	
MORTGAGE	600	7200	0.31
UTILITIES	140	1030	0.04
TELEPHONE	70	900	0.04
FOOD	350	4200	0.18
CLOTHING	120	1440	0.06
CAR EXPEN	80	960	0.04
CAR INSUR	160	320	0.01
SAVINGS	150	1800	0.08
LEISURE	125	5150	0.22

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 \$4190, or 21%.

12. The @NA and @ERROR Functions

Type @ to set the direction indicator to !, and 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 II drive. Type / S S and, in response to the prompt FILE FOR SAVING, press the ◀ key. The Disk II drive should whirr, and a filename should appear on the edit line. Continue pressing the ▶ key, if necessary, until you have the name LESSON THREE #1 on the edit line. Then type ESC 2 ®, and watch the edit line. You are saving the sheet under the revised name LESSON THREE #2. 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 four narrowed columns N, O, P and Q 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.

13. 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 should 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 magically 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 make sure that the direction indicator is a dash, —, and 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 as 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 THREE #2, 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:IRMONTH◆/FR/R:C2.M2: (This replicates the format /FR)
JAN◆FEB◆MAR◆APR◆MAY◆JUN◆JUL◆AUG◆SEP◆
OCT◆NOV◆DEC ®
```

14. Calculating Interest On a Savings Account

Type **> A 1 5 :** to scroll the window leftwards, and set the direction indicator to **—**. 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 **SAV ACCT** at A15, then press **◆** and type **. 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).

Lesson Three Calculating Interest On a Savings Account

Press \odot to set the direction indicator to $!$, then press \blacktriangleright 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:

$/F\$ + A17 + \blacktriangleleft + B12 \textcircled{\text{R}}$

(If you like, you can use cursor movements with the space bar 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:

$\blacktriangleleft/R\blacktriangleright:C16.M16:NRRRR$

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. Now press \odot and hold down \blacktriangleright and REPT 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:

$\blacktriangleright N17:F\$ + M17 + N14 \textcircled{\text{R}}$

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

15. The Move Command

Type $\blacktriangleright A 1 1 :$ to scroll the window leftwards, and make sure that the direction indicator is set to $!$. 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 blinking box. Now press \blacktriangleright . The cursor moves down to highlight SAVINGS, and the edit line reads A11. . .A12. Press the \blacktriangleright 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 $\textcircled{\text{R}}$, 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 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) ©**. 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!

16. 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**, ▶ as necessary to bring the filename LESSON THREE #2 onto the edit line, and **ESC 3 ©**. (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

Lesson Three Obtaining Monthly Expense Percentages

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 THREE #3 appears, and then pressing Ⓞ. Now, set the direction indicator to a dash, —, and type exactly the following:

```
>A20:/R ESC A5.A11:A20:
►/F$ + B5/B3 Ⓞ
/R:B21.B26:RN
/R.B26:►.M20:RRRRRRRRRRRRRRR    (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.

17. 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. Set the direction indicator to !, and use the ◀ key to 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 13 (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. Press Ⓞ to set the direction indicator to —.

Now press ► five times to examine some of the expense percentages. As expected, the bottom window begins scrolling rightward, bringing columns A, D, E and F into view. 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, and this window currently shows only columns A, B, C and D. 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 2-13 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 PERSONAL BUDGET @**.

18. 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; 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 miscellaneous 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; and issues related to VisiCalc’s order of recalculation of formulas. 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.

19. 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 many models of line printers. If you have a printer or terminal connected to your Apple, you can try it out by printing a copy of the personal budget we've just created. (If you don't have a printer, you can skip the discussion of the print command and go on to Lesson Four.)

Let's return to a single, "untitled" screen window with `/ W 1 / T N > A 1 :` If you've used your line printer with BASIC or PASCAL, you'll know how to connect it properly to your Apple, and you'll be familiar with any issues of communications line speeds, special control characters, and line spacing on your printer. If you're using a printer for the first time, it's a good idea to ask the dealer who sold you the printer to show you how to set it up and try it out to make sure that it works properly. Because there are many different models of line printers, we can offer only a general checklist here. See that your printer is connected by its cable to an appropriate controller card, and that the card is plugged into one of the slots numbered 1 to 7 on the main circuit board of the Apple. (Slots 2 and 3 are the ones most commonly used for printers.) Your printer's power cord should be plugged in, and its power switch should be turned on. Some printers also have a switch which must be turned to the setting marked LINE or COMM or ONLINE or SELECT. Make sure that paper is feeding properly into your printer, and that there are no mechanical parts which might be jammed.

