

Lucid

EXCEPTIONAL SPREADSHEET
On Snap-in™ ROM for the TRS-80 Model 100

Portable Computer Support Group



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CHAPTER I

INTRODUCTION

LUCID on Snap-In ROM

PCSG was the first to develop software for the Model 100. That was back in April of '83. We could have rushed out onto the market with an inferior spreadsheet, but we chose to undergo a significant development and produce a spreadsheet for the Model 100 that would truly be world class. A spreadsheet that would rival Lotus 1-2-3*.

LUCID is here now. It is on a ROM cartridge that snaps into the compartment on the back of your Model 100. It takes no memory to load and no memory for operating overhead. That means you have the full 29.6K bytes free to store your data.

LUCID is amazing in so many ways. First of all, it is memory conserving. It will let you build a large spreadsheet—254 row by 126 column capacity. Where other spreadsheets actually consume 4 to 5 bytes for an unused cell, LUCID uses no memory for empty cells. This lets you build huge spreadsheets in your Model 100's RAM that could consume 80 to 100k on a desktop computer.

Secondly, LUCID is fast. Whenever you ask other spreadsheets to calculate a file of any size, you can get up and go get a cup of coffee before they are through. LUCID is so rapid, a 36 column corporate financial statement took less than 4 seconds to calculate.

Thirdly, LUCID has features you won't find in most other spreadsheets. For example, when you type a label (text) it will cross column boundaries, in other words when you type a label or title it will appear as you type it irrespective of column width. LUCID also allows you to set column widths individually, and of course LUCID has insert row and insert columns, as well as other standard features. LUCID even lets your formulas refer to cells in other spreadsheet files. Further, LUCID has what no other spreadsheet has: Cut, Copy, and Paste. It uses the same keys as Cut and Paste in TEXT, but here's the difference: LUCID takes all the formulas with it when you paste and they all automatically recalculate with the entire sheet.

And here is what is really amazing. You can copy or cut from one spreadsheet and paste into another spreadsheet or even a TEXT file.

LUCID has so many features that you will say "this is what I need in a

*Trademark Lotus Corp.



spreadsheet", such as automatic prompting of an incorrectly typed-in formula showing just where the mistake was made.

LUCID has expanded "go to" functions that remember and produce a windowing capability. It has a special block definition capacity that makes many other features possible that refer to whatever section of the spreadsheet you designate. LUCID has many enhancements that make it easy to use. Once anyone begins to use it they say "this is the way a spreadsheet ought to work".

But perhaps most remarkable is that LUCID is not only a spreadsheet but a program generator as well. First, LUCID lets you protect all cells against entry or change, and then unprotect just the cells you want for someone else to use as input fields.

Combined with the spill-over length feature, you can design input questions such as "What is your name?, What is your age?, Choose which applies to you: a) Tall b) Medium c) Short, Type in the state where you were born". You can provide complete on screen instructions for use. This lets you create a series of prompts so that you can have a person totally unfamiliar with computers, entering information that you want to process, to create a personalized report based on calculations made using the facts and numbers they put in.

You see, LUCID will not only process values, but text input as well so that the facts other than numbers can be responded to. LUCID has the ability for you to refer in a formula to cells containing words. This feature combines with the capacity of doing "if then" statements that work by doing table look-ups against even massive X/Y charts of text or numerical information. A simple example based on the inputs illustrated above would be to report the recommended calcium intake for tall people based on their age. You can make even more specific inquires and reports, such as recommended amount of aerobic exercise based on age and weight. Answers can be values or words depending on the situation, eg. 150 lbs., 25 years might be "30 minutes" but 280 lbs., 50 yrs. might be "Warning: Aerobic exercise could be dangerous". You can produce a program that responds to inputs with no programming knowledge whatsoever.

You can prepare a report section in your spreadsheet with instructions to your user for printout, and they can produce a personalized printout that responds to their input. All your formulas and tables that did the calculations and provided the facts are invisible to that user. LUCID is useful for doctors for patient questionnaires, trouble-shooting techni-

cians, purchase clerks, people doing job quotes, stores for customer workups, insurance agents and anybody who needs to process specific facts and numbers to produce a report based on those responses.

This LUCID manual explains not only the characteristics of LUCID, but will train you how to use a spreadsheet even if you have never seen one before. You are shown how to do budgets, forecasts, breakeven analysis, amortization charts and many other types of personal and business reports and calculations.

User friendly is such an overused term in this industry, but we can tell you that everyone who uses LUCID, who has experienced any other spreadsheet, says that LUCID is amazingly easy to use. A typical comment has been "I have never seen a spreadsheet that does so much, and yet LUCID is so much easier and faster to use."

LUCID is a result of a most exhaustive developmental effort in which PCSG's objective was to develop a spreadsheet that was better than the state-of-the-art. We are so pleased because LUCID provides for the Model 100 spreadsheet capability you cannot equal on a desktop computer. Plans are underway to offer LUCID someday for larger computers, but for now TRS 80 Model 100 owners have the good fortune of having this powerful exciting ROM program exclusively.

LUCID is the easiest to use, fastest and yet most feature-rich spreadsheet, with capability that takes it far beyond the definition of a mere spreadsheet. We are so excited about LUCID, because it changes the Model 100 into a totally different computer with power and function most never dreamed possible.

LUCID is, in our opinion and that of those who have examined it, a breakthrough. We sell it on a 30 day trial. If you are not completely satisfied, return it within 30 days for a full refund.

CHAPTER II

INSTALLATION

A. Make sure that you have a backup copy of all the important files in your machine. Normally you will not lose any data when installing your LUCID ROM, but it is best to be safe. Turn your Model 100 off (the switch on the side, NOT the memory power on the bottom). Turn it over on a flat surface, and pry off the cover in the center at the bottom. You can use a screwdriver or pocket knife, or a dime will do.

B. There are two sockets under the cover. One is a long, flat one with two parallel sets of holes. This is the system bus. The other is nearer the edge of the computer. It is raised black socket with a row of silver contacts down the inside of each edge. This is the option ROM socket. Note that at one end of the socket there are two notches, and at the other end there is only one in the center. It is important the LUCID ROM is installed in the correct orientation.

C. Take the LUCID ROM and inspect it. You will notice that at one end there is a tiny little finger that projects, and that at the other end the circuit board overlaps slightly, and has PCSG etched on it. You install the ROM with the label facing toward you with the label reading in the same direction as the Model 100 serial label, and little finger fitting into the single notch side of the socket. (This "finger and notch" will prevent you from installing it in the wrong direction.) Press the LUCID ROM into the socket firmly with both thumbs. Don't replace the cover yet, turn the computer so you can see the screen.

D. Switch the computer on. If you don't see the main menu switch the Model 100 off again, remove the LUCID ROM and reinstall it carefully following the instructions above.

E. STARTING LUCID: When you see the main menu, place the wide bar cursor on BASIC and press ENTER. When you see the OK prompt type in the following

CALL 63012

F8 T200
CALL 27801,,0

And press ENTER. After a moment you should see the Copyright notice of LUCID. If you don't, switch off the computer, remove the LUCID ROM, and reinstall it carefully following the instructions above.

F. When you see the Copyright notice of LUCID, press F8 to return to the main menu, where you will see LUCID appear just like the built in programs.

NOTE: This CALL 63012 is only necessary once, just to tell your computer that there is a ROM present.

G. That's all there is to it. You can replace the cover on the little opening on the back of the Model 100.

SOME MORE HINTS

1. Make sure your Model 100 is turned off before installing the LUCID ROM. Turn off the power switch on the side, NOT the main memory power switch on the bottom.
2. Remove the door on the bottom of the Model 100 with a key or dime.
3. The LUCID ROM comes to you in its correct form. Do not attempt to remove the clear spacer on the bottom of the LUCID ROM, as it is important. The ribbon is used to remove the ROM from the socket.
4. The LUCID ROM will only go in one way. The first time you install a LUCID ROM, you will have to press hard. Press on the two ends of the LUCID ROM with both thumbs.

Do not press on the center of the LUCID ROM, as there is a little window that could be broken if you press there.

5. Fold the two ends of the ribbon down if necessary when you replace the door.

OTHER ROMs

If you use other ROMs from PCSG (like DISK+), the LUCID name on the menu will not change when you change ROMs until you select the ROM program by pressing ENTER on the LUCID name. Although the old ROM's name, in this case LUCID, was on the menu, you will find yourself running the new ROM you just installed, and when you exit back to the main menu, the name will have changed to the correct one automatically.

LUCID ROM REMOVAL

The LUCID ROM removes easily using the ribbon, which is provided so that you can grasp it on each end and pull it out steadily and evenly. If you wish to remove the LUCID ROM and not replace it with another PCSG, you will have to remove the name from the main menu before taking out the LUCID ROM. Go into BASIC, and type the following:

CALL 63012,0,1

FOR T200
CALL 27801,256

This will remove the LUCID name from the menu, and you can now simply take out the LUCID ROM.

CHAPTER III

GETTING STARTED

LUCID is a spreadsheet. It has many characteristics that make it different than any other spreadsheets, but it can be described in simplest terms as a spreadsheet. Most people know what a spreadsheet is but a quick review of definition will set the stage for this manual for even old spreadsheet pros.

When you put the cursor on LUCID and press ENTER the screen gives the copyright notice and says

Lucid file?

Each spreadsheet is given a filename of up to six characters that will appear on the main menu. Type in a name, for example, TEST and press ENTER. Immediately you will see a display that looks like this

	A	B	C	D			
001							
002							
003							
004							
005							
006							
Edit	Calc	File	Ins	Del	Util	Sel	Exit
1	2	3	4	5	6	7	8

For now press the F8 function key (Exit) to go to the main menu. Notice that the file name TEST.CA appears there. The .CA extension is unique to LUCID and contains the data for the spreadsheet you are creating. ".CA" stands for Calcsheet. After you have created a spreadsheet filename you can access that spreadsheet anytime from the main menu just by placing the cursor over the ".CA" file name and pressing ENTER. You can also put the cursor on LUCID and press ENTER, and type the filename you want to access, but it is easier just to open it right from the main menu with the widebar cursor and the ENTER key. You would only put the cursor over LUCID when starting a new sheet.

In either event, immediately you are into the LUCID program and you see the spreadsheet display as shown earlier. Accessing the spreadsheet directly from the main menu is a very nice LUCID feature. The user has no access to raw stored data that could be altered or damaged accidentally. LUCID data is only accessible by means of LUCID and ".CA" files cannot be viewed from TEXT, or loaded or saved from BASIC.

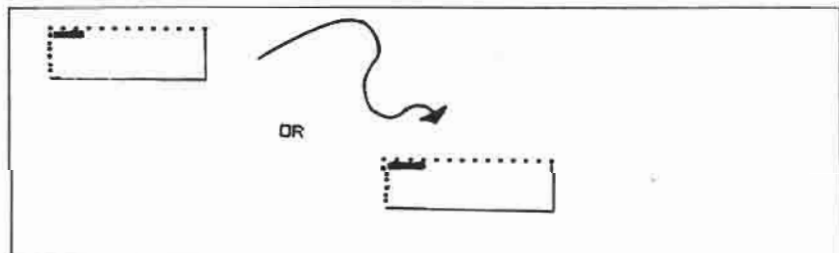
After you have placed the cursor on TEST.CA and pressed ENTER and you have the spreadsheet display on your screen, study its characteristics.

A spreadsheet is a group of cells that are arranged in a rectangle. Across the top are letters which identify the columns of cells from left to right. On the left hand side the numbers designate the cell rows. This is an old method of assigning designation, or coordinates, to a position on the sheet, and has been used on maps and graphs for centuries.

The cell in the upper left hand corner is called cell A1, because it is in Column A, Row 1 (or 001). Use your arrow key and move the wide bar cursor about the screen. Notice that the cursor entirely fills a cell. You can move the cursor from cell to cell with all four arrow keys. When you are in Column A, the left arrow key gives you a beep and the cursor will not move further, and likewise in row 1 the up arrow key gives the same result. But try to move off the screen on the spreadsheet and you will see that when you move right the letters for the columns keep on going, and when you move down the numbers for the rows continue.

As you experiment you will see that the screen you are looking at is merely a window on a very large spreadsheet. In fact the LUCID spreadsheet is 126 columns by 254 rows. The sheet you are looking at is 10 feet long and 4½ feet tall. Later we will talk about expanding column widths, and at maximum column width the spreadsheet would be 30 feet by 4½ feet.

The best way to visualize the spreadsheet is think of it like a giant sheet of paper that we will type on. The screen shows a small window on that sheet.



Now if we were to move across a literal sheet of grid paper that size with letters across the top and numbers on the side with a window the size of the Model 100 screen, it would be confusing if all we could see would be what was shown in the window. We couldn't tell where we were because the letters and numbers at the very top and far left side could not be seen. So, for an electronic sheet the numbers and letters are displayed always, to show where your window is looking on the larger sheet.

As we mentioned, the columns are designated by letters and since there are only 26 letters in the alphabet, we identify the 126 columns by using AA, AB, AC, etc. after the first 26. Column #126 is designated DV.

Because the screen is so small and spreadsheets can be very large, we need some aids to keep it from being confusing. We made it much easier to follow by providing LUCID with some excellent ways of making cursor movement easy and rapid.

CURSOR MOVEMENT

We have already described the use of the four arrow keys moving you from cell to cell. In the same fashion as the up and left keys beep at the top and left margins, the down and right arrow keys will beep at the bottom (row 254) and right (column DV) boundaries.

Moving through the sheet cell by cell makes sense if you are moving short distances, but you have several other options for covering greater territory. Perhaps the most useful is CTRL up arrow. This combination takes you to cell A1 from anywhere in the sheet.

Following is a description of cursor movement. It is good for you to practice and experience each of these techniques as they are explained, because familiarity with these cursor movement methods will enable you to become more adept in using the spreadsheet.

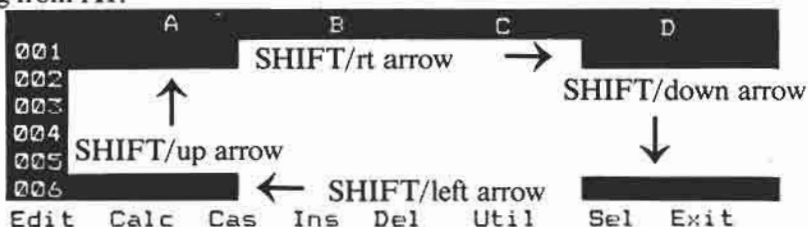
A. As we explained earlier, when you press an arrow key once and release it it will move the cursor one cell in the direction of the arrow.

B. When you press an arrow key and release it multiple times in rapid succession the number of strokes is stored or queued, and the cursor will move that many cells. Movement is very rapid and you will find that you won't get too far ahead, but you can rapidly count out spaces and be assured it will move the number of cells you keyed in.

C. When you hold down an arrow key without releasing it you will move

through the sheet cell-by-cell in very rapid succession. This moves you very quickly, but at first it is difficult to control and you can find yourself a lot further than you had wanted, and have to go back with more precise methods.

D. When you press the **SHIFT** key and either the right or left arrow key simultaneously, the cursor moves immediately to the far right or far left of the screen. When you press the **SHIFT** key and the up or down arrow keys you will move the cursor to the top or bottom row of what is displayed on the screen. In order to gain a good appreciation of the shift arrow cursor movements around the screen, practice moving the cursor around the periphery of the screen with the **SHIFT** and arrow keys starting from A1.



E. When your cursor is at the far left or far right of your screen and you press **SHIFT** and left or right arrow, you will move over one screen length of cells, provided of course there is space in that direction.

In order to maintain visual continuity you don't look at an entirely new screen. The far right column when you do **SHIFT** right arrow becomes your far left column. When you do **SHIFT** left arrow the far left column becomes displayed as your new far right column. For example:

If you had a screen view like this:



and you did **SHIFT** right arrow, the screen would look like this:



Later we will talk about how to change column widths. When you start a new sheet it automatically starts with a width of 9 spaces for all columns. When you have different column widths, and you do the SHIFT left or right arrow, often you will see part of the screen to the right will be blank. This is because LUCID will not show a partial column on the screen. It is too confusing. If there is not enough room for the column on the far right to be displayed in its entirety, the screen will show the area that would have been partially exposed as blank.