Now type `/ P`. VisiCalc's prompt line reads `PRINT: SLOT # OR D`. You should type the number, from 1 to 7, of the slot into which you have plugged the controller card for your printer, followed by `@`. (If you simply press `@` without typing a slot number, VisiCalc will search the slots for one of several models of controller cards, but this procedure is not guaranteed to work for all possible printers and controllers. So, for this first trial, it's a good idea to type the slot number. The alternative keystroke `D` will be explained later.)

After you press `@`, the prompt line reads `PRINT: LOWER RIGHT, "SETUP, -, OR +`. We'll explain the various options possible at this point in a moment. For now, just press `C 5 @` and see what happens. With any luck at all, something should print on your line printer. Don't worry if you see the VisiCalc screen display being obliterated by a series of white bars speckled with miscellaneous characters. This is caused by the action of certain models of controller cards; when the printing process is complete, VisiCalc will restore the screen display. You can interrupt the printing process at any time by holding down the `CTRL` key and pressing `C` (i.e. by typing `CTRL-C`). If nothing at all happens, check that your printer, cable, and controller card are attached properly, and that all switch settings are correct. If you cannot solve the problem, ask your Apple dealer for assistance.

If your line printer faithfully reproduced what you see on the VisiCalc screen display, in the rectangle from A1 to C5 (i.e. columns A, B and C of rows 1 to 5), you can skim the following section dealing with control

characters and continue with the summary discussion of the print command. If your printer is double or triple spacing between lines of print, you will need to read this section.

Besides telling the printer what characters to print at each position on the paper, the computer must tell the printer when to perform certain actions such as advancing to the next line. It does this by sending *control characters* to the printer, which do not cause anything to be printed but have some other effect. The control characters used for line spacing are called CARRIAGE RETURN and LINE FEED. CARRIAGE RETURN literally means "move the print mechanism back to the beginning of the current line," while LINE FEED means "advance the paper to the next line." VisiCalc normally sends first a CARRIAGE RETURN character and then a LINE FEED character to cause the printer to advance to the beginning of the next line. However, certain types of printers are physically incapable of moving the print mechanism back to the beginning of the line without advancing to the next line at the same time, so they in effect supply their own LINE FEED character. In addition, certain controller cards attempt to get into the act by supplying an additional LINE FEED character whenever they see that a CARRIAGE RETURN character is being sent to the printer, whereas other controller cards do not do this. If your printer is triple spacing (which is commonly the case with a Centronics printer and Apple's parallel printer interface card), this is happening because VisiCalc, the controller card, and the printer are each supplying a LINE FEED. To make the printer space lines normally, two of these three LINE FEEDS must be eliminated. In the prompt message PRINT: LOWER RIGHT, "SETUP, -, OR +, the hyphen is used to eliminate VisiCalc's LINE FEED, and the "SETUP or *setup string* is used to eliminate the controller card's LINE FEED.

Let's try the print command again, using the following steps:

1. Press / P. The prompt line reads PRINT: SLOT # OR D.
2. Type your controller card's slot number, followed by @. The prompt line reads PRINT: LOWER RIGHT, "SETUP, -, OR +.
3. Press -. The hyphen will not be displayed on the edit line, and the prompt line will remain the same.
4. If your printer was double spacing on your first try, skip to step 5. If you have a Centronics printer which was triple spacing, do the following:
 - i) Type " (be sure to use the **SHIFT** key).
 - ii) Hold down the **CTRL** key, press **I**, then release the **CTRL** key.
 - iii) Press **K** @. Again, the prompt line will appear unchanged.
5. Type **C 5** @. Your printer should print the characters you see in columns A, B and C of rows 1-5 on the screen, with single spacing between lines.

If your printer does not respond to the foregoing incantation, or if it behaves strangely in other ways, you may need a different setup string.

Read the section on setup strings on pages 17-18 of your Apple Parallel Printer Interface Card Installation and Operation Manual. If you have a serial interface card, you may have to change some of the switch settings on the card itself; consult your Serial Interface Card manual for details. If necessary, ask your Apple dealer for assistance.

The print command has two further options to help you deal with unusual models of line printers. Some printers must receive a CARRIAGE RETURN character before printing anything or before accepting the setup string. When the prompt line says PRINT: LOWER RIGHT, "SETUP, -, OR +, you can press the + key to immediately send a CARRIAGE RETURN character to your printer. Finally, there are some types of printers which cannot be handled with any combination of the options of the print command. Or, you may want to do something special with the printed output, such as print multiple copies, edit or reformat the printed listing, or transmit it over a communications line. Hence, VisiCalc allows you to direct the printed output to a "text file" on diskette. This file can be read by another program, written, say, in BASIC, and manipulated in any way desired. To use this option, type / P and, in response to the prompt PRINT: SLOT # OR D, press D. The prompt line will then read PRINT: FILE NAME. Simply type a valid diskette filename and press Ⓜ to send output to the diskette.

As you have probably guessed from our efforts so far, VisiCalc will print a rectangle of any size of entries anywhere on the electronic sheet. The position of the cursor at the time you type the /P command is taken as the upper left hand corner of this rectangle, and, after typing the -, + or setup string as required, you can either type the coordinate which VisiCalc will take as the lower right hand corner of the rectangle, or you can simply move the cursor to that position and VisiCalc will fill in its coordinate. When you press (the final) Ⓜ, the printing process will begin. VisiCalc will print exactly what you see through the screen window (ignoring the window dimensions or any fixed title settings). You can change the formats of numbers and labels or the widths of columns as you see them on the screen, and VisiCalc will print them the same way.

Now, let's print out our entire budget. Before you try to do this, pause for a moment and think about the limitations of your printer. Our budget extends across the sheet for fifteen columns; if each column is nine characters wide, the entire budget display will be 15 x 9 or 135 characters long. Can your printer print a line of this many characters? If not, you must either narrow the columns with the /GC command, or else print the budget in two vertical segments, and "paste up" these segments side by side. For example, you might start with the cursor at A1 and print the figures through June by making the lower right hand coordinate G26. Then you would start with the cursor at H1 and print the remaining figures through O26. The second printing would cover eight columns, each nine characters wide, for a total of 72 characters per line. Or, to avoid having to paste up a wide sheet, you may wish to include the descriptive titles from column A at the left border of the second printing. Since VisiCalc prints exactly what appears on the sheet, not what you see on the screen window, you must arrange the appearance of the left hand border yourself. To print the budget

in two separate pages on a 72 column printer, you might do the following:

- i) Starting at A1, type /P, provide for any control characters, and move the cursor to H26, then press @.
- ii) With the cursor again at A1, press /M, then move the cursor to column I and press @.
- iii) Then, with the cursor at column H (the new position of the titles INCOME, LEISURE, etc.), type /P, provide any control characters, and move the cursor to O26 to print the second half of the budget.

Now print out the entire budget in the form required by your printer. Be sure to type the -, + and/or setup string, if required, for each use of the /P command. If necessary, you can interrupt printing at any time by typing CTRL-C.

LESSON FOUR

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.

1. 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 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: Type / F \$ to set dollars and cents format at position B1. Then type / G C 6 Ⓢ. 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.

2. Scientific Notation

Type / C Y to clear the sheet. At position A1, type 99999999 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 .00000001 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 -.00000001. Next, type / G C 7 Ⓢ and ◀ ◀ ◀ to scroll the window back to display A1. 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).

3. 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, unlike many other programs, such as BASIC, which maintain numbers in binary form. In any number base, certain fractions (such as 1/6) cannot be expressed exactly with any fixed number of significant digits. In binary form, for example, the fraction 1/10 (a dime, to financial people) cannot be expressed exactly. VisiCalc uses decimal based arithmetic so that it can maintain accuracy in calculations involving dollars and cents. To accomodate 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 ESC a few times to "back out of" the VALUE entry you have started on the edit line.

4. 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, however, 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 set the direction indicator to !, 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, but different from languages such as BASIC and FORTRAN: VisiCalc 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 \blacktriangleright to move to A2 and then type $9 + (6 / 3) @$. The answer highlighted by the cursor is 11. Parentheses may be nested to any depth: Type $\blacktriangleright - (\blacktriangleleft \blacktriangleleft + ((A 2 - 1) / A 1)) @$. 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.

The exponentiation operator ^ lets you calculate "powers." For example, type $\blacktriangleright 2 ^ 3 @$ to calculate "2 to the 3rd power," or 8. Try another example: Type $\blacktriangleright 2 ^ . 5 @$ 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 $\blacktriangleright 5 ^ (1 / 3) @$. VisiCalc will calculate and display the value 1.709976.