Any right arrow cursor movement from a column that is visible on the far right of the screen will show the next column completely.

F. When the cursor is resting on the top or bottom row of what is on the screen, and you press SHIFT up or down arrow you will move one screen distance of cells in the direction of the arrow.

Again, here just like with the left and right movement, in order to maintain continuity, you won't see an entirely new screen. When you press SHIFT down arrow, the row that was on the bottom becomes the top row. For example, if you were displaying rows 002 thru 007 and your cursor were on the bottom row, and you press SHIFT down arrow, you display rows 007 thru 012.

In like fashion when the cursor is on the top row, SHIFT up arrow causes the row on top to be displayed as the new bottom row on the screen. For example, if your cursor is on the top row, and rows 014 thru 019 were displayed, SHIFT up arrow would cause rows 009 thru 014 to show on the screen.

You will notice some similarities in cursor movement between LUCID and TEXT. This is intentional, as both programs have a need to move rapidly about the copy, and it is important to have as much common functionality as possible.

G. No matter where you are on the spreadsheet you will go immediately to the top left on cell A1 by pressing CTRL up arrow.

H. You can go immediately to any cell location on your spreadsheet by what is referred to as a "Goto:" command. When you press ">", (SHIFT .) the screen says

Goto: A1

The keyboard symbol for GOTO is easy to remember because the greater than sign (>) looks like an arrow pointing to the right. When you

start a new sheet and use the "Goto:" command for the first time the screen will say "Goto: A1" wherever you are on the sheet. You can backspace and delete the A1 and type in any new location (for example T55) and press ENTER. Immediately the location you typed will be the new top-left cell on your screen and the cursor will be on that cell.

I. Often you will want to work with two different parts of your spreadsheet and you need to go back and forth between them often and rapidly. LUCID has an excellent feature called jump that lets you have two work zones and go back and forth between them instantly producing a windowing effect. Here is how jump works.

Whenever you do the "Goto:" command LUCID remembers the location where you were when you executed that command. From your new location or any area that you move the cursor when you do the "Goto:" the screen will automatically show that last originating location. Press ENTER and you are back to that cell.

Following are two examples where jump is extremely useful.

EXAMPLE 1:

To window row or column labels.

Many times when you are working on figures at the bottom of a column you will need to be reminded of the labels at the top of that column. Likewise when you are some distance out on a row and you move down or up a few rows you will need to see the row labels so that you don't put an entry under an incorrect designation. If you were working on column M row 28, you could do the "Goto:" command, (>), type in A28 and press ENTER. You could then study your labels, move around with the cursor, if you wish, and then do the Goto: again. The screen would say Goto: M28, which is the cell you were in when you did the last Goto:. You just press ENTER, without having to type in the cell designation. You now can toggle back and forth between the label area and the work whenever you like.

EXAMPLE 2:

To window two separate data areas and work them together.

Sometimes you will be working on a spreadsheet, perhaps in the upper left of your sheet, such as a corporate budget. One of the entries in the corporate budget might be, for example, cost of raw materials, another might be fixed expenses. Now you want to have an exploded study or

breakdown of these items, but you don't want to have those breakdowns showing close to the budget, because you want to keep the budget in its simplest form for viewers that might be confused by the entire assemblage of items and expenses.

It would work like this. Say you were working on the budget in the D25 area, press ">" (SHIFT .) and type in a distant designation like AA1, press ENTER. You can work on your expense breakdown in the new location. When you need to go back to the budget press ">" (SHIFT .) The screen immediately says "Goto: D25". Press ENTER and you are back at your budget. You can then zip back and forth between the two work areas anytime with your "Goto:" command. As you work with LUCID you will find this feature invaluable.

CHAPTER IV

TYPING LABELS OR TEXT

Before typing in labels or text, read the section on moving around the spreadsheet.

Since a spreadsheet is characterized by rows and columns and you have a need to label those rows and columns for many applications; text that appears on a spreadsheet is often referred to as a label.

With LUCID you will be labeling rows and columns or certain cells, but often with the spreadsheet files you build you will want to have text that is more than a label, i.e. words that will cover several columns so that you can have titles or explanations or comments. This is an area where LUCID shines. As you read the discussion which follows we will often use the word label interchangeably with text or titles or prompts, but with LUCID you are not restricted to a certain width for text you wish to appear on your sheet.

Put the cursor wherever you wish to type text and merely begin typing. Immediately the label line will disappear and the text that you type will appear on that bottom line.

As you type, notice that you have the full edit capabilities like TEXT. You can use your left or right arrow keys to move your small cursor through any of the text that you have typed so that you can make additions or corrections. The DEL/BKSP key works just like TEXT. In other words, press SHIFT DEL/BKSP and you delete the character the cursor is on. Just press DEL/BKSP and you erase the character to the left of the cursor.

Whenever you move the cursor through the text you have typed you can begin typing and what you type is inserted at the cursor location on the edit line.

Also note that pressing SHIFT and the left arrow key will move you immediately to the beginning of the edit line and SHIFT right arrow will move you to the end of the line you have typed.

You may type any length label or text up to 36 characters including spaces. When you have completed that label you can enter it onto the spreadsheet by pressing ENTER or by pressing either the up or down arrow keys.

An important feature of LUCID is that your label or text will appear on the spreadsheet even if it is wider than the column where you started the label. The text merely spills over regardless of the column boundary. Now if you already have or later make entries into the cells that are overlaid by that text, the spill over will not show. But the wonderful characteristic of this feature is that you can type in comments or explanations or titles for your spreadsheets and you don't have to change column width to have them appear in the sheet.

At first you might think that 36 characters is not enough, but that is the maximum width that will appear on the Model 100 screen with the row border on the left and allowing one space on the end. If you need more text for prompts or explanations you can simply go to the cell below or the next cell past where your 36 characters ended. You will find it is possible to produce very professional looking copy for your spreadsheet when you need to print words that are something other than a column or row label.

LUCID has several other convenient features that make typing labels easy and the text attractive.

ESC To Abort

The ESC (Escape) key allows you to erase any characters that you have typed if you change your mind while typing in some text. When you press ESC (F8-Exit will work also), the label line is restored and the previous contents of the cell are left intact. Of course if you have already pressed ENTER or the up or down arrow keys then ESC won't have any effect in that cell.

Blanking A Cell — Spacebar, ENTER.

If you wish to erase any cell that has already been written on the spreadsheet whether it is a label or a value or formula (discussed later) you simply move the cursor to that cell, press the spacebar once and then press ENTER. That cell is then empty and incidently takes up no bytes or RAM. This is one of the ways that LUCID is memory conserving. Other spreadsheets often consume from 3 to 5 bytes for an unused cell on the sheet.

Replacing The Contents Of A Cell

If you want to change any label or text that has been entered and already appears on the spreadsheet you can do that two different ways. If you want to completely type something new you just move the cursor to the

cell and start typing. The new text appears on the bottom line. Remember, press ESC if you change your mind and want to keep what is presently displayed. If the new is right just press ENTER or the up or down arrow keys (of CTRL left or right arrow), to replace the old with the new.

Changing The Contents Of A Cell

The second way is if you want to add or change the text in a cell without typing the whole thing over. In this case you put the cursor on the cell with the label or text you want to change and press function key F1 (Edit). Immediately you see the text on the bottom line but with the small cursor on the end, with full editing capability just as though you were typing it in for the first time. You can now erase and correct or add to the text that appears. If you change your mind while editing just press ESC and the original text on the display will remain unchanged. While typing in on the bottom of the screen whether editing an existing cell or entering new text, numbers or formulas, the arrow keys have a slightly different effect than when moving around on the spreadsheet. Right and left arrow move you through the text just like in TEXT. Shift left and right arrow move you to the beginning or end of the line respectively, and Control left and right arrow move you right out of the cell you are editing, and into the adjacent cell on the spreadsheet. Up and down arrow also exit you from the text you are editing, again moving you to an adjacent cell. ENTER has a similar effect, but does not change the location of the spreadsheet cursor.

Positioning Labels

When you type text and press ENTER or the up or down arrow keys it (or CTRL left or right arrow), it will display on the screen flush left in the cell. In other words, when you type a label or any text that takes up fewer characters than the width of the cell, it will appear on the left of the cell, but you might like to have it appear flush right or even centered.

To make a label display centered in the cell type the caret symbol (^) (SHIFT 6) as the first character of the label. The (^) symbol will not appear on the spreadsheet but it shows on the edit line. When you press ENTER or the up or down arrow keys then the label will display centered in the cell.

To make a label appear flush right type an quotation mark (") as the first character of your label. As with the caret, the (") symbol will not appear on the spreadsheet, but only on the edit line. After you press ENTER or the up or down arrow keys, the label will be displayed flush right in its cell.

In other words with leading spaces as opposed to trailing spaces. This gives a nice right justified look to a column of labels or it can provide a better look to a label at the head of a column of numbers, which are automatically right justified. Positioning of your labels is a matter of personal taste, and you can use these signals to achieve the appearance and layout you prefer.

In a later section we talk about entering values. Values are numbers that will be used for calculation in some fashion as part of your spreadsheet. But sometimes you want a number as a label and not as a value. A number as a value is displayed a certain way and has other restrictions; for example text cannot be written in the same cell as a value.

Numbers As Labels

Anytime you start typing a numeral (or digit, 0-9) at the beginning of the edit line, LUCID interprets it as a value. If you want a number to be a label just type an apostrophe (') before the name and it will be regarded as a label. You can type any text following that number and it is the same as any other label or text you would enter. The apostrophe appears on the edit line, but will not appear displayed on the spreadsheet.

If you want a number to appear as a label and you want it right justified or centered you don't need the apostrophe ('). Just the quotation mark (") or the caret symbol (^) before the numeral will cause the number to be regarded as a label and to be positioned in the cell the way you have indicated.

SCAN

Sometimes you would like to scan through the cells of the spreadsheet and see the edit line that appears in each cell. Later in the section on values and formulas you will see how this feature is particularly useful for cells with those kinds of contents. But scanning is also useful for text or label cells as well, particularly when the label you have typed is larger than the cell and the cell where the excess would have spilled over and displayed has something in it. In those cases the excess is still recorded, but it won't overlay on the filled cell. It is nice to scan or review your whole text so you can decide if you want to shorten the message or perhaps move the other cell contents to some other cell where the text that you typed will display entirely.

To scan just press the "/" key or the LABEL key, either of which turns

off and on the function key labels. You will see the contents of the cell on the edit line. Now you can move from cell to cell with the arrow keys and look at each cell's contents.

You will note that the small cursor does not appear on the bottom line with the contents display because you are not actually editing these cells. You can start typing, but you will notice it starts fresh with a blank cell, and you are replacing not editing (changing). Press ESC if that's not what you want.

You can scan all over the sheet by moving your cursor with the arrow keys as you learned in the section on cursor movement and see your complete cell contents. If, while scanning, you reach a cell you want to edit (correct, modify or change) just press "F1".

Observe that an empty cell that has some text spilled over into it from the cell adjacent will show nothing when you scan it. To see the entire text you must go to the cell where the text began, because that is the cell where that text is recorded even though it has spilled over and is displaying in adjacent cells.

If you are scanning and want to quit just press the LABEL (or "/") key to restore the function key labels on the bottom line.

CHAPTER V

TYPING IN VALUES

We talked about typing numbers for labels, such as to show catalog numbers. But usually when you put numbers into a spreadsheet you will want those numbers treated as values because you will want your sheet to use them as part of calculations. To type in a number or a value just move the cursor to the cell where you want the number to appear and type it in. LUCID treats numbers as values unless you put a format signal in front of it, Like (^), ("), or (')

Immediately the LABEL line (your function key labels) will disappear. The number you type will appear on that bottom line. This line is also referred to as the Edit line when you are editing the contents of a cell.

When you are typing in a number you have full editing capability on the bottom line just like we discussed about typing in a label or other text. The edit keys include DEL/BKSP, and left and right arrows as well as the shift left or right arrows which take you immediately to the beginning or end of the line where you are typing in the numbers. The F1 (Edit) key and the ESC key and the / (or Label function key) all function as with label entry.

Later we will discuss in detail another form of a value, the formula. A formula is a reference or series of references to other cell values which enable you to design a spreadsheet that has multiple interacting values that relate to each other. The simplest example would perhaps be a formula in a cell that refers to the contents of two other cells and adds them together.

But we would be getting out of sequence to discuss formulations now. At this point you need to understand that a number is typed in directly by merely placing the cursor on the cell where you want the number and typing the numerals. A number is entered into its cell by pressing ENTER or by using the up or down arrow keys (or CTRL and left or right arrows).

CHAPTER VI

CELL FORMATTING

There are three separate functions that make up what is called formatting. Formatting is simply changing a cell so that it appears differently, but without changing its contents or values. The three functions are:

- 1) Number display format
- 2) Column width
- 3) Protection against entry

Each of these is explained in the following discussion, followed by the procedures for achieving the various format options.

RANGE SELECTION

In order to format (and do many other functions of LUCID such as Copy, Cut, Paste, Delete, Insert and Print) you must first indicate what cell or cells you will be affecting. This exercise is significant because the selection process is the same as for many features that we will discuss later.

First, press function key F7 (Sel) to begin the selection process. Remember this is the same function key for "Select" as in TEXT. The process will be very similar in many ways to block selection in TEXT, but with some pointed differences because a spreadsheet has a different layout than a text file. The primary difference is what is known as "range definition".

When you press F7 (Sel) the bottom line clears and the screen says,

Range A6:A6

For this example our cursor was on cell A6 when F7 (Sel) was pressed.

"Range" describes what cells you are selecting. The smallest range would be one cell. It starts at A6 and ends at A6. With your arrow keys move about the spreadsheet from cell to cell. Notice that the range definition changes to correspond to whatever cell you are on. Range actually describes a rectangle this way,

Range Upper Left Corner: Lower Right Corner

A) Range can be a single cell

A6 Range A6:A6

B) Multiple cells in a row

A6 B6 C6 Range A6:C6

C) Multiple cells in a column

A6
A7
A8 Range A6:A9
A9

D) Cells including both multiple columns and rows

A6 B6 C6
A7 B7 C7
A8 B8 C8 Range A6:C9
A9 B8 C9

With "Range you can define any block of cells on the spreadsheet. The entire spreadsheet, or a "global" range would be

Range A1:DV254

To define an entire row or column to the last cell on the row or column:

Row) Range A1:DV1
Column) Range A1:A254

There will be occasions when you will want to make entire row or column selections. Incidentally, when we discuss the column width procedure later, you will discover that you won't have to define an entire column for changing a column width. A single cell range is fine because there can't be multiple widths of cells in a column.

SPECIFYING RANGE

You have two choices for specifying the range you want. Which method you select will depend entirely on your personal preference. Sometimes one method is easier than the other for a particular situation.

A) Specifying Range — Typing in cell designations

After you have pressed F7 (Sel) and the range of the cell you are on is shown on the screen (e.g. A6:A6), press F1 (Edit).

You now have full editing ability for the range. Use your BKSP key to erase and you can type in any range definition you desire.

Typing in the range can be done two ways. You can just delete the second cell designation, and respecify only the lower right hand corner of the block.

Or, you can delete the entire range and respecify both the upper left AND lower right corners of the Range.

1. Typing lower right corner only.

a) After pressing F7 (Sel), move the cursor with the arrow keys or using any of the cursor movement methods discussed earlier.

b) When you reach the cell that is your upper left corner of your rectangle you want to define press F1 (Edit).

c) Backspace and erase just the second cell designation, leaving the colon.

d) Type in the cell designation for the lower right corner of the range you want.

e) Press ENTER.

2. Typing in the entire definition.

a) From any location on the sheet press F7 (Sel) and then F1 (Edit).

b) Using the BKSP key delete the entire range.

c) Type in the entire range definition you wish to select e.g. M16:P22. That would be a rectangle with cell M16 being the upper left hand corner and cell P22 being the lower right hand corner.

d) Press ENTER.

When you press ENTER the bottom line changes and new function key labels appear. If you hear a BEEP, that means that you incorrectly specified a cell, or left out the colon. LUCID will put the cursor on the mistake in the range.

This excellent feature of LUCID will be described in greater detail later. Simply correct the mistake and press ENTER.

These new labels appear:

Disp	Wdth	Ptct	Unpt	Copy	Cut		Exit
1	2	3	4	5	6	7	8

We will discuss these functions after describing the second method of selecting range.

B) Specifying Range — Reverse Video Block

Defining a reverse video block is almost like TEXT. You will find yourself using this technique often because it is so "hands on". You see exactly what is being selected.

Here is the procedure:

- 1) Press F7 (Select).
- 2) Move the cursor to whatever cell you wish to be the upper left hand corner of the range you are selecting. Notice the range changes to show each cell the cursor is resting on.
- 3) Press period (.) to "lock" or "anchor" the cursor at your upper left corner selection.
- 4) Now at this point we have an expanding cursor. Literally, when you locked the cursor at the upper left location the cursor split to allow a second cursor to move from the locked location to define the reverse video area.
- 5) Now using the arrow keys and the SHIFT arrow key combinations we discussed under cursor movement, move the cursor to the cell you want to be your lower right corner. Observe that like in TEXT you are defining the section where you travel in reverse video.

NOTE: Not all of the cursor movement options (that were explained earlier) for moving about your spreadsheet are available for doing reverse video.

You cannot do: a) CTRL up arrow to go to A1.
Goto commands (>).

But all other cursor movement functions work the same. You should go back and review that section if you are not familiar with those techniques.

- 6) When your expanding cursor covers the entire range you wish to select simply press ENTER.
- 7) New function key labels will appear on the bottom line. These are the functions you can do to the range you've just selected.

Disp	Wdth	Ptct	Unpt	Copy	Cut	Exit
1	2	3	4	5	6	7 8

Now you have made your range selection and you are ready to proceed with either cell formatting or copying, cutting and pasting. We will discuss formatting first and then Copy, Cut and PASTE.

HOW TO DO CELL FORMATTING

The four function keys that relate to formatting are,

Disp	Wdth	Ptct	Unpt
1	2	3	4

I. Display

When you enter numbers or when calculated numbers appear on a spreadsheet you will have preferences of how you will want them to appear. For example, you might want some numbers to appear as dollars as, \$87.00 and others to appear as whole numbers as, 14. These and other options are available with a LUCID function called display. You can have a number or any group of numbers appear in your choice of five display formats:

- A) Dollar format
- B) With trailing minus (if a minus number)
- C) Whole numbers (no decimal point)
- D) To your choice of decimal places
- E) With commas showing thousands

DISPLAY OPTIONS

When you are causing display changes on your numbers you will be faced with numerous situations where you want those changes to have different effects on your sheet.

You may want to:

1. Have all future entries display to standard default.
2. Change all future entries to a new default.
3. Change only the present entries that you desire.
4. Change all present entries, but not affect future.
5. Change all present entries and all future entries to the same new display.

LUCID allows you to:

1. Have the standard display default. When you open a new sheet, numbers are automatically displayed as,

8.00
-9.00
87.00
8,600.00

This display is described as two decimal places, leading minus sign, no dollar sign and commas on thousands.

2. Change the display default for the entire sheet. This affects all new entries on a sheet, and is generally done at the beginning of building your sheet, but can be done at any time.

To effect:

When you select your range, F7 (Sel),

Screen says Range A1:A1 (if you are on cell A1)

Press F1 (Edit), type A1:DV254

Press ENTER

This will not change any previous sheet entries.

3. Change the display format of single cells or cells in any range you choose. When you select your range, describe the area you wish changed. NOTE: This only affects numbers already entered. Future entries will ALWAYS be either the standard default, of the new global default that you specified as is in #2, above.

4. Change the display format of all previous entries on your sheet, but leave the default for future entries as the standard or your new global default. (You might call this "existing global display" change).

To effect:

When you select your range F7 (sel)

Screen says A1:A1 (if you are on cell A1).

Press F1 (Edit). Type: A1:DV253. (NOTE: this is one less than for a future (or global) default).

Press ENTER.

5. Change display of all present and future numbers to the same.

To effect:

Do both the #2, (all future entries), and #4, (all present entries) procedures, making the display choices for each the same, but doing one right after the other.

A REVIEW OF THE DISPLAY OPTIONS

1. Future entries, Standard default.

No action required.

- Future entries only, new global default
Select range as A1:DV254
- Existing entries, but not entire sheet, not future
Select range you desire
- Existing entries, entire sheet, not future
Select range as A1:DV253
- Existing and future entries, entire sheet
Do procedures 2 and 4, one followed by the other in any order.

After you have selected (F7 Sel) the cell or cell range that you want to be displayed a certain way then press F1 (Disp). The bottom line clears and a new set of function key labels appears:

	#.#	###-		\$###		.,###	Exit
1	2	3	4	5	6	7	8

Each of these allows you to cause numbers in the range you selected earlier to be displayed as follows:

F2 (#.#) Decimal Places—

Lets you specify how many decimal places you want to appear on the screen. It should be noted that all numbers are kept to 14 places of accuracy regardless of how many are actually displayed.

If you want a whole number (or integer) portion of a number to display you will designate 0.

When you press F2 the bottom line clears and the screen says,

Decimal places:2

Two places is the default. In other words if you just press ENTER, numbers in the range of your selection will be displayed as 8.00 or 24.00, carried to two decimal places.

If you want just the whole number, backspace (BKSP) erasing the 2 and type in a 0 and press ENTER.

If you want any other number of decimal places displayed from 1 through 7 delete the 2 using the DEL/BKSP key and type in the number you want, and press ENTER.

When you press ENTER the bottom line clears and you are again shown the display options.

	#.#	###-		\$###		.,###	Exit
1	2	3	4	5	6	7	8

The reason you don't return immediately back to your spreadsheet is that you may wish to change other display options such as turning off commas on 1000's or making negative numbers have trailing minus signs as we explain following.

If you don't wish to effect any more options, press F8 (Exit).

The screen will clear and the numbers in the range you had selected earlier will automatically be displayed as you have chosen.

F3 (###-) Trailing minus sign. Many people like to show minus, or negative numbers with a minus sign at the end rather than in front.

When you press F3, a negative number you have already entered in the range you specified (selected) will be shown with a minus sign on its right. For example:

817.00-

Notice that the label **###-** now shows in reverse video. Press F8 if you have completed your display choices.

F5 (\$###) Dollars. If you wish numbers that you have entered to be reported or displayed as dollars in the range you selected, press F5. When you press F5 you will observe that the label **\$###** shows now in reverse video.

Press F8 (Exit) when you have no more display options to select.

F7 (,###) Commas in thousands, notice that when you first see all the function key labels, the F7 label (**,###**) is already in reverse video. This is because this is a default. You press F7 to turn it off if you don't want numbers you have entered in the range you selected to show commas in thousands.

If you press F7 (,###) the label will no longer show in reverse video. Press F8 (Exit) when you have completed your display choices.

II. FORMATTING—COLUMN WIDTH

F2 (Wdth)

You will often want to have different column widths than what the spreadsheet starts with. When you start a new sheet each column is 9 spaces wide. Sometimes you may want to change one or more columns, either wider or narrower. You might even like to change width of every column in the entire sheet.

SETTING A NEW COLUMN WIDTH

1. Select your range by pressing F7 (Sel). After F7 (Sel) immediately you are shown the "Range" prompt showing the cell you are on, for example:

Range M14:M14

You have three choices of width control.

- A. You can change the width of one column only.
- B. You can change the width of a range of columns.
- C. You can change the width of all columns, i.e. Global

A. Changing the width of a single column.

1. After F7 (Sel), put the cursor on any cell in the column you are changing the width and press ENTER.

Range selection is quite easy for doing column width because any single cell designation is all you need.

For example if the screen says

Range M14:M14

Pressing ENTER for this cell would be the signal for setting the range for Column M. This is because you cannot have different column widths in the same column.

2. The bottom line clears and the function key labels appear:

Disp	Wdth	Pctt	Unpt	Copy	Cut	Exit
1	2	3	4	5	6	7
Press F2 (Wdth)						

The bottom line clears and screen says

Width?

Now simply type in the number of spaces you would like the column you selected to be wide. Press ENTER.

Immediately the bottom line clears, the function key labels reappear, and the column you selected is changed to the new width.

B. Changing the width of a Range of columns.

1. After F7 (Sel), the range prompt shows for example

Range M16:M16

You have two ways you can effect the range change.

a. Type it in. Press F1 (Edit), erase and type in the range of columns you want changed. You can use any row number because the column designations are all that is important.

Example: Range B4:M4

Press ENTER

b. Reverse video. Put the cursor on the left most cell of the group of columns that you want changed. Press period (.) to lock the cursor then stretch the expanding cursor to the last column. Press ENTER.

Example: Range M16:Z16

2. Now the screen shows

Disp	Wdth	Ptct	Unpt	Copy	Cut		Exit
1	2	3	4	5	6	7	8

3. Enter the width for the range you selected just like for a single column.

C. Global width change

1. When selecting range, type in

A1:DV1 (or any row number)

2. Follow steps just like for single column width change.

III. FORMATTING—PROTECT AND UNPROTECT

F3 (Ptct) and F4 (Unpt)

PROTECTION AGAINST ENTRY

When you prepare a spreadsheet often it will be arranged so that someone else will be using it and putting in certain information that your spreadsheet will use to calculate or respond. We will discuss later many examples and options that you have to design sheets like these. When you have created such a spreadsheet to be used by someone else you don't want them erasing or typing over any values or text or formulas that make up the permanent structure of the spreadsheet. You want them to just type in data or other answers where you designate. With LUCID you can protect all your cells that have entries and unprotect only those where you want entries to be made.

Protect is a feature that prevents the keying in of any text, numbers or formulas into a cell, until it is unprotected, using the function F4 (Unpt).

Protect is particularly useful when you have designed an input area to your spreadsheet, which you will learn about later.

Here are some characteristics about Protect (F3-Ptct) and Unprotect (F4-Unpt):

- a. Any cell that has information or contents already entered is protected by the F3 (Ptct) key.
- b. You can protect a single cell, a range of cells, or the entire sheet.
- c. Blank cells in a Range that you have protected will allow entry. Those new entries would not be protected unless you again went through the protection procedure which follows.
- d. When you have text or labels that have "spilled over" into adjacent blank cells, those spillover cells are actually blank and will not be protected.

However, your sheet and work is still protected because even if someone writes on top of some text it is not lost. The text is recorded in the first cell where the text began. If someone inadvertently wrote over the spill over area, all you would have to do would be to "blank" that cell (SPACEBAR, ENTER) to restore your original copy.

- e. When you have protected a Range of cells or an entire sheet you can go back and unprotect any cells using F4 (Unpt).
- f. Unprotect is useful when you have designed input fields. Input fields that are to be processed by LUCID will possibly show something in the cell perhaps a 0.00 or an X. You will learn more about this later. When these input fields are in a protected range you will need to unprotect them so that people who answer the questions can type in their responses.

HOW TO PROTECT OR UNPROTECT

A. First select the Range Press F7 (Sel)

You can protect or unprotect:

1. A single cell.
2. Multiple cells in a row.
3. An entire row.
4. Multiple cells in a column.

5. An entire column.
6. An rectangle of rows and columns.
7. An entire sheet.

Refer back to the section where we described range and review range definition.

- B. You can either type in your range or use the “reverse video” method.
- C. Press ENTER.
- D. Next you see the function keys.

Disp	Wdth	Ptct	Unpt	Copy	Cut		Exit
1	2	3	4	5	6	7	8

- E. Press F3 (Ptct) to protect, or F5 (Unpt) to unprotect
- F. The bottom line will clear and the original function key labels appear.
- G. Now when you put the cursor over a protected cell and try to type a label or a number or a value, the bottom line clears, the computer beeps and screen says

Protected

Press ENTER, or any key to clear the bottom line.

H. If you had pressed F4 (Unpt), you will find the cell(s) in the range you selected are now unprotected, and entries can be made in them, even if they are in the middle of an otherwise protected area.

NOTE: Protect only prohibits entry by typing. You can PASTE into a protected cell. You can also Copy it or Cut it. Cut, Copy and PASTE are similar to TEXT. We explain them specifically for LUCID later.

When you Copy protected cells and PASTE them, the new cells will be protected as well. But when you PASTE a new value into a protected cell the replacement value is unprotected.

CHAPTER VII

CUT, COPY AND PASTE

This is one of the most remarkable of the LUCID features. To be able to cut, copy and paste in a spreadsheet is a nicety that you will utilize over and over, and become very dependent upon.

You have used Cut and PASTE in TEXT and know how wonderful that feature is. In LUCID, Cut, Copy and PASTE uses the same keys and works almost like TEXT, but actually is far more powerful and functional.

First, LUCID allows you to not only select by doing a reverse video block, but it allows you to type in the Range you wish to Copy or Cut.

Second, LUCID's Cut, Copy and PASTE takes cell formulations with it to new location.

Third, you can PASTE to a different location on the same spreadsheet file, you can PASTE to a different spreadsheet file, or you can PASTE into any TEXT file.

Here's how to do it:

A. First, F7 (Sel) to select the Range that you'd like to Copy or Cut.

You can Copy or Cut:

- A single cell
- Multiple cells in a row
- Multiple cells in a column
- Multiple cells in a column
- All cells in a row
- All cells in a column
- Any rectangle made up of any number or rows and columns

You are only restricted in copying or cutting by memory available, just like you are with a TEXT file.

2. The section of the manual on specifying ranges describes in detail how to make your selection. Review that at this time. You can either type in your range (F1, edit, when the "Range" prompt appears) or do a reverse video block (After moving the cursor to the upper left cell location, press the "period" to lock, then using cursor movement methods go to the lower right location.)

3. Press ENTER

B. The bottom line clears and you see the function keys:

Disp	Wdth	Ptct	Unpt	Copy	Cut		Exit
1	2	3	4	5	6	7	8

C. At this point if you wish to copy what you selected, press F5. If you wish to cut, press F6. Upon pressing either F5 or F6, screen says wait, the bottom line clears and the original LUCID function keys are displayed.

D. PASTE

You have three choices for pasting LUCID spreadsheets.

1. You can paste into another section of the same sheet.
2. You can go over to another LUCID spreadsheet file in RAM and paste anywhere in that sheet.
3. You can go over into any TEXT file (.DO) in RAM and paste anywhere in that document.

Formula Transfer — In the next section we discuss doing formulations. With formulas, you give references in cells to other cells and instruct the contents of various cells to relate and interact with one another making calculations. Whenever you perform a copy or cut from any .CA file, those formulas in the cells transfer as well. When you PASTE, LUCID automatically re-calculates in the new position.

Formula transfer with Cut, Copy and PASTE is discussed in more detail in the formula writing section.

E. Here is how to PASTE

1. After you have selected your range, and pressed copy or cut, you have two choices. One involves moving the cursor, the other, just typing in the target location of the paste. If you choose to move the cursor, you can move it to the location where you want the material which you have cut or copied to appear now, or you can wait to move the cursor after the next step, if you prefer.
2. Press PASTE. The function key label line clears and the screen says:

Range A16: A16 (or whatever cell the cursor is on)

3. If you had chosen not to move the cursor, but to just type in your target

location, press F1 (Edit).

You have full editing capability for the range line. Type in your target upper left cell where the paste is to occur. Press ENTER.

4. If you chose to move the cursor be sure cursor is positioned on the upper left hand cell of the location where you wish to paste. Press ENTER.

5. The copy will appear in the new location.

Note: Large PASTES can take a long time, just like in TEXT. It takes about 10 seconds to PASTE 50 cells. While you are pasting, on the bottom line appears a flashing reverse video sign:

Wait

When you are copying, cutting and pasting you may get a screen message "out of memory", just like when doing a cut, copy and paste in TEXT. You are faced with the same memory restrictions as in TEXT, because you temporarily use up RAM filling a paste buffer whenever you copy or cut. When you paste you consume more memory, because you are writing to RAM your new material, but not deleting from the paste buffer. If you have used TEXT's cut, copy and paste, however, you are familiar with these restrictions.

6. LUCID has a convenient feature for PASTING. You can PASTE another way. After making a selection and pressing F5 (copy) or F6 (cut), many users will move their cursor to the new location and intuitively press F7 (Sel). LUCID handles this just fine.

Just press PASTE and the copy is pasted immediately. Range doesn't appear again when you PASTE this way, and you don't have to press ENTER.