5. 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 $+B2-@S(B4.B11)$, 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 parenthe-

ses; 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. Use the \blacktriangleright key to move to position A7, and type:

@S(A1.A4, \blacktriangleleft \blacktriangleleft *A5, \blacktriangleleft *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:

\blacktriangleright @ M (A 1 . A 7) @

\blacktriangleright @ 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 and set the direction indicator to ! with / C Y \odot and type the following:

1 \blacktriangleright \blacktriangleright 3 \blacktriangleright 4 \blacktriangleright \blacktriangleright 6 \blacktriangleright \blacktriangleright 8 \blacktriangleright / - - \blacktriangleright

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..entryn) and let $DR = 1 + dr$, the result of the function is $(entry1/DR) + (entry2/(DR^2)) + (entry3/(DR^3)) + \dots + (entryn/(DR^n))$. To illustrate the use of this function, type / C Y / G C 6 Ⓢ to clear the sheet and display six columns, A through F. 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.

6. 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 / G C 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. 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 : ◆ . B 1 7 : 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 / F D / R : ◆ . B 1 7 : 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 then type / R : ◆ . C 1 7 : 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.) 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 @ E X P (A 1) @ / R : B 2 . B 1 7 : 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

Lesson Four Transcendental Functions and Graphing

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. 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.

7. 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, the letter C at the upper right corner of the screen 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.