Another way to state your two options for pasting is this:

After you have made a selection and pressed copy or cut you can initiate the paste by pressing F7 (Sel) or PASTE interchangeably. After positioning the cursor on the upper left cell where the paste is to occur, the paste is initiated by the PASTE key if you used F7 first, or the ENTER key if you used PASTE first.

6. Moves

Although you could extrapolate the procedure for what follows from what has already been detailed, we will go through a common sequence

that you will find most useful as you become more adept at designing and building a spreadsheet.

Many times when you are working with a spreadsheet you just want to move a section, most often a row or column, to a new location. You know what it is you want moved, and you know where you want to put it. And you don't need or want to go to either location to effect the move.

Here's a typical example:

Column move

- a. You want to move the contents of column C to column M
- b. No matter where you are on the spreadsheet Press F7 (Sel).

Screen says:

Range X10:X10 (depends on cell you are on)

- c. Press F1 (Edit). Press BKSP/DEL to erase the cell designations.
- d. Type C1: C127. Press ENTER. Press F6 (Cut)
- e. Press PASTE, screen says Range X10:X10 (same as before). Press F1 (Edit. Press BKSP/Del to erase cell designations.
- f. Type in M1:M1 . Press ENTER. Move is accomplished.

Here is another example:

Row move

- a. You want to move the contents of row 5 to row 40
- b. No matter where you are on the sheet, press F7 (Sel).

Screen says

Range X10: X10 (or wherever you are)

- c. Press F1(Edit). Use BKSP/DEL to erase cell designations.
- d. Type A5:DV5. Press ENTER. Press F6 (Cut).
- e. Press PASTE. Screen says

Range X10: X10 (same as above)

 Press F1 (Edit), use BKSP/DEL to erase designations.
- f. Type in A40: A40 . Press ENTER. Move is accomplished.

REPLICATION

Range For Paste

Remember that range for PASTE is different than any other range you select. PASTE range only refers to the upper left hand corner of the paste. Ever. It will always be a single upper left hand cell designation (e.g. A10:A10) unless you are doing replications as described following, but even then, range will still will be two upper left hand cell designations.

Range in PASTE means:

1st PASTE upper left: last PASTE upper left

Replication — is the multiple duplication of a cell, or group of cells. Later, in the section on formula writing replication is important when you are extending formulations down or across your sheet.

Replication is important for formulas, because it will allow a formula or series of formulas to be reproduced and cause the new location to relate to the cells it is suppose to.

But, before you are introduced to formula writing this is a good time to become familiar with the replication technique, because you don't need to know anything about formulas to understand the mechanics of replications.

You can replicate:

1. A single cell across a row into as many cells as you want.
2. A single cell down a column into as many cells as you want.
3. A single cell into a rectangle of as many rows and columns as you like.
4. A row of cells into multiple rows.
5. A column of cells into multiple columns.

Multiple PASTES

At this point you may be saying "I can already do every one of these six items with the copy, cut and paste techniques already learned. I can just paste again and again to do multiple duplication".

Of course, the answer to you would be that you are correct. Replication is merely a feature that allows you to do the same thing as multiple pastes in one step.

In fact, the understanding about multiple pastes helps you to comprehend why paste range only relates to the upper left hand corner of the pastes. It illustrates that range in paste means:

First paste upper left location: Last paste upper left location.

Here is how to replicate:

For these examples type the word, "test", into any cell, for example, cell A5:

1. Replicating a single cell across a row.

a. Press F7 (Sel). Range says A10:A10 (or wherever you are).

Either move the cursor to the cell A5 and press ENTER, or Press F1 (Edit), erase and type A5:A5 and press ENTER.

b. Press F5 (copy)

c. Press PASTE. Screen says range A5:A5 (if you moved to cell A5).

Remember range in PASTE means:

First upper left location: Final upper left location

Either

i. Press F1 (Edit) and type in paste range A6:P6 and press ENTER

or

ii. Press cursor on first cell where duplication is to begin, press period (.) move cursor to last cell and press ENTER.

2. Replicating a single cell down or up a column.

a. Select as in step 1 a. above

b. Same as 1b.

c. Paste as in step 1c. above, except range would be, for example A6:A16.

3. Replicating a single cell into a rectangle.

a. Select, same as 1a.

b. Same as 1b.

c. Paste same as 1c, except the target range would be, for instance A6:D10.

Still remember, for PASTE range it means,

First paste upper left: last paste upper left

Since the last paste is coincidentally, the lower right corner of the rectangle, this one example, for a single cell into a rectangle, can confuse your thinking, but don't allow it to.

4. Replicating a row of cells into multiple rows.

a. Press F7 select. Type or reverse video the row you want to replicate (multiple paste) and press ENTER.

b. Press F5 (copy)

C. Press PASTE. Screen says

Range X10: X10 (or wherever you are)

Either

i. Move cursor to left hand most cell of first paste and press period. Then move cursor to most left hand cell of last row to be pasted.

Press ENTER.

or

ii. Press F1 (Edit) type upper left hand most cell of first paste: left hand most cell of last paste

e.g. B3:B10

Press ENTER

Row replicate example:

Select range A2:H2

	A	B	C	D	E	F	G	H	I
001									
002									
003									
004									
005									
006									
Edit	Calc	File	Ins	Del	Util	Sel	Exit		
1	2	3	4	5	6	7	8		

PASTE range A3:A9

	A	B	C	D	E	F	G	H	I
001									
002									
003									
004									
005									
006									
007									
008									
009									
010									

replicated area

5. Replicating a column of cells into multiple columns.

a. Press F7 (Sel). Type in range, or reverse video the column you want to replicate (multiple paste) and press ENTER.

Select range example,
A2:A9

b. Press F5 (copy)

c. Press PASTE. Range says

X10: X10 (or wherever you are)

Either

i. Move the cursor to the left hand most cell of the first paste and press period. Then move the cursor to left hand most cell of last paste and press ENTER.

or

ii. Press F1 (edit) and type in left hand most cell of first paste: left hand cell of last paste.

Example,
B2: H2

Column Replicate

Example,

Select range, A2:A9

	A	B	C	D	E	F	G	H	I
001									
002									
003									
004									
005									
006									
007									
008									
009									
010									

Selected area

PASTE range, B2:H2

	A	B	C	D	E	F	G	H	I
001									
002									
003									
004									
005									
006									
007									
008									
009									
010									

replicated area

6. Replicating a rectangle of rows and columns into multiple rectangles.

The only way to do this kind of replication is to do each paste individually. If you try it as a replicate you will just get one column, or one row, from the original, repeated over and over and only the last paste will be a complete paste like your original rectangle.

CHAPTER VIII

DELETE AND INSERT ROW AND COLUMN

Delete row or column is an excellent function, because it allows you to do something different than you can with "cut". When you use delete, the rows or columns you remove are gone and the other entries on the sheet move over or up to close the gap.

Delete also can serve as a way for you to clear an entire sheet if you want.

With Delete you can:

- a. Delete a single row.
- b. Delete a single column.
- c. Delete any range of rows.
- d. Delete any range of columns.
- e. Delete or clear an entire sheet.

Here is how to do it:

a. To delete a single row.

Move the cursor to any cell in the row you wish to delete and press F5.

Screen says

Row	Col
1	2

Press F1 for row

The bottom line clears and the screen says:

Range X5: X5

depending on which cell you are on.

Press ENTER. The row is deleted and other rows move up to close the gap.

Alternate Method: You can delete a row without moving your cursor to that row.

When the range prompt appears simply edit (F1) the range, and type in the appropriate row numbers that you want to eliminate. For example if you were on Row 5 column D the range would say D5:D5. You could, without moving, type in D10:D10 and press ENTER, deleting row 10.

When you delete a row such as row 10, or course you delete all the entries on that row, and the rows below move up to take its place. Row 11 becomes now numbered as Row 10, and what was Row 12 is now numbered Row 11 and so on.

b. To Delete a single column.

Move the cursor to any cell in the column you wish to delete and press F5 (Del). Now press F2 (Col) for columns. Now follow the same procedures as for deleting a single row. When you delete a column, the column to the right will move left. As with row deletion the column letters such as A or B are not deleted, only the content. The column to the right of the deleted one moves over to take its place.

In other words, what was in column D is now in column C and what was in column E is now in D and so on.

c. & d. Deleting a range of rows or columns.

After you press F5 (Del), you can delete as many rows or columns as you select.

Three ways to delete a range:

After you press F1 (Row) or F2 (Col), and you are shown the range, you have three options:

1. You can move the cursor to any cell in either the last or the first row or column you want to delete, Press F1 (Edit), and type in the appropriate ending or beginning column or row designation.

Range for delete means:

First row or column:Last row or column.

For example, if you want to delete columns B, C, D, E and F, move the cursor to any cell in column B or F. Example: cell B4

Screen says Range B4:B4

Press F1 (Edit) and type B4:F4 and press ENTER.

2. You can move the cursor just like in "a." above, but press "period" (.) to lock the cursor, and with the arrow keys define the range of rows or columns you wish to delete. Press ENTER.

3. You don't have to move the cursor. From any location distant from where you wish to delete you can press F1 (Edit) at "Range" and type in

the target columns or rows to delete. When you press ENTER the deed is done.

E. Delete or clear an entire spreadsheet. From anywhere on the sheet define the range by any of the methods described above to read Range A1:DV1, if columns or A1:A254 if rows, and press ENTER. The entire sheet is clean.

Insert Row And Column F4 (Ins)

Insert row and column works like "Delete", but with a major exception.

The exception concerns inserting multiple rows or columns.

The location of the cursor is what defines the beginning of the insert range, even if you type in something different.

The rule is: LUCID will always insert the number of rows or columns you specify from the location of the cursor; downward with rows, to the right with columns.

You should experiment with insertion of rows and columns, so that you understand about cursor locations.

CHAPTER IX

PRINTING

The objective of this manual is to educate you on all the mechanics of doing the spreadsheet, so that when you are ready to prepare spreadsheets for actual use, you will have all the tools.

LUCID has a wonderful print function that lets you print out your sheet anywhere on the page just the way you specify. Ordinary spreadsheets simply don't allow you the degree of print format that LUCID does.

To print simply press the PRINT command key. (One of the little keys on the top of your keyboard, between the arrow keys and the function keys.

The bottom line clears and these new function key labels appear

Go	Rnge	Outp	Page	List	Ctrl		Exit
1	2	3	4	5	6	7	8

A. F2 (Rnge) defines range

Range definition for printing is the same as for copy and cut. When you press F2 (Rnge) you are shown the range of the cell the cursor is on.

Range F7:F7 (if you are on cell F7)

Define the range for print as a rectangle

Upper left hand cell: lower right hand cell

You can:

1. Type in the range you wish to print by pressing F1 (Edit), first moving the cursor to the upper left or lower right and typing the opposite corner cell.
2. Type in the entire range to print after F1 (Edit) from any location on the sheet.
3. Move the cursor to either the upper right or lower left cell you want to print and press period (.) to lock the corner. Now define the block to print in reverse video by moving the floating cursor with the arrow keys.

Press ENTER

After pressing ENTER, the label line clears, and you see the printing function key labels again.

Go	Rnge	Outp	Page	List	Ctrl		Exit
1	2	3	4	5	6	7	8

B. F1 (Go) prints the spreadsheet range you selected.

LUCID is set up to print with these defaults:

Output device parallel line printer "LPT:"

Page width: 76 characters

Page Length: 66 characters

Top Margin: 4 line spaces

Bottom margin: 4 character spaces

Left margin: 4 character spaces

If these parameters are what you want then pressing F1 (Go), after selecting range is all you need to do. Of course, make sure your printer is connected properly and on.

If any of these default setting needs changing you will make those changes as explained following by using the F3, and F4 function keys, prior to pressing F1 (Go).

After pressing F1 (Go) the printer is activated, and the range you selected is printed out. LUCID automatically fits wide spreadsheets to fit narrow paper widths. Two wide parts are printed on subsequent sheets. All sheets fit exactly for Scotch taping together a wide printout.

While printing screen says

Wait (flashing)

Prior to printing you may have need to change some of the print conditions from the default settings. Here is how it is done:

C. F3 (Outp) defines the output.

Press F3

The bottom line clears and the screen says:

Output to: LPT:

LUCID has fully redirectable output, but the default is to a conventional parallel line printer. "LPT:" is the symbol for parallel line printer. The symbols for the other output devices can be found in the manual that came with your Model 100 under Basic I/O.

If you are printing to a parallel printer, in other words where you use your printer cable port on the back of your Model 100, you don't need to press F3.

You only need to press F3 if you are defining output to some other device.

You have the following output choices with LUCID:

1. LPT: (colon must follow). For parallel line printer (default).
2. COM: (colon must follow). This is to the serial port. Type in transmission configuration such as 97N1E or 87N1D, depending on the device you are wanting to communicate with.
3. XXXXXX (no colon). The X's stand for an up to 6 letter filename. This will create a new file or erase and write over an existing RAM file.
4. CAS: (colon must follow). This is not the way to "save" your spreadsheet files complete with formulations, but merely a textual output. The next paragraph discusses this more fully.

When you "output" with the PRINT function, you are "printing" to any of these devices. Therefore you are not transferring a spreadsheet file with all the formulas but merely the "print out" or a text copy. If you wish to save your files, complete with formulas on another computer you can use the DISK+ or REMOTE DISK program from PCSG for instantaneous transfer (also available on ROM). If you wish to save "formula complete" files to cassette use the F3 (File) function key from the LUCID main function key labels. The F3 (File) function is discussed in a later section of this manual.

D.F4 (Page) Lets you specify print format.

This is for width, length, and margins (top, bottom, right and left).

Press F4 (Page)

The bottom line clears and these new labels appear,

Wdth	Lnth	Mgns						Exit
1	2	3	4	5	6	7	8	

E. F1(Wdth) sets width

When you press F1 (Wdth), the bottom line clears and the screen says,

Width: 76

This means how many characters wide the printout will be.

Combined with the left margin, the two settings cannot be wider than your paper.

You are already in the "edit" mode. Just use the DEL/BKSP key to erase the numbers and then type in the new setting. The smallest width you can have is 40 characters and the maximum is 254.

Press ENTER to set the width for this print out.

The bottom line clears and the page setting labels reappear.

Wdth	Lnth	Mgns						Exit
1	2	3	4	5	6	7	8	

F. F2 (Lnth) sets the length

The bottom line clears and the screen says

Length: 66

This refers to how many line spaces the printout will be. A sheet of paper 11 inches long is 66 line spaces. These 66 lines include the top and bottom margins.

Use DEL/BKSP to erase the numbers, and type in the new settings of your choice. The maximum page length is 254 lines and the smallest is 1 line.

Press ENTER and the bottom line clears, and the page setting labels reappear.

If you have completed your page setting selections, press F8 (Exit) to take you back to the print function key menu. If not press F1 (Wdth) or F3 (Mgns) for other setting changes.

F. F3 (Mgns) sets margins

Press F3 (Mgns)

The bottom line clears and the margin setting labels appear.



Top	Botm	Left						Exit
1	2	3	4	5	6	7	8	

All these functions work alike. DEL/BKSP erases the default settings, and you can then type in your new settings for your current printout. Default settings remain the same for subsequent printouts.

a. F1 (Top) and F2 (Botm)

Control the number of line spaces from the top of the page before printing begins, or to the bottom where printing ends. Minimum is 0. Remember when considering the maximum setting, that page length includes the margin settings. Maximum setting for top margin is the page length setting, minus the bottom margin setting, minus one line for printing. If you had a page length of 254 you could have a top margin of 253, and a bottom margin of 0, leaving one line for printing at the bottom. Of course, such conditions would be ridiculous, but the example illustrates margin setting capabilities.

If you have completed your margin settings, but still have other page settings to make such as width or length, press F8 (Exit) to take you back to the page setting function key labels.

If you have completed page settings you can go back to the print function keys by pressing F8 twice.

ESC would take you all the way back to the main LUCID function key labels.

b. F3 (Left)

Sets the left margins. Just remember that the left margin setting is part of the page width. By having your printout width on the paper set up as left margin plus page width, LUCID allows a simple, but effective print control device that produces the same effect as having a right margin setting.

$\text{right margin} = \text{paper width} - \text{page width}$

The default settings of left margin 4 and page width 76 give 72 actual printing character positions across the page, and on 8" wide paper and ten point type, a right margin of 4 spaces.

Press F8 once if you have more page setting functions.

Press F8 twice for print function keys.

Press ESC to go directly to LUCID main function keys.

CHAPTER X

CASSETTE FILING

A. Saving a spreadsheet file

From the LUCID main function keys:

Edit	Calc	File	Ins	Del	Util	Sel	Exit
1	2	3	4	5	6	7	8

a. Press F3 (File)

The bottom line clears and the new labels appear.

	Load	Save					Exit
1	2	3	4	5	6	7	8

Be sure your cassette recorder is connected as described in your Model 100 Manual. Make certain the tape is advanced past the leader. Press the Record and Play buttons into the locked position.

b. Press F3 (Save)

Immediately the cassette recorder starts turning as the file you are in is being saved. LUCID automatically writes the up to six letter filename on the tape the same as the filename you have called the spreadsheet in RAM.

When saving is complete, the cassette recorder stops. The bottom "label" line clears, and the LUCID main function key labels reappear. It is a good idea to save files three times on cassette, because flaws in the tape can result in an unloadable file. Backups provide greater assurance that the file is properly preserved. Be sure to write the filename on the cassette label for future reference.

B. Loading from cassette

LUCID is designed for a logical intuitive load of a file from cassette. You do it just like when you start a new LUCID file. Here is how it is done.

1. When you turn on your Model 100 the name LUCID appears on the main menu like a built in. Place the wide bar cursor on the name LUCID, and press ENTER.

2. The screen says

TRS-80 Model 100 Software
Copr. 1984 PCSG

Lucid File?

3. Simply type in the LUCID spreadsheet filename you wish to load from cassette. As you recall filenames are up to 6 letters, no need for the ".CA" extension. The filename you type in must be exactly as it was saved on cassette. Press ENTER.

4. The screen shows a blank new spreadsheet:

	A	B	C	D			
001							
002							
003							
004							
005							
006							
Edit	Calc	File	Ins	Del	Util	Sel	Exit
1	2	3	4	5	6	7	8

5. Press F3 (File)

Bottom line clears and these new function key labels appear.

	Load	Save					Exit
1	2	3	4	5	6	7	8

6. Make sure your tape player is connected properly as described in your Model 100 Manual. Rewind the tape completely, and press the PLAY button into the locked position. Press F2 (Load).

7. Immediately the tape player will start turning and the little speaker will begin to emit a whining sound as it finds data on the tape. You may wish to turn the sound off. The Model 100 improves its loading ability with sound off. If you wish to do this, go into BASIC, type SOUND OFF, and press ENTER. If other entries had been saved on the tape prior to the file you are loading, the screen will say:

Skip: XXXX (or whatever filename it is skipping) When the file you have asked for is located, the screen will say,

Found: XXXX (X's represent up to a six letter filename)

The cassette player will continue to turn, and the sounds will emit (unless you have executed SOUND OFF). When the loading is complete the screen will fill with the spreadsheet you are loading. The main LUCID function key labels will reappear on the bottom line. You may disconnect your cassette player now.

8. You may get a message on the bottom of your screen while attempting to load the file. The screen might say: System Error.

This means that there is a problem with your recorder or the tape is flawed, and the load was aborted. You can try a reload of other copies on the tape, or rewind and make adjustments such as "Sound Off" as described earlier, or volume variations.

Our experience has shown that the Radio Shack CCR81 is the best data recorder/player for the Model 100, and the CCR82 is a close second. Other tape players just seem to have problems with providing the proper signal for the Model 100.

CHAPTER XI

FORMULA WRITING

Now we come to the good part. This is where we explain how to make LUCID perform the tasks that made the electronic spreadsheet concept popular.

We have talked about putting values into cells and about putting text into cells. Now we will describe how to write formulas which will allow cells to relate to each other and thereby perform even complicated math functions.

A. Simple Math Calculations

Instead of entering a value in a cell you can enter a series of values separated by calculating symbols such as + (for additions), - (for subtraction), * (for multiplication) and ^ (for exponentiation or power).

These symbols which we have used from grade school on, are called "arithmetic operators". Experiment as follows with several calculations in cells to gain an understanding of how this works.

Examples:

Put the cursor on any cell and type the following

6+2 Press ENTER

6+2 appeared on the edit line, and when you pressed ENTER, 8 appeared in the cell. Note: To enter a value or text that you have typed, you can either press ENTER or the up or down arrow key. (or CTRL left or right arrows)

Now move to a new cell and type:

8/4 Press ENTER. Cell says 2

Move to new cell and type:

6*8 Press ENTER. Cell says 48

Move to a new cell and type:

24-16 Press ENTER. Cell says 8

Move to new cell and type:

10^2 Press ENTER. Cell says 100

The calculated value appears in each cell, but the formula that you wrote is still recorded as the "contents" of that cell.

To look at the "contents" of a cell, either press the LABEL key to turn off the labels or press the ?/ key. Now with the arrow keys move the cursor over each of the cells where the calculated numbers appear.

You will observe that the "formula" or calculation steps that we typed in are still there even though the calculated value appears in the cell.

Note about Entry, Edit and SCAN:

Although we discussed entry and edit in an earlier section, it is good to review those concepts now.

Entry-To enter new material in a cell just move the cursor to that cell, and start typing. When you first type in a number or formula or text you can go back with arrow keys and correct or change the line you are typing while you are typing.

In other words LUCID allows you to enter characters and be also in the edit mode. You can move your cursor over characters you wish to change with the arrow keys, and use Delete or Backspace. New characters typed will simply insert at the cursor location, just like when you entered the cell contents the first time (as in TEXT). Shift left arrow or shift right arrow takes you to the beginning or end of the line you are editing.

Edit-If you wish to go back to a cell where you have made an entry and correct or change something without typing the whole entry over, you can press F1 (Edit). You again have the full edit capacity just like when you entered the cell contents the first time.

SCAN-As we mentioned when you press the label key or the ?/ key you can scan the contents of any cell that you move the cursor over.

If you wish to replace the contents of a cell you are viewing, with a new entry just start typing. Press ENTER to record. Use ESC before pressing ENTER to cancel the new entry.

If you wish to edit the contents of a cell you are scanning, that is to correct or change or add to the contents, press F1 (Edit).

B. Doing a series of calculations

As we explain formula writing, it is important for you to realize how LUCID will perform a series of calculations.

Example 1:

Go to an empty cell and type in the formula $6+4/2*3$. Press ENTER. Cell says 12.00

LUCID calculates this formula by what is known as an algebraic evaluation.

Multiplications and divisions are made as distinct calculations from additions or subtractions.

Here are the steps LUCID takes:

$$4/2=2:$$

$$2*3=6$$

$$6+6=12$$

LUCID will perform multiplications and divisions first, as separate expressions, prior to additions and subtractions. In other words, LUCID follows the rules of algebraic calculation.

If you want your formula to be calculated differently than it reads, then you must separate with parentheses, the numbers with their operators (+, - etc), that you want evaluated together.

Example 2:

If you want to add 6 to 4, and then you want that amount divided by 2, and then the result of that calculation multiplied by 3. You would enter it:

$$+(6+4)/2*3 \quad \text{Press ENTER. Cell says 15.00}$$

Note: If you start an entry with a parenthesis, LUCID regards your entry as a label or text. A + sign at the beginning of any value entry that doesn't start with a number, tells LUCID to regard the entry as a value.

Example 3:

If you want to add 6 to the quantity of 2 divided by 6-4, and have the result of that calculation multiplied by 3, enter like this:

$$3*(6+2/(6-4)) \quad \text{Press ENTER. Cell says 21.00}$$

This is called nesting parenthesis. This way you cause LUCID to treat the $6-4$ as a separate calculation, then cause that quantity to be divided into 2 then added to the 6 as yet another calculation, then that result is multiplied by the 3.

Example 4:

Suppose you want to add 6 to 4, and you want that result divided by the result of multiplying 2 times 3.

You would type in:

$+(6+4)/(2*3)$ Press ENTER. Cell says 1.67

Example 5

If you wanted to add 6 to the amount that was the result of dividing 4 by the quantity of 2 times 3, you would type:

$6+4/(2*3)$ Press ENTER. Cell says 6.67

If this concept of algebraic expression is new or not clear to you, practice with these five examples and test some of your own.

C. Doing a cell reference

In LUCID, as in other spreadsheets, you can make a reference in one cell to another cell. When such a cell is being calculated, the reference in the formula is replaced with the value of the cell referred to. LUCID is superior to other spreadsheets in that you can also make a reference to a cell with text.

Example: Go to cell A5 and type in 65. Press ENTER. Cell A5 says 65. Now go to cell A8 (or any other cell) and type in +A5 and press ENTER. (+at beginning of entry means it's a value)

Cell A8 says 65.

Later, we'll describe how LUCID, unlike other sheets, will let you make a reference to a cell with text, and get the contents of that cell, and we'll describe some exciting things we can do with that capability.

Notice, how we typed +A5 not just A5. Without the + LUCID would regard the entry as a label. With the + at the beginning of the entry, LUCID sees it as a value.

D. Doing formulas with cell references.

Clear the sheet you are working on.

(To clear, press F5 (Del) and then F2 (Col). Now edit the range to read A1:DVI and press ENTER)

Now go to the four cells we show below and type in the numbers 6, 4, 2 and 3, pressing ENTER after each.

	A	B	C	D			
001		6.00					
002		4.00					
003		2.00					
004		3.00					
005							
006							
Edit	Calc	File	Ins	Del	Util	Sel	Exit
1	2	3	4	5	6	7	8

Move the cursor to cell B6 and type $+B1+B2+B3+B4$, and press ENTER. You can type either upper or lower case letters for your cell designations. LUCID will regard these the same. In cell B6 it says 15.00. With this formula we added all these numbers, by referring to their cell designations and providing arithmetic operators (in this case +) to make the calculation.

Note: As you recall, the + sign at the beginning is to tell LUCID that this is a "value" not text. The other +'s are just the math signs telling LUCID to add the values in the referenced cells.

We, of course, produced a sum by using a series of + signs. In section I in Chapter XII we show an easier way to get the sum of any range of values. It is done by using what is called a "function".

E. Examples

Go back and look at example 1 in the B section of this chapter. We did an exercise of putting into a cell $6+4/2*3=12$. Review that explanation. Now we will do that formula by cell references.

Move to another cell with the cursor and type in the following formula.

Example 1:

$+B1+B2/B3*B4$

Before pressing ENTER, observe that right now as you type this formula you have full editing capabilities like TEXT. Use the arrow keys and go back and correct any mistakes or experiment by changing a math sign and putting it back correctly.

Press ENTER. Cell says 12.

Notice the first cell reference has a +, because that denotes to LUCID that this is a value. Type this formula in a cell without the +, and notice that the formula and not the calculated value will appear, because it now is regarded as a label.

Following all the other examples in the B section, move to other cells and enter formulas to do the same calculations as those examples, except now using cell references.

Example 2:

$$(6+4)/2*3=15$$

In new cell type +(B1+B2)/B3*B4

Press ENTER. Cell says 15.00

Example 3:

$$3*(6+2)/(6-4)$$

In a new cell type +B4*(B1+B3/(B1-B2))

Press ENTER. Cell says 21.00

Example 4:

$$(6+4)/(2*3)=1.67$$

In a new cell type +(B1+B2)/(B3*B4)

Press ENTER. Cell says 1.67

Example 5:

$$6+4/(2*3)=6.67$$

In a new cell type +B1+B2/(B3*B4)

Press ENTER. Cell says 6.67

F. Practicing with SCAN

1. First move the cursor from cell to cell. All you see is the calculated value in each cell and the main LUCID label line appears at the bottom.

2. Now press either the ?/ key or the LABEL key to view the

contents of each cell. As you move the cursor with the arrow keys, each formula appears on the bottom line.

G. Practicing with F1 (Edit)

Put the cursor on the cell where you did example 5 above. Press F1 (Edit). Now the formula appears on the bottom line as with SCAN, but now it has a small cursor on the right end.

Of course, you don't need to be using the SCAN feature to do F1(Edit).

It works anytime you have your cursor on the cell you want to edit.

Now, using the left arrow key go back and delete the + sign and type in a - sign in its place.

Formula now reads

$+B1-B2 / (B3*B4)$

Your small cursor is now resting on the B of B2 on the edit line. You don't need to move it to the end. Just press ENTER. Cell now says 5.33

What this formula did was get the value in cell B1 and subtract from that value, the result of dividing the B2 value by cell B3 x B4.

H. Entering something completely new

Move the cursor to one of the cells where you entered a formula. Begin typing any characters. The bottom line clears, and the characters you are typing appear on the bottom line.

Press ESC if you want to cancel what you typed, and restore the cell to like it was. Press ENTER after typing in new characters if you wish the old cell contents to be replaced with the new.

I. Blanking Or Erasing A Cell

If you want to erase a cell, move the cursor to that cell, press the space bar once, then press ENTER. This action completely erases the cell contents. LUCID does not record a single space in a cell, but recognizes that as a signal to "blank" or erase the cell.

J. Wander Mode

LUCID has a feature called "wander", that allows you to go get a cell designation when you are entering a formula, without having to type it in.

When entering a formula just press CTRL W or CTRL up arrow. Then go to a cell you want in the formula and press ENTER. It displays the cells you are on as you travel and records the one you are on at the time the ENTER or any sign or parenthesis is pressed. You are back at the edit line to complete the formula.

Here is an example to illustrate how this works.

Go to a blank cell. We will now enter a formula, but without typing in the cell designations:

$$+B4*B3+(B1-B2)$$

1. Type +
2. Now press CTRL W (or CTRL up arrow). Move with the arrow keys up to cell B4. Notice the moment you press the CTRL W (or CTRL up arrow), the small edit line cursor disappears, and the designation of the cell you are on appears on the edit line. As you move from cell to cell with the arrow keys you will observe that each cell your cursor crosses shows its designation on the edit line.

When you arrive at the cell designation that you want in your formula (in our example B4) press the * (or ENTER then *). Bottom line now says +B4* (and the small cursor resides again on the line).

3. Press CTRL W or CTRL up arrow
4. Move to cell B3, press + (or ENTER then +)
5. Type (then CTRL W (or CTRL up arrow)
6. Move to cell B1, press - (or ENTER then -)
7. Type CTRL W or CTRL up arrow
8. Move to cell B2, press) (or ENTER then ")")
9. Press ENTER

The formula has been entered without having to type any cell designations. You will find this feature is useful not just to save you the energy of typing, but to go get a cell designation some distance from where you are putting in the formula. This way you don't have to go find the cell you want to refer to, remember it, and find your way back. You can do it in one action, not have to remember anything, and return automatically with one keystroke.

K. Prompting For Mistakes

LUCID has a wonderful feature that you will really appreciate when you build spreadsheets with formulas. LUCID will sense when you are typing a mathematically incorrect formula, prompt you by emitting a beep, and show you with the small cursor where the mistake was made.

Here is an example of how this works:

Go to any blank cell and type in this formula:

+B4*5B3 Press ENTER

The computer beeps, and the small cursor rests on the B or the B3. We have omitted an arithmetic operator between the 5 and the B3. You can edit by just typing in the correct mathematical sign.

L. ENTER or Up arrow or Down arrow

Although it has been mentioned previously, be reminded that when you finish making any entry on your bottom line not only does the ENTER key record the formula or value or text, but the up or down arrow keys perform the same function, as do the left and right arrow keys when used in conjunction with the CTRL key.

M. Upper or Lower Case in Formulas

Another significant characteristic that bears emphasis is that you can write your formulas paying no attention to whether you use capital or lower case letters for the cell designations. LUCID will interpret them all as upper case after you press ENTER. When you go back to SCAN or Edit that cell, you will see that formula will show in all upper case.

N. Circular Reference

A circular reference is one which refers directly or indirectly to the cell you are writing the formula into. Often this is a mistake. LUCID has an excellent prompt that enables you to correct that typing error. The screen says Circular!

Example:

If you were on cell C6, and you typed +B4*C6, and pressed ENTER (or up or down arrow keys), the bottom line would say

+B4*C6 Circular!

When you see this message, just press ENTER, and then F1 (Edit), if you need to correct it.

Now it may seem that such a reference to the cell you are on would always be an error, but later we explain how in some calculations you will intentionally make circular references. This is because LUCID has a feature that lets you do a series of calculations that will narrow in on values that are being approximated.

CHAPTER XII

FUNCTIONS

LUCID has certain three letter key words that you can put into formulas that perform different functions. These functions provide you with more for your spreadsheet.