8. 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 ➤ - A 2 ®
> A 2 : 1 + A 1 ➤ 2 * B 1 ®
> C 5 : + A 1 ➤ 1 + C 5 ®
> C 6 : - D 5 ➤ 2 * C 6 ®
> A 1 :
```

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.

9. 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 **> B 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 \blacktriangleright / I C - \blacktriangleright \textcircled{R} . At the moment, A1 is 3, the new B1 is 4, C1 is -4, and D1 is 4. Now press \blacktriangleleft 1 \textcircled{R} . 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 + \blacktriangleright \textcircled{R} . The entry contents line reads A1 (V) 1+B1, and the value under the cursor is 1, as expected. Now type \blacktriangleright 1 + \blacktriangleleft \textcircled{R} 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.)

Once you are aware of the issues involved in recalculation, it is not difficult to avoid conflicts in the order of recalculation or forward and circular references. Generally these problems arise when you are working too quickly without a plan, or "patching" an existing layout on the electronic sheet. If your approach to the problem is orderly and well thought out, it is unlikely that you will encounter any problems with recalculation.

10. 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 replica-

tion capabilities to solve complex problems quickly and easily.

Lesson Four concludes our tutorial introduction to VisiCalc. There are still more fine points to VisiCalc not discussed here, as well as countless techniques and application ideas that may be useful in your work. Look for discussions of some of these techniques and ideas in the VisiCalc Users' Newsletter. 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's Comment Form 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.

11. Postscript: Reference Card Cross-Index

As you use VisiCalc after reading through this manual, your primary information source will be the VisiCalc reference card located in the pocket on the inside back cover of the binder holding this manual. At times, if something is unclear to you and the brief notes on the reference card are not enough to answer your questions, you may wish to refer back to the discussions of certain VisiCalc features in this text. What follows is a cross-index between the numbered panels and subtitles on the reference card, and the sections of this manual. You can use it to quickly locate explanations and examples of various VisiCalc features.

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- 1.1 Moving the Cursor
- 1.2 Scrolling the Window
- 1.3 The REPT Key
- 1.4 Direct Cursor Movement

2. THE ESC KEY

- 1.5 Backing Up and Out With the ESC Key

2. SETTING A LABEL ENTRY

SETTING A VALUE ENTRY

- 1.6 Writing on the Electronic Sheet
- 1.7 Formulas and Recalculation
- 1.8 More on Labels and Values
- 4.2 Scientific Notation
- 4.4 More on Formulas

3. VALUE REFERENCES

- 1.9 Cursor Moves in Formulas
- 4.3 More on Value References
- 4.8 The Order of Recalculation
- 4.9 Forward and Circular References

3. FUNCTIONS

4. EXAMPLES OF FUNCTIONS

- 3.7 The Built-in Function @SUM
- 3.12 The @NA and @ERROR Functions
- 4.5 More on Built-in Functions
- 4.6 Transcendental Functions and Graphing

4. ENTRY RANGES

5. LISTS

- 2.2 Replicating a Formula
- 2.3 Replicating a Range of Formulas
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4.5 More on Built-in Functions

5. COMMANDS

/B

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/C

1.6 Writing on the Electronic Sheet

/D

3.13 The Insert and Delete Commands

/F

/FD

3.8 Formatting a Single Entry

4.1 More on Numbers and Formats

/F*

4.6 Transcendental Functions and Graphing

/GC

/GF

2.7 Adjusting Column Widths

2.4 Formatting the Screen Display

2.9 Global Commands in Separate Windows

4.1 More on Numbers and Formats

/GO

4.8 The Order of Recalculation

/GR