For example:

SUM lets you get the sum of all numbers in a range or MAX will return the maximum value in a range.

LUCID provides you with all functions necessary to build any spreadsheet. LUCID has several functions not found on other spreadsheets. A few, seldom used functions found on some other sheets are omitted, because with LUCID they can be easily derived as shown later, sometimes by simple formulas which are entered once and that cell referred to like a function.

Following is a listing and explanation of functions in LUCID.

1. SUM

Refer back to section D of this chapter, and review the example of the four entries we made. We then added up their values. The screen showed:

	A	B	C	D			
001		6.00					
002		4.00					
003		2.00					
004		3.00					
005							
006							
Edit	Calc	File	Ins	Del	Util	Sel	Exit
1	2	3	4	5	6	7	8

We showed an example of a formula in cell B6 that produced a total of the four values:

$$+B1+B2+B3+B4$$

The function SUM makes it a whole lot easier to get a total.

Sum is shown as +SUM(range).

Exercise:

Type in those same values that are shown above. Go to cell B6.

Type +SUM(B1:B4), press ENTER

cell says 15

SUM will total all values in a range. You can do a column, a row or a rectangle or rows and columns. For example, type in a group of values in a rectangle with the upper left corner as A2 and the lower right corner as E7. Now go to a cell outside that range and type +SUM(A2:E7) press ENTER. Cell will show the total of all cell values in that range.

Using SUM in a formula: Since the function SUM returns a value, you can use SUM in a complex formula just as if it were a cell reference.

For example you might have +B10*SUM(A4:A11)/3

2. MAX

This function will give you the maximum value in a range. You can use it for a column, row or rectangle.

Max is useful when you are showing sales results by territory, and want to single out the one with the most. MAX is shown as:

+MAX(range)

If you were to look at the values shown in the section 1 example with MAX it would be done like:

Go to a new cell and type

+MAX(B1:B4) Press ENTER

Cell says 6

You can use MAX in a formula. Since the function MAX returns a value, you can use MAX in a complex formula just as if it were a cell reference.

Example: 14/MAX(P4:R12)-B11

3. MIN

Minimum is just like maximum, except it will return the minimum value in a range.

One typical application is, if you were showing a series of price quotes for the same item from a group of suppliers, and would like to report the minimum price.

Minimum is written as +MIN(range)

**Example**

Enter a group of numbers in row B from B2 thru B12

In a cell outside this range type

+MIN(B2:B12) press ENTER

Cell shows minimum value in the range.

Your range can be any size row, column or rectangle.

Like MAX or SUM you can use MIN in a complicated formula just like a cell reference. It returns a value so you can add it or multiply it, or do any math calculation with it.

For example, a typical formula could be:

+A4/MIN(B2:B12)+SUM(C16:C24)

4. REF

REF lets you refer in a formula to a cell in another LUCID spreadsheet file that you have in RAM.

REF has two excellent uses:

a. REF will save you from having to build a spreadsheet over, that has values or data that would need to be repeated in the one you are preparing now.

b. REF will let you have multiple interfacing files. For example, you could have one file for an input sheet, another for a report, and another for the tables and calculations.

REF is written as +REF ("filename",A1)

Examples:

If you had a spreadsheet file (.CA file) named BUDGET.CA and in that spreadsheet you had RENT shown as \$1800 in cell C3

as:

	A	B	C	D			
001							
002							
003		RENT	\$1800				
004							
005							
006							
Edit	Calc	File	Ins	Del	Util	Sel	Exit
1	2	3	4	5	6	7	8

You might later be building another spreadsheet, and need to refer to that same value.

Just remember, the spreadsheet that you are referring to needs to be in your Model 100 at the same time, in order to return the value you are seeking.

REF will not work on labels. If you refer to a label in another spreadsheet, it will return the value zero.

Where you wish the \$1800 to appear, type

+REF("BUDGET",C3)

Press ENTER

You can use the function in the middle of a formula as well. For example, if you needed to add the rent value from the other sheet to another value (eg C8) in the new sheet, and multiply the total by 1.61. You would write it as:

+(C8+REF("BUDGET",C3))*1.61

5. CNT (or Count)

The function CNT (Count) will provide the Count of all values in a range. The range can be cells in a row, a column or rectangle.

Count (CNT) is useful for a number of applications. One example is, if you were preparing a bill of materials, listing all of the parts that went into the assembly of a manufactured item. You might want to show the count of how many parts were on the list.

Count is shown as +CNT(range), for example, +CNT(B14:F20) would return the number of values shown in a rectangle with cell B14 in the upper left corner and cell F20 in the lower right.

6. Average or mean.

Average is not a function in LUCID because the formula is so simple. It is just SUM/COUNT.

For example, if you wanted to obtain the average for a group of numbers in the range of D4:D20, you would go to a cell outside the range and type

+SUM(D4:D20)/CNT(D4:D20)

Press ENTER or up or down arrows (or CTRL left or right arrows).

The cell would show the average of that range.

7. TBL (or Table)

TBL or table is an extremely powerful function that is exclusive with LUCID. It does everything that such functions as LOOKUP and CHOOSE do in other spreadsheets, plus it provides you with remarkable characteristics that give you complex "if then" capability. This means that you can have input fields that will allow you to type in answers to questions, and then in other cells provide a report based on those answers.

TBL lets you have two input cells. It will look up those inputs on a chart. It finds one input on the x axis or top row part of the chart and the other input in the y axis or left column part of the chart. Where the two points cross on the table is the result that is returned. TBL also allows you to interface multiple tables so that you can have an input area with multiple questions that require interacting responses.

TBL will allow you to have either text or values as the input responses, and the answer that is returned from the table can be either text or a value. The table can even have a mixture of varying values and text either arranged in order or completely in a random fashion.

Table is written like this:

+ TBL(C1,C4,D6:G19)

In this example, C1 and C4 are the two input cells, and the table where they are looked up is found in a rectangular range with D6 as the upper left corner and G19 as the lower right corner.

Points about TBL

- Table will allow you to store and recall information that can only be derived by studying two inputs.
- Table will allow you to store and retrieve information that has but one input and looks up along a column or row of entries.
- Table will allow you to link responses from one or multiple tables so that you can respond to multiple inputs.
- Table is even made more useful with the Protect and Unprotect feature of LUCID. This means that you can design sheets with questions or query sections that are protected and leave the cells where answers are to go unprotected.
- The table function is written like this:

+TBL(A2,A5,F2:K10)

Of course, these cell designations are just examples.

f. On the example above, A2 is the first input cell. It will be looked up on the column part (or left hand border) of the table. This is also called the y axis, and in this example consists of cells F3 through F10

g. A5 is the second input cell, it will be looked up on the row part (or top border) of the table. This is also known as the x axis, and in this example consists of cells G2 through K2

h. In the example F2:K10 defines the location of the table to be studied.

Following is a simple example of a table that will illustrate how the TBL function works.

Follow these instructions to create the following example:

TABLE Example 1 - two input look up

- Go to Type
- A1 Your age?
- A3 Your weight?
- A5 Aerobic points:
- C1 0 (optional)
- C3 0 (optional)
- C5 +TBL (C1,C3,F1:K6)

Note: cell C5 will say ERR until table below is entered.

Now we will write the table. You will observe that the upper left corner of the table (in our example F1) is blank. Always remember when creating a table to leave the upper left corner cell blank.

	F	G	H	I	J	K
A01		90.00	120.00	170.00	220.00	300.00
A02	20.00	30.00	35.00	38.00	Lose weight	Warning! Exercise harmful
A03	40.00	25.00	30.00	32.00	Lose weight	Warning! Exercise harmful
A04	60.00	20.00	25.00	27.00	Lose weight	Warning! Exercise harmful
A05	80.00	10.00	15.00	18.00	Lose weight	Warning! Exercise harmful
A06	100.00	See Doctor	before exercise			
A07						

(Repeat the message shown in G6 in H6, I6, J6 and K6)

To build this table use some of the features we have described earlier.

1. Replicate the text that is repeated from cell to cell.
2. Notice that on a table you don't need to widen your columns to have long text responses. You won't be viewing the table, so these can be hidden (overlapped) by adjacent entries.

After you have completed this table go back to your input screen and type in some answers. Press F2 (Calc) each time, after completing your responses. See the recommended aerobic points in the cell where you put the TBL formula (C5).

You have now created a simple program, later you'll see how to deal with more sophisticated inputs and conclusions. These values are not necessarily correct for aerobics points, but we provided this example merely for you to observe how the TBL function works.

Test it several times over a range of inputs, and observe how you will get back the appropriate answers.

Here are some more points to remember about TBL. Using the example formula `+TBL(C1,C3,F1:K6)`, and sample table we prepared, observe that:

1. The first cell reference in the formula is the look-up value for the left column border (y axis). An easy way to remember this is that as you look at the table from left to right, the y axis appears first. We chose this easy to remember method over the more academic xy order for simplicity and for consistency with the column/row designation used by the spreadsheet, e.g. A1.
2. The second cell reference in the formula is the look-up value for the top row border (x axis).
3. The range defines the geography of the entire table.
4. The upper left cell reference of the range definition is a blank cell. That cell is at the juncture of the top row (x axis) look-up values and the far left column (y axis) look-up values. The first (top left) range reference cannot be above or to the left of the table, but must be exactly that particular blank cell.
5. The second range cell reference is the lower right of the table. It doesn't have to be exact. Just so it includes all the table. Going beyond won't effect the results.

6. The look-up items on the x axis (top row) and on the y axis (left column) must be in numerical order, or if text, in alphabetical order. The reason is so that your numerical input answers can be approximate. LUCID will look for the nearest. If the answer isn't exactly like a table axis sentry, LUCID always goes to the next highest value on the table. LUCID also searches alphabetically, and will find an exact spelling or variations on either side of a spelling without regard to upper and lower case. Later you'll see an example which explains this feature.

7. If there is a likelihood of an answer being given that is off the chart or greater than your last look-up value, you need to make the last value very large, for example 10^{50} or if text zzz. This will mean that any response greater than your next to last look-up value will get the appropriate answer from the last column or row. This is known as a sentry. If an input is given that is greater than the last column or row heading LUCID will return an ERR message for the TBL functions.

TABLE Example 2 - single input lookup

Go to	Type
A2	Enter state:
A3	Press ENTER then F2
A4	The capital is:
C4	+TBL (C2,G1,F1:G6)
G1	X (or any character in cell G1)
F2	Alabama
F3	Alaska
F4	Arizona
F5	Arkansas
F6	California
G2	Montgomery
G3	Juneau
G4	Phoenix
G5	Little Rock
G6	Sacramento

If you wish keep entering in this fashion and build the Table until it includes all 50 states and capitals. Because of space limitations in the manual we are showing only six states.

As you enter these names you will note that the G column of labels will over lap the F column. You could widen these columns as you have learned in an earlier section, but for a table, it isn't really necessary, because only the computer is going to look at these entries.

Now test it out. Of course, if you only typed in the 6 states you can only enter one of these 6 to get a response. Remember to press F2 (Calc) after typing in the state to get back the capital.

Some points about TBL for single input:

1. Note that the second cell reference is merely the cell on the table that is the column heading for the response entries of capitals.
2. We showed an X as the heading for the response entries. This literally could be any number or text entry.

Table Example 3 - comparison for exactness or equality

Sometimes you would like to pose a question, and then test if the answer is correct. The following is an illustration of such a comparison.

Go to	Type
A2	U.S. capital?
A4	You are
B4	+TBL (C2, G1, F1:G4)
C2	X (optional)
F2	Washington
F3	Washington D.C.
F4	zzz
G1	X
G2	wrong
G3	correct
G4	wrong

Now go back and answer the query, or have someone else try. Always press F2 (Calc) after typing in your answer. Notice that no matter what answer you give other than Washington or Washington D.C. LUCID says, "You are wrong".

Some points about Table for comparison for exactness.

1. Notice that this is a single input table, and one of the cell references in the table formula is directly the top row heading on the table.
2. As with any LUCID table, the left column border (or row border or both as the case may be) gives a series or range of answers. In this

case these is one right answer which will return a response of "correct".

3. The other two answers are entries like we talked about earlier, which will cover all possible other answers and return a response of "wrong".

4. LUCID searches alphabetically or numerically. For example, when you test this table where you ask the capital of the United States, you will find that many people might answer Dallas or Houston - a natural mistake. Of course, they are really surprised when the computer tells them they are wrong. LUCID searches alphabetically and a wrong answer is located alphabetically just like a correct one.

This is an example of alphabetic arrangement:

A thru Z, AA thru AZ, AAA thru AAZ, AAAA thru AAAZ

If you followed this succession down to ZZZZZZ you would have spelled every one through six letter word there is. To create a sentry alphabetically above a correct answer, just spell the sentry word like the correct answer, but with the sentry's last letter as one prior on the alphabet. Since LUCID searches forward either numerically or alphabetically, in this case an answer of "a" would return a wrong answer all the way down to "Washington".

You might not want just the perfect spelling as the correct answer. You might wish to provide some latitude for close tries. If you wanted all answers from WASH to Washington to be correct, you would then write WASI as the sentry. The way we entered it, both Washington and Washington D.C. will return as correct answers. 5.

To create the sentry below the correct answer, zzz will provide the limit to the range. Every spelling from the correct one to zzz will return a "wrong" answer.

TABLE Example 4: Providing for more than one correct answer.

Perhaps you would wish to have the answer "District of Columbia" as correct as well. Here is that table:

Use the same table inputs as the previous example, but with the changes on the table as shown.

B4	+TBL(C2,G1,F1:G6)
G1	X
F2	District of Columbh
F3	District of Columbia
F4	Washington
F5	Washington D.C.
F6	ZZZ
G2	Wrong
G3	Correct
G4	Wrong
G5	Correct
G6	Wrong

Note, if you wanted, you could provide even more correct answers. Each one you add must also set other sentries to allow for wrong answer locations.

TABLE Example 5: Interfacing several table references for more sophisticated programming.

LUCID truly provides you with the ability to generate programs that will process a variety of inputs and return a variety of answers. This is accomplished by linking TABLES with each other so that the results of one lookup becomes an input for another.

In this program example we:

- Provide the program user with an input screen that lets him name any state in the U.S.
- It then asks the user to guess the capital city.
- He is told whether his answer is "correct" or "wrong".
- He can find out, or confirm, the correct capital by moving with the down arrow to see the answer displayed.

Before studying how this is done, try to think it out. It is similar to example 3, and at first you might think that you would need 50 tables, one for each state, to do this.

As you will see, the information is processed with only two tables, but LUCID actually creates a new temporary table with each state input. The first table becomes a repository for the second table's search words.

As you build this example in your own Model 100, consider the possibilities. You can do very detailed input questions, and have those multiple inputs processed in conjunction with each other in many combinations against data compiled in several tables.

For the example that follows we only show 6 states and capitals. If you wish to complete all 50 just look them up in an encyclopedia (if you can't remember them all), and fill out the table.

Go to	Type
A2	Press ENTER then F2 after answering
A3	Name a state
C3	X
A4	Guess the capital
C4	X
A5	You are
A6	Wrong? Push down arrow for capital
B5	+TBL (I6,C4,I5:L6)
A8	Capital is:
C8	+TBL (C3,F2,E2:G60)
F2	a
G2	b
E3	Alabama
E4	Alaska
E5	Arizona
E6	Arkansas
E7	California
E8	Colorado
F3	Birmingham
F4	Juneau
F5	Phoenix
F6	Little Rock
F7	Sacramento
F8	Denver
G3	Birmingham
G4	Juneau
G5	Phoenix
G6	Little Rock
G7	Sacramento
G8	Denver

J5	+TBL (C3,G2,E2:H60)
K5	+TBL (C3,F2,E2:H60)
L5	zzz
I6	X
J6	Wrong
K6	Correct
L6	Wrong

Points about interfacing tables.

1. Observe that one table merely acts to hold the search references for the top row of the second table. Although we only show a few, you could have as many search entries as you wish.
2. On this example, we showed one table feeding one search axis (x axis). You could have yet another table feeding the y axis.
3. You could design a sheet that takes an answer from the assembled table, and instead of just reporting it as we did, have that looked up on another table. You need to let your imagination run, on whatever application you have. Just write out how many inputs you will have, and consider how they relate to each other and their relationship with facts that can be concluded.

TABLE Example 6: "If then" statements, "greater than" or "less than"

Sometimes you will have an input that will require a certain response or calculation if the input is one amount, and another response if it is less than or greater than that amount.

For example: if you might need to calculate the price of a service that was priced at \$10 per hour, but had a 4 hour minimum.

The input would be the number of hours. The bill would be simply number of hours times 10. But if the number of hours is less than 4 then it must be calculated as 4.

Go to	Type
A1	Rate per hour:
C1	10
A2	Number of hours:
C2	X (optional)

A5	The bill is
C5	+TBL (C2,B8,A8:B10)*C1
B8	x
A9	4
B9	4
A10	10 50
B10	+C2

Your table should appear like this:

	A	B
008		x
009	4.00	4.00
0010	% 1E+50	X

Note: As we explain elsewhere in the manual astronomically large numbers are displayed by scientific notation. The result of 10^{50} would be trillions and trillions.

Here's how the example works.

1. The bill is calculated by what is found on the table times the rate per hour.
2. On the table, the number of hours worked is found on the y axis. Since this is a single input table, the x axis entry is merely any designation.
3. When you type in the number of hours (C2), LUCID searches along the y axis values, and then returns the one opposite. As discussed earlier, LUCID searches numerically. Any value not shown is regarded as the next number upward from one that is shown. For example, any input from 0.00 to 4 will be returned as 4.
4. Any input from 4 to 10 to the 50th power will be regarded as exactly the input on this particular table.
5. We again have used "sentries" to set the "if then" parameters. Using 10^{50} sets an astronomically high limit at one end. If you wanted a 0.00 entry to return a 0.00 response you would make the table like this.

	A	B	C	D
001	Rate per hour:		10	
002	Number of hours:		0	
003				
004				
005	The bill is		+TBL(C2,B8,A8:B11)*C1	
006				
007				
008		X		
009	0	0		
010	4	4		
011	10^50	+C2		

This table says: If input is 0 calculate as 0.

If input is greater than 0, but less than 4 then calculate as 4.

If input is greater than 4, calculate as input.

8. INT

INT returns the integer portion of a number, truncating all decimal places. For example INT(4.56789) will evaluate to 4. If you wish to round up decimals above 0.5, simply add 0.5 to expression. For example INT(1.49+0.5) gives 1, but INT(1.5+0.5) evaluates to 2. Of course the parentheses following the INT can contain any formula including cell references and numbers, for example INT(A9/3+2*B7).

9. RND

RND gives a random number between 0 and 1. If you wanted a random number between 1 and 100 you would simply multiply it by 100. You would write this as RND(1)*100.

10. SQR

SQR gives the square root of the expression following it in parentheses. For example SQR(4) would give a result of 2. You can also calculate a square root using the ^ operator, since 4^.5 would also return the square root of 4. Another way to calculate a square root would be to take the log of a number, divide by two, and then take the EXP of the answer.

11. LOG

LOG gives the natural log (base e) of a number. It is written like this: LOG(5). You can have any formula in the parentheses instead of 5. To get the log base 10 of a number, simply divide the log base e by the log base e of 10, which would look like this: +LOG(5)/LOG(10).

12. EXP

EXP gives the antilog (base e) of a number. Write it like this: +EXP(3.145). As usual you can have any expression or formula in the parentheses. To continue the example given under SQR, you could take the square root of 4 like this: +EXP(LOG(4)/2). To get the antilog base

10 of a number, simply raise ten to that power. For example antilog (base 10) of 2.4 is $10^{2.4}$.

13. COS

COS(formula) gives the cosine of the value or formula in the parentheses. The value must be in radians. To get the cosine of an angle in degrees, simply multiply the angle in degrees by $\pi/180$. If you can't remember π , you can get it from the formula $4*ATN(1)$. For example, the cosine of 60 degrees is $+COS(60*ATN(1)/45)$.

14. SIN

SIN(formula) gives the sin of the value or formula in the parentheses. Like with COS, you need to put the value in radians. Multiply by $\pi/180$ (or $ATN(1)/45$) to get degrees into radians.

15. TAN

TAN(formula) gives the tangent of the value or formula in the parentheses. Like with SIN and COS, you will need to convert any angles in degrees into radians to use this function.

16. ATN

ATN(formula) gives the arctangent of the value in parentheses. It can also be used to give the inverse sin and inverse cosine using the following derived function table.

17. Absolute Value.

To return the absolute value of a cell without regard to its sign, simply take the square root of the square of the cell, for example $ABS(G2)$ could be determined by the following formula $SQR(G2^2)$. Another way would be to multiply the cell by its sign, using the TBL function to determine the sign. This is likely to calculate faster than the root of the square.

18. Sign

The SGN function in BASIC can be simulated in LUCID by constructing a table like the one below. The cell whose sign is desired is used to look up down column E, and the sign is found in column F. It works like this. The first occupied cell in column E is -10^{-61} . If a cell evaluates to be less than or equal to this, it's sign is negative, and the table returns -1 . The next value in column E is 0, in case the cell we are inspecting has a value of 0. Anything greater must have a positive sign, so the next number in column E is the largest one that LUCID can comprehend, to prevent large numbers falling off the end of the table.

The formula in cell D5 will always evaluate to -1 , 0 or $+1$.

Example of finding the sign of cell D3:

	D	E	F
001			SGN
002		-10^{-61}	-1
003	$-.5$	$+0$	$+0$
004		10^{61}	$+1$
005	+TBL(D3,F1,E1:F4)		

Derived Functions

Function	Functions Expressed in Terms of LUCID Functions. X is in radians.
SECANT	$SEC(X) = 1/COS(X)$
COSECANT	$CSC(X) = 1/SIN(X)$
COTANGENT	$COT(X) = 1/TAN(X)$
INVERSE SINE	$ARCSIN(C) = ATN(X/SQR(-X*X+1))$
INVERSE COSINE	$ARCCOS(X) = -ATN(X/SQR(-X*X+1))+1.5708$
INVERSE SECANT	$ARCSEC(X) = ATN(SQR(X*X-1))$ $+ (SGN(X)-1)*1.5708$
INVERSE COSECANT	$ARCCSC(X) = ATN(1/SQR(X*X-1))$ $+ (SGN(X)-1)*1.5708$
INVERSE COTANGENT	$ARCCOT(X) = -ATN(X)+1.5708$
HYPERBOLIC SINE	$SINH(X) = (EXP(X)-EXP(-X))/2$
HYPERBOLIC COSINE	$COSH(X) = (EXP(X)+EXP(-X))/2$
HYPERBOLIC TANGENT	$TANH(X) = -EXP(-X)/(EXP(X)+EXP(-X))*2+1$
HYPERBOLIC SECANT	$SECH(X) = 2/(EXP(X)+EXP(-X))$
HYPERBOLIC COSECANT	$CSCH(X) = 2/(EXP(X)-EXP(-X))$
HYPERBOLIC COTANGENT	$COTH(X) = EXP(-X)/(EXP(X)-EXP(-X))*2+1$
INVERSE HYPERBOLIC SINE	$ARCSINH(X) = LOG(X+SQR(X*X+1))$
INVERSE HYPERBOLIC COSINE	$ARCCOSH(X) = LOG(X+SQR(X*X-1))$
INVERSE HYPERBOLIC TANGENT	$ARCTANH(X) = LOG((1+X)/(1-X))/2$
INVERSE HYPERBOLIC SECANT	$ARCSECH(X) = LOG((SQR(-X*X+1)+1)/X)$
INVERSE HYPERBOLIC COSECANT	$ARCCSCH(X) =$ $LOG((SGN(X)*SQR(X*X+1)+1)/X)$
INVERSE HYPERBOLIC COTANGENT	$ARCCOTH(X) = LOG((X+1)/(X-1))/2$
PI	$4*ATN(1)$

Valid Input Range

Inverse Sine	$-1 < X < 1$
Inverse Cosine	$-1 < X < 1$
Inverse Secant	$X < -1$ OR $X > 1$
Inverse Cosecant	$X < -1$ OR $X > 1$
Inverse Hyper, Cosine	$X > 1$
Inverse Hyper, Tangent	$X*X < 1$
Inverse Hyper, Secant	$0 < X < 1$
Inverse Hyper, Cosecant	$X < > 0$
Inverse Hyper, Cotangent	$X*X > 1$

	A	B	C
001	Payment	\$183.28	
002	Interest	0.02	
003	Term	36	
004	PV	[\$5,000.00]	
005			
006			

$$+B1*(1-(1+B2)^{-B3})/B2$$

3. Future Value:

The formula for FV is similar to the formulas for PMT and PV:

$$FV = \text{payment} * ((1 + \text{interest})^n - 1) / \text{interest}$$

Using the same example as for PMT and PV:

	A	B	C
001	Payment	\$183.28	
002	Interest	0.02	
003	Term	36	
004	FV	[\$8,801.94]	
005			
006			

$$+B1*((1+B2)^{B3}-1)/B2$$

4. Term:

The above formula can be reworked to find the term as follows:

$$\text{Term} = -\ln(1 - PV * \text{interest} / \text{payment}) / \ln(1 + \text{interest})$$

	A	B	C
001	Principal	\$5,000.00	
002	Payment	\$183.28	
003	Interest	0.02	
004	Term	[\$ 36.00]	
005			
006			

$$-\text{LOG}(1 - B1 * B3 / B2) / \text{LOG}(1 + B3)$$

5. Interest on a loan:

Interest cannot be found by a simple formula, but must be homed in on by a series of guesses, each being refined by the results of the previous one. The formula is a rather complicated one, but fortunately you will

only need to enter it once, then you can use your 'interest' spreadsheet any time simply by filling in the various values of principal, term and payment. Here is the formula we use:

(i=previous guess at interest)

Next Guess= $i - (1 - (1 + i)^{-n} - \text{Prin} * i / \text{Pmt}) / ((n * (1 + i)^{-(n+1)} + ((1 + i)^{-n} - 1) / i)$

This is more easily illustrated by an example:

	A	B	C
001	Term (months)	36.00	-0.00
002	Principal	\$5,000.00	-7.15
003	Payment	\$183.28	
004	Interest	0.02	0.02
005	Annual Int.	19.00	
006			
	Edit	Calc	File
	1	2	3
		Ins	Del
		4	5
		Util	Sel
		6	7
			Exit
			8

Here are the contents of the cells:

	A	B	C
001	Term (months)	+36	$1 - (1 + C4)^{-B1} - B2 * C4 / B3$
002	Principal	+5000	$+B1 * (1 + C4)^{-B1} + ((1 + C4)^{-B1} - 1) / C4$
003	Payment	+183.28	
004	Interest	+C4 - C1 / C2	+B4
005	Annual Int.	+B4 * 1200	
006			

Building this spreadsheet is like building an archway, you must put the keystone in last. In this case the keystone is cell C4. When first constructing the spreadsheet, fill in cell C4 first, but with a fake constant, for example 0.01. Don't change this to what it should be (+B4) until everything else has been entered.

When all the formulas and some dummy values have been entered, press F2—Calc. This will set up the formulas without any zero values which could provoke errors. Only now are you ready to change you keystone cell C4 to what it really should be, +B4. When you have made this change, press F2—Calc. The screen will say 'Circular!'. This is Ok, since you do have a circular reference in the spreadsheet. You will see a different value under Interest, one which is closer to the right answer.

Continue to press F2—Calc until the value in cell B4 stays the same for two successive redisplay (remember to set the display for this cell to 7 decimal places). Then recalculate once or twice more to ensure

accuracy in the eighth through fourteenth places of precision. Note: Although Lucid shows a maximum of seven decimal places, you can view the other places by entering a formula in any empty cell of $+B4*10^{15}$. This moves the decimal places to the left of the decimal point for inspection.

Now that you have the spreadsheet set up, all you need to do to calculate the interest on any ordinary annuity is to type in the values for Principal, Payment and Term, then press F2 until the value in the cell labeled interest stabilizes.

6. Net Present Value:

The Net Present Value of a series of unequal cash flows is the sum of their individual present values. The following example is of an initial outlay of \$10,000.00, with five subsequent cash inflows of varying amounts.

	A	B	C
001	Interest	0.08	
002	Period #	Amount	FV
003	0	-10,000.00	-10,000.00
004	1	2,000.00	1,851.85
005	2	2,400.00	2,057.61
006	3	2,800.00	2,222.73
007	4	3,450.00	2,535.85
008	5	2,800.00	1,905.63
009			
010	Net Present Value		573.68

What is in the cells:

	A	B	C
001	Interest	+.08	
002	Period #	^Amount	^PV
003	+0	-10000	+B3*(1+\$B1)^-A3
004	+1	+2000	+B4*(1+\$B1)^-A4
005	+2	+2400	+B5*(1+\$B1)^-A5
006	+3	+2800	+B6*(1+\$B1)^-A6
007	+4	+3450	+B7*(1+\$B1)^-A7
008	+5	+2800	+B8*(1+\$B1)^-A8
009			
010	Net Present Value		+SUM(C1:C8)

The formulas in column C were copied down the column from cell C3. Note that the \$ sign in front of the reference to cell B1 causes it to be an absolute reference that does not change when it is copied.

7. Internal Rate of Return:

The IRR of a series of cash flows is the notional interest rate at which the NPV of a series of cash flows is exactly zero.

	A	B	C	D
001	IRR	0.1000113		0.10
002	Period #	Amount	f(i)	f'(i)
003	0	-10,000.00	-10,000.00	0.00
004	1	2,000.00	1,818.16	1,652.86
005	2	2,400.00	1,983.43	3,606.20
006	3	2,800.00	2,103.62	5,737.08
007	4	3,450.00	2,356.30	8,568.27
008	5	2,800.00	1,738.49	7,902.15
009			=====	=====
010	Net Present Value		0.00	27,466.56

The term $f(i)$ in this table is what we called PV in earlier examples. The derivative of this $-f'(i)$ is meaningless in itself, but is used as an intermediate term to close in on a better value for IRR. This formula, like the one for interest on an annuity, is iterative, and therefore displays the message 'Circular!' when you press F2—Calc. Again, it is important to leave your 'keystone' until last. In this case, put a dummy value such as 0.1 into cell B1 until all the other formulas are entered, then put in the reference to cell.

What is in the cells:

	A	B	C	D
001	"IRR	+D1		+B1-C10/(-D10)
002	Period #	^Amount	^f(i)	^f'(i)
003	+0	-10000	+B3*(1+\$B1)^-A3	+A3*B3*(1+\$B1)^-(A3+1)
004	+1	+2000	+B4*(1+\$B1)^-A4	+A4*B4*(1+\$B1)^-(A4+1)
005	+2	+2400	+B5*(1+\$B1)^-A5	+A5*B5*(1+\$B1)^-(A5+1)
006	+3	+2800	+B6*(1+\$B1)^-A6	+A6*B6*(1+\$B1)^-(A6+1)
007	+4	+3450	+B7*(1+\$B1)^-A7	+A7*B7*(1+\$B1)^-(A7+1)
008	+5	+2800	+B8*(1+\$B1)^-A8	+A8*B8*(1+\$B1)^-(A8+1)
009			'=====	'=====
010	Net Present Value		+SUM(C1:CB)	+SUM(D2:DB)

Keep pressing F2—Calc until the value labeled IRR stabilizes, or until the sum at the foot of the column labelled $f(i)$ (i.e. the NPV) becomes 0.

CHAPTER XIV

LUCID SPREADSHEET EXAMPLES

Now we provide you with several examples of spreadsheets which will illustrate the actual building of a worksheet, and putting to use the various features which we have described.

Study these examples not only for their actual practicality for your own use, but because they illustrate the possibilities of how to make LUCID perform virtually whatever task that you have in mind.

Absolute vs. Relative References

Before we describe these application examples, we need to explain about absolute and relative references.

These terms are familiar to persons who have used other spreadsheets, because they entail an arduous procedure whenever you wish to replicate or move cells. With LUCID, however you will find that absolute and relative references are made very simple.

Absolute and relative references only concern any cell contents that are going to be moved or copied or replicated.

Relative Cell Reference:

This is a cell reference that when moved or copied, changes “relative” to where it is placed. When a relative cell reference is copied or moved, it will refer to a cell or cells an equal distance and direction from the new cell as the originating cell did. In other words the new references are changed to “relate” to the new location.

The wonderful feature that LUCID has is that all cell references in LUCID are relative, unless you indicate otherwise in the formula, as we will explain later.

Example:

Go to	Type
A3	16
B3	+A3+10

Now copy B3 and paste into cell C3

The formula reads

+B3+10

Paste into cell F3, the formula reads

+E3+10

Absolute cell reference:

This is a cell reference, which when moved, remains the same. For example, if you wanted, in the exercise above, the reference to always say +A3+10 no matter where you moved it, then you would want it to be absolute.

In LUCID to make a formula have an absolute cell reference, just type in a \$ sign before the cell reference.

Example:

Go to	Type
A3	16
B3	+\$A3+10

Now copy B3 and paste it into cell C3.

The formula reads +\$A3+10, the same as originally.

Paste it to cell F3

The formula reads +\$A3+10, again the same.

Review of Absolute and Relative Cell References:

1. Absolute and relative only have meaning if you are moving, copying or replicating a cell reference.
2. Absolute means a reference that won't change when moved.
3. Relative means a reference that changes when moved. Each new reference is in exact relationship to cells around it as the original was to the cells it referenced.

Application examples.

The following are application examples which utilize the procedures and techniques described in this manual. Study these examples and learn to use these methods for your own specialized needs.

Application example 1

Price quote workup:

The example which follows illustrates a number of “if then” situations and multidimensional table searches that are common requirements in preparing quotes, but impossible to do with conventional spread-sheets.

The example we have chosen is a small, quick copy kind of print shop.

Here are the pricing parameters and your problem:

1. For this shop, printing charges are a table of prices for small runs of under 1,000. The prices for quantities of 50, 100, 200, 300, 400, 500, 600, 700, 800 and 900 have been arbitrarily set and do not follow a mathematical formula.
2. There are two sets of prices for these quantities, one for $8\frac{1}{2} \times 11$ and the other for 11×17 . The $8\frac{1}{2} \times 11$ price for a given quantity bears no relation to the 11×17 price for the same quantity.
3. For runs over 1,000, there is a price per 1,000 for each of the two sizes.
4. All jobs have the option of collating, stapling, stitching, cutting, or folding. Some jobs might have all services, some might have only one or two, others would have none.
5. For each one of these services there is a price per 100, but there is a minimum price for any service used if the per 100 price is less than the minimum. And of course if a service is not opted for, the minimum would not apply.
6. All jobs can have multiple colors. A single color is no extra charge. Each extra color has a per 100 rate, but there is a minimum charge of \$5.00 per color if the per 100 calculation is less than \$5.00.
7. The shop owner gives you the following information:

Copy prices

$8\frac{1}{2} \times 11$	50	100	200	300	400	500
	3.80	4.95	6.90	8.40	9.95	10.95
	600	700	800	900	1000	
	12.95	14.95	15.65	16.95	18.00	



exceptional spreadsheet

11x17	50	100	200	300	400	500
	5.50	6.20	7.89	9.30	12.90	14.66
	600	700	800	900	1000	
	16.60	17.40	18.60	20.07	22.10	

Over 1000:

8½x11	13.25	per 1000
11x17	16.20	per 1000

Services

	Prices per 100	Minimum charge
Collate	.65	2.00
Cut	.25	2.00
Fold	.34	1.00
Staple	.95	3.00
Stitch	2.50	3.00
Extra Color Ea.	.45	5.00

8. The objective is to prepare an input area where a clerk (or customer) can simply type in the number of copies needed, then indicate which of the services are required, the size of paper and the number of colors. You would want to be able to type in the customer name and address. Then with one button you want to calculate the complete price quote for the job, which could be printed out for the customer to take with him.

9. The following is a way you could have the clerks (or customers) input screen, and quote report, to appear:

Customer
Name
Address
City
St. & Zip

Costs

# of copies	600.00	Printing	12.95
Collate (y or n)	y	Collate	3.90
Cut (y or n)	n	Cut	0.00
Fold (y or n)	n	Fold	0.00
Staple (y,n)	y	Staple	5.70
Stitch (y,n)	y	Stitch	15.00
Xtra Clr? (y,n)	y	Xtra clr.	5.00
# of Xtra colors?	1.00		
A) 8.5x11 B) 11x17	a	TOTAL	42.55

Can you design the worksheet which will provide the calculations, taking into consideration all the parameters and conditions of every quote possibility?

Following is a listing of all the cell contents along with comments to explain what is being accomplished. Type this in, test it and study the way it solves the problems.

Go To	Type
A1	Customer
A2	Name
A3	Address
A4	City
A5	St. & Zip
A8	# of copies
A9	Collate (y or n)
A10	Cut (y or n)
A11	Fold (y or n)
A12	Staple (y,n)
A13	Stitch (y,n)
A14	Xtra Clr? (y,n)
A15	# of xtra colors?
A16	A)8.5x11
A26	Copy prices
A28	a)8.5x11
A29	b)11x17
A33	Services, price/100
A35	Minimum
A36	n
A37	y
A41	Collate
A42	Cut
A43	Fold
A44	Staple
A45	Stitch
A46	Xtra clrs
B16	B)11x17
B27	50
B28	3.80
B29	5.50
B34	Collate
B35	2
B37	.65

exceptional spreadsheet

B40	0
C8	100
C9	y
C10	n
C11	y
C12	n
C13	y
C14	y
C15	2
C16	b
C27	100
C28	4.95
C29	6.20
C34	Cut
C35	2
C37	.25
C40	.99
C41	+B35
C42	+C35
C43	+D35
C44	+E35
C45	+F35
C46	5*C15
D6	Costs
D8	Printing
D9	Collate
D10	Cut
D11	Fold
D12	Staple
D13	Stitch
D14	Xtra clr:
D15	`-----

*Note: you could make reference to the other occurrences of these labels rather than typing them over.

D16	TOTAL:
D27	+C27+100
D28	6.90
D29	7.89
D34	Fold
D35	1

D37	.34
D40	1.99
D41	+B35
D42	+C35
D43	+F43
D44	+E35
D45	+F35
D46	5*C15
E8	+TBL(C8,G30,F30:G32)
E9	+TBL(D9,G41,\$A40:\$G46)
E10	+TBL(D10,G42,\$A40:\$G46)
E11	+TBL(D11,G43,\$A40:\$G46)
E12	+TBL(D12,G44,\$A40:\$G46)
E13	+TBL(D13,G45,\$A40:\$G46)
E14	+TBL(D14,G46,\$A40:\$G46)
E16	+SUM(E8:E14)
E27	+D27+100
E28	8.40
E29	9.30
E34	Staple
E35	3
E37	.95
E40	2.99
E41	+F41
E42	+F42
E43	+F43
E44	+E35
E45	+F35
E46	5*C15
F27	+E27+100
F28	9.95
F29	12.9
F31	1000
F32	10 ^ 50
F34	Stitch
F35	3
F37	2.50
F40	4.99
F41	+G41
F42	+G42
F43	+G43

exceptional spreadsheet

F44	+G44
F45	+G45
F46	5*C15
G27	+F27+100
G28	10.95
G29	14.66
G30	x
G31	+TBL(C16,C8,A27:M29)
G32	+G31*C8/1000
G34	xtra clr
G35	5.00
G37	.45
G40	10 ^ 50
G41	+TBL(C9,D9,\$A34:\$G37)*\$C8/100

NOTE: you can use copy and paste here if you want. Place the cursor on cell G41, and press F7-Sel then ENTER, then F5-Copy. Then move to cell G42 and press PASTE, then the period, and stretch the cursor down to G46, then press ENTER. Then move to G46 and edit the formula to add *C15.

G42	+TBL(C10,D10,\$A34:\$G37)*\$C8/100
G43	+TBL(C11,D11,\$A34:\$G37)*\$C8/100
G44	+TBL(C12,D12,\$A34:\$G37)*\$C8/100
G45	+TBL(C13,D13,\$A34:\$G37)*\$C8/100
G46	+TBL(C14,D14,\$A34:\$G37)*C15*C8/100
H27	+G27+100
H28	12.95
H29	16.60
I27	+H27+100
I28	14.45
I29	17.40
J27	+I27+100
J28	15.65
J29	18.60
K27	+J27+100
K28	16.95
K29	20.07
L27	+K27+100
L28	18
L29	22.10
M27	10 ^ 50
M28	13.25
M29	16.20

Figure 1, Application Example 1

	A	B	C	D	J	K	L	M
001	Customer							
002	Name	Ajax Tool Company						
003	Address	2343 Fremont						
004	City	Dallas						
005	St. & Zip Tx	75228						
006			Costs					
007	# of copies			Printing	14.66			
008	Collate (y or n)	Y	450.00	Collate	2.93			
009	Cut (y or n)	Y		Cut	2.00			
010	Fold (y or n)	Y		Fold	1.53			
011	Staple (y,n)	n		Staple	0.00			
012	Stitch (y,n)	Y		Stitch	11.25			
013	Xtra Clr? (y,n)	Y		Xtra clr.	10.00			
014	# of Xtra colors?	Y	2.00	TOTAL	42.37			
015	(A)8.5x11 (B)11x17	b						
016								
017								
018								
019								
020								
021								
022								
023								
024								
025	Copy Prices							
026	(A)8.5x11	50.00	100.00	200.00	300.00	400.00	500.00	600.00
027	(B)11x17	3.00	4.95	6.90	8.40	9.95	10.95	12.95
028		5.50	6.20	7.89	9.50	12.90	14.66	16.60
029								
030								
031								
032								
033	Services, price/100							
034	Collate	2.00	2.00	1.00	3.00	3.00	3.00	5.00
035	Minimum							
036	Cut	0.65	0.25	0.34	0.95	2.50	0.45	
037								
038								
039								
040	Collate	0.00	0.99	1.99	2.93	2.93	4.99	1E+50
041	Cut		2.00	2.00	2.00	2.93	2.93	
042	Fold		1.00	1.53	1.53	1.13	1.13	
043	Staple		3.00	3.00	3.00	1.53	1.53	
044	Stitch		3.00	3.00	3.00	0.00	0.00	
045	Xtra clrs		10.00	10.00	10.00	11.25	11.25	
046								
047								
048								
049								
050								
051								
052								
053								
054								
055								
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TBL 1 (A27:M29)

TBL 2 (F30:G32)

TBL 3 (A34:G37)

TBL 4 (A40:G46)

Application Example #1, NOTES:

Here are some points to observe when learning how we built this spreadsheet example:

1. We used four tables.

a. TBL 1 (A27:M29) contains the pricing for the 2 sizes of paper in the arbitrary dollar units for quantities under 100. On the end are the over 1000 prices. For all these we use another TABLE (TBL 2) to actually calculate the printing costs.

b. TBL 2 (F30:G32) enables LUCID to determine if it takes a less than 1000 price directly from TBL 1 or calculates the over 1000 price in multiples of 1000. Notice that the printing costs tabulations formula, E8 which is $+TBL(C8,G30,F30:G32)$, refers only to TBL 2.

c. Here is a sequence of what happens in calculating the printing costs, E8. E8 comes entirely from TBL 2. It searches the y axis for the quantity (C8), the x axis is merely the single column marker for the table. Therefore you can see LUCID will choose only one of two answers; G31 if quantity is less than 1000, and G32 if it is greater.

If the quantity is less than 1000, G31 returns $+TBL(C16,C8,A27:M29)$ this means it looks at the size (C16) and the quantity (C8) on Table 1 to get the price.

If the quantity is greater than 1000, G32 returns $+TBL(C16,C8,A27:M29)$. This means it looks at the size, C16 (a or b) and the quantity, which of course is the >1000 category, on TBL 1, then multiples that by the number of 1000's which it gets by dividing the quantity C8 by 1000.

d. TBL 3 (A34:G37) is only used to feed information to TBL 4 (A40:G46). TBL 3 contains the minimum price for each service as well as the per/100 price. Also note that we included a price section of 0.00's for a "n" answer. In the listing these 0.00's aren't shown because 0.00's in a table are automatically filled in by LUCID when a TBL is referenced elsewhere.

e. TBL 4 (A40:G46) is where the prices for the services are actually derived.

f. Look at one service, "cut" as an example. The price for cut (E9) is shown as `+TBL(D10,G42,A40:G46)`. To get the price LUCID looks at TBL 4. On the y axis it looks for "Cut" (D10), on the x axis it looks (G42) for a number calculated by referring to TBL 3.

g. Examine the formula in G42, `+TBL(C10,D10,A34:G37)*C8/100`. That formula actually calculates the price of the service (in this case Cut) as if there were no minimum prices. It calculates the price by searching in TBL 3. LUCID looks on the y axis for the yes or no answers in C10, on the x axis for the name "Cut". It then returns the price per 100 which is multiplied times the quantity (C8) ordered divided by 100. `Quantity/100` gives the number of hundreds. Now this price is searched on the x axis of TBL 4. TBL 4 x axis is made of exact answers and sentries for all the minimums. If the price calculated is less than that service's minimum then the minimum is reported, but if it is greater, then the price itself it is reported.

h. Note that extra colors are handled by G46 which utilizes the same table formula as the other services but picks up the number of colors in C15.

2. We protected the entire sheet and unprotected cells C8:C16.
3. This particular spreadsheet example was prepared by a person with no computer coding knowledge. This individual has had no programming training or experience, doesn't even know BASIC, and had worked with LUCID for only one week.
4. You can arrange the display of cells to suit width requirements or \$ signs if you like.
5. Occasionally you'll notice absolute cell references in the formulations. This was because many of these formulas were merely copied and the cell references which were left as relative allowed each similar formula to be exactly replicated.

Application Example 2

Breakeven Analysis

Breakeven analysis is useful for a business to study variations in price levels of a product in order to determine if an item can be sold at a profit. Further, it is important to study variations in all the factors that determine the profit and loss status of a business to see if better controls can improve profitability.

Breakeven analysis is done by considering the volume of sales, cost of goods and other variable expenses, fixed expenses and sales price.

Objective: to create a work sheet that will allow you:

1. To select which one of the factors of breakeven you wish to study by choosing either price, fixed costs, variable costs or volume.
2. To be prompted to type in the quantities for the other three factors.
3. To be shown the calculated breakeven amount for the factor you specified.

To set such a spreadsheet in operation you must establish the mathematical relationship between the factors.

The breakeven relationship is defined as follows:

A business is at breakeven when, in a given unit of time, the fixed costs plus the product of the variable cost per sales unit times the volume (or output) equals the volume multiplied by the price of goods.

Where F =fixed costs, V =variable costs/unit, O =output or volume, P =price/unit, then $F + (V \times O) = O \times P$, at breakeven.

In other words, if the product of factors on one side of the equation exactly equalled the other, your company would breakeven.

If the right side value is larger than the left, the difference is profit.

If the right side value is smaller than the left, the difference is loss.

We can put the understanding of this relationship to work in many ways with LUCID. The example that follows is one of those, but you could have many spreadsheet variations that utilize this same relationship.

Goto	Type
A2	BREAKEVEN STUDY
A3	Breakeven point (no p or L):
A4	Type in which factor to study,
A5	price, volume, fixed or variable
A6	costs, press F2, type as prompted.
A8	Choose factor:
A9	+TBL(F7,\$C8,\$F6:\$J10)
A10	+TBL(F8,\$C8,\$F6:\$J10)
A11	+TBL(F9,\$C8,\$F6:\$J10)
A12	+TBL(F10,\$C8,\$F6:\$J10)
A13	Breakeven
B13	+TBL(C8,K6,F6:K10)
C12	Now press F2
D13	+TBL(C8,L6,F6:L10)
F7	Fixed costs
F8	Price
F9	Variable
F10	Volume
G6	Fixed costs
G7	No entry:
G8	Price:
G9	Variable:
G10	Volume:
H6	Price
H7	Fixed:
H8	No entry:
H9	Variable:
H10	Volume:
I6	Variable
I7	Fixed:
I8	Price:
I9	No entry:
I10	Volume:
J6	Volume
J7	Fixed:
J8	Price:
J9	Variable:
J10	No entry:
K6	x

K7	fixed costs are:
K8	price is:
K9	variable costs are:
K10	sales volume is:
L6	y
L7	+B12*(B10-B11)
L8	+B11+B9/B12
L9	+B10-B9/B12
L10	+B9/(B10-B11)

Application Example #2-NOTES

The breakeven study is very interesting because it uses