4.7 Manual and Automatic Recalculation

6. /I

3.13 The Insert and Delete Commands

/M

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/P

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/R See "Replicate"

/S See "Storage"

/T

2.5 Fixing Titles in Place

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3.11 Changing Windows and Titles

/V

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/W

2.8 Splitting the Screen

3.11 Changing Windows and Titles

3.17 Synchronized Scrolling

/-

3.2 Replicating Numbers and Labels

6. PRINTING

3.19 Postscript: The Print Command

7. REPLICATE

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2.3 Replicating a Range of Formulas

3.2 Replicating Numbers and Labels

3.4 Replicating Down a Column

3.5 Replicating a Column Across Rows

3.9 Replicating a Format Specification

3.10 Using Replicate to Copy a Row or Column

3.16 Obtaining Monthly Expense Percentages

8. STORAGE COMMANDS

/SS

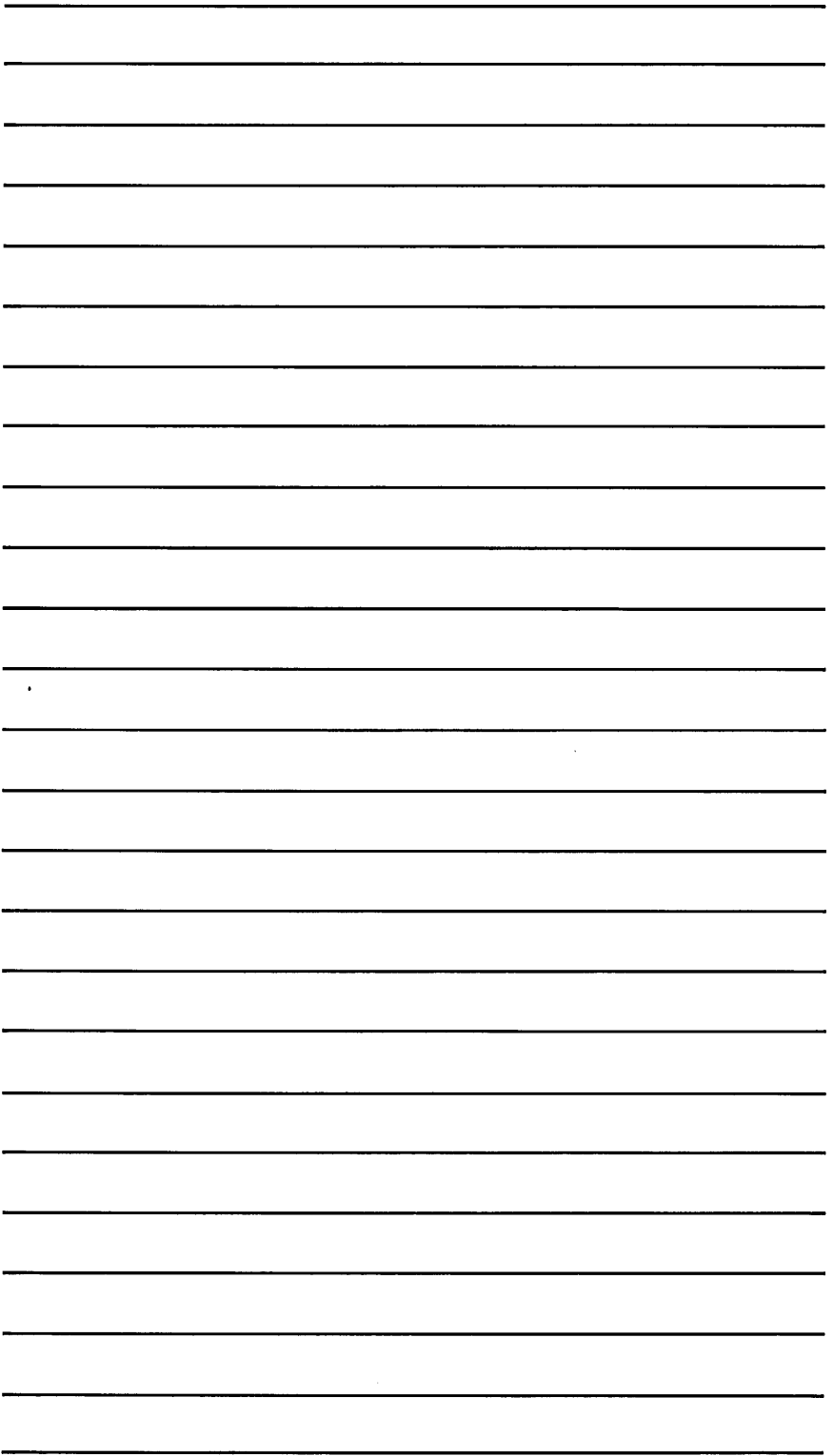
1.10 Saving the Electronic Sheet on Diskette

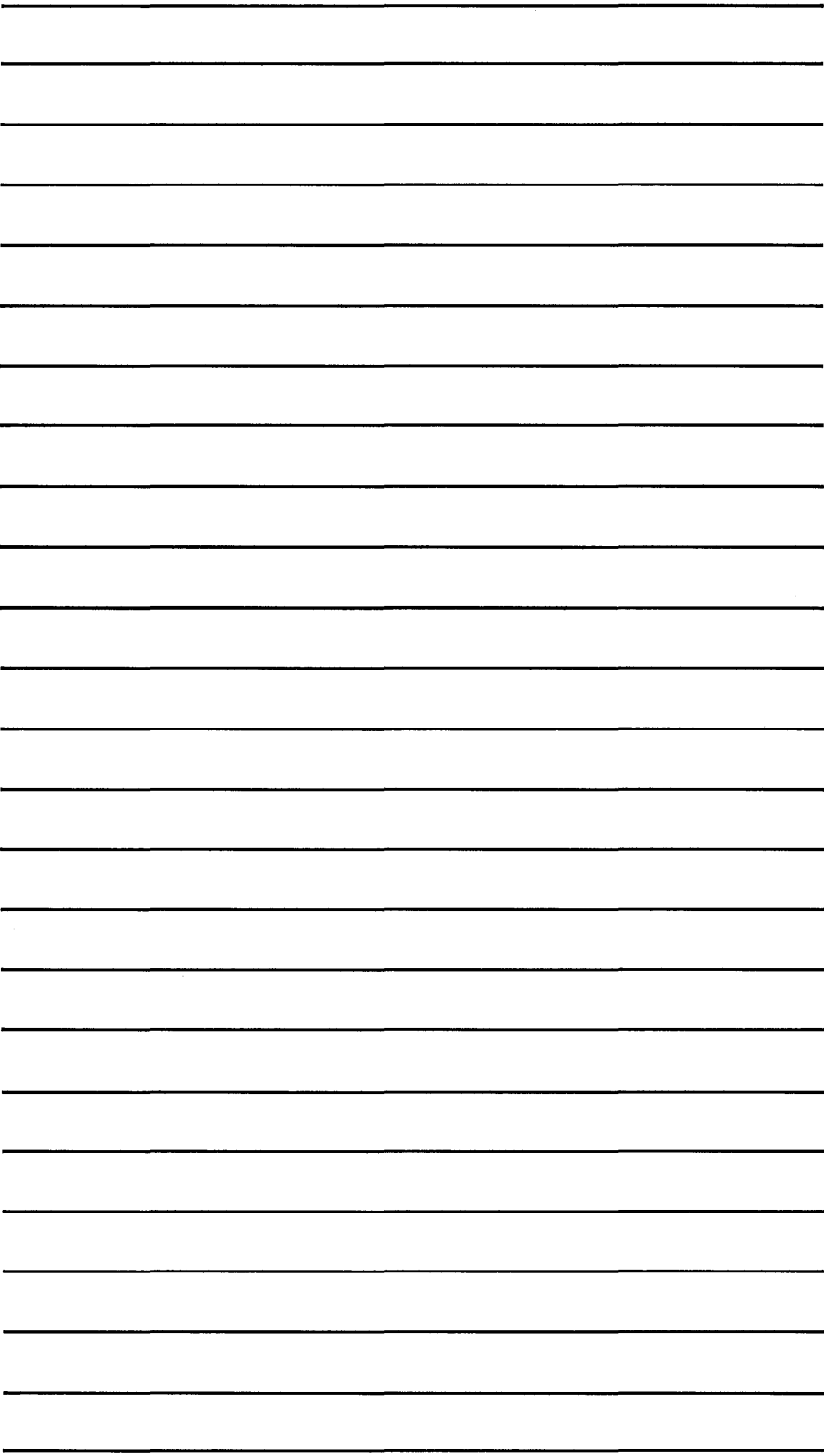
/SL

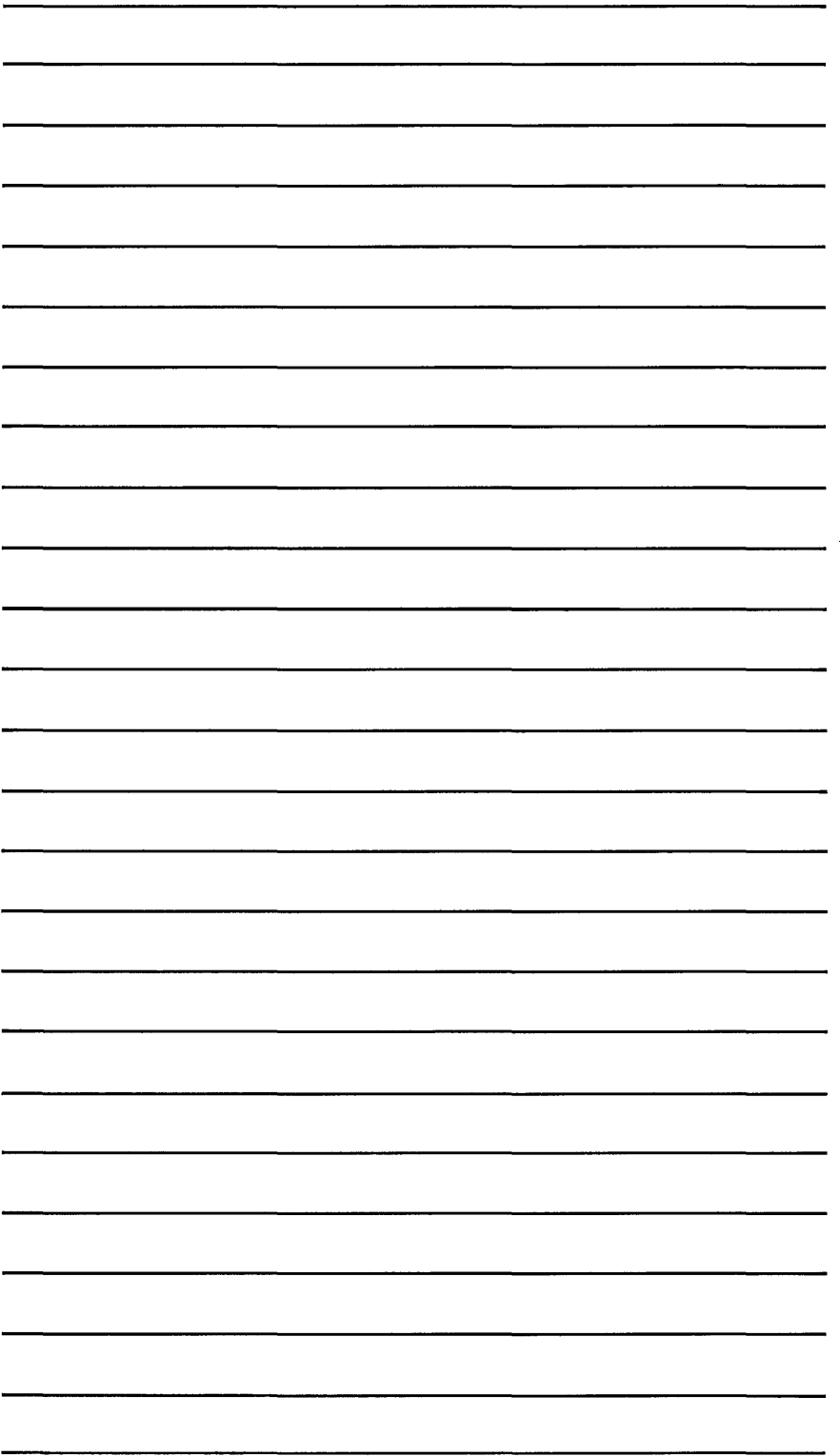
2.1 Loading the Sheet From Diskette

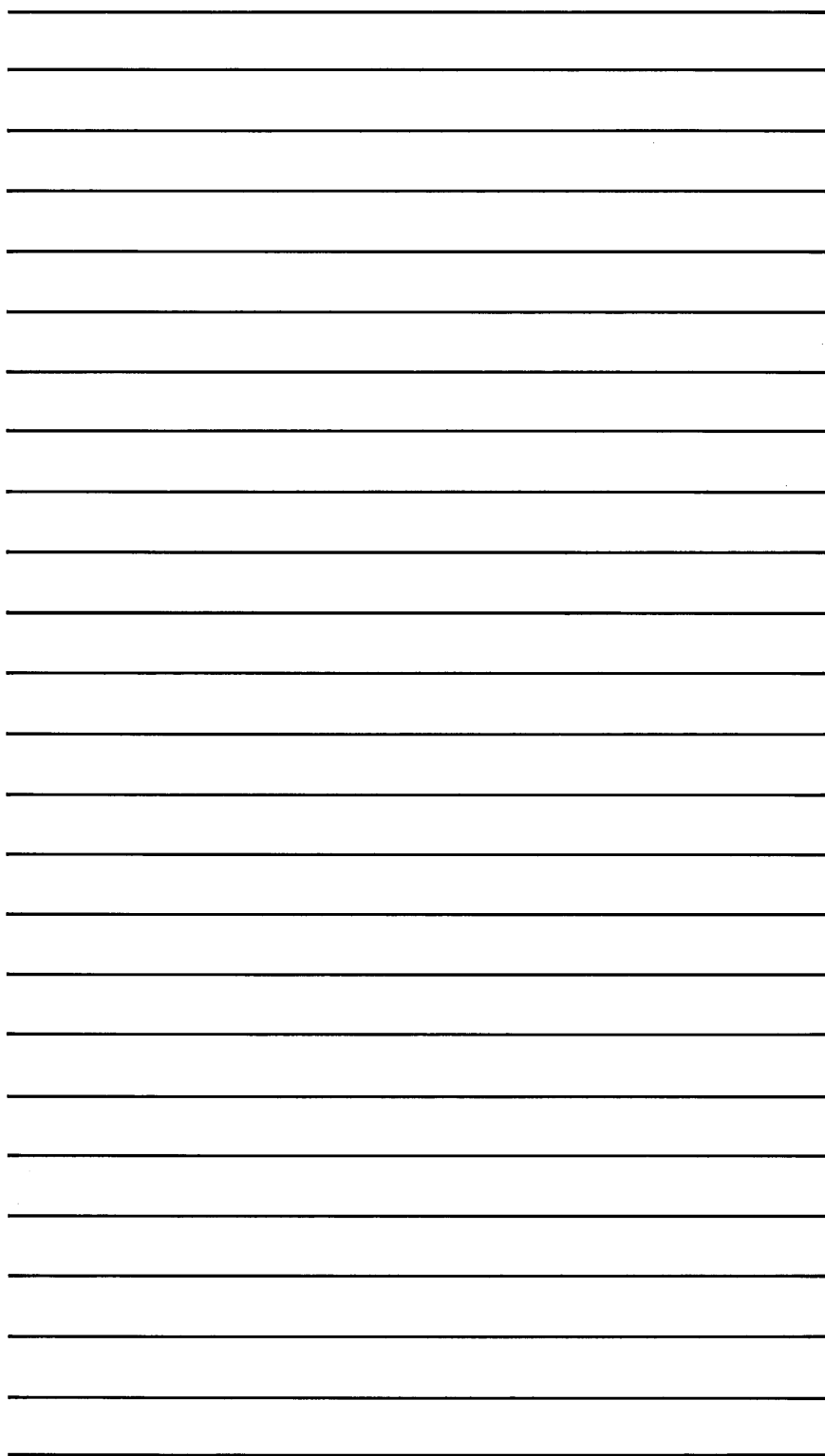
/SI

0.7 Initializing VisiCalc Storage Diskettes









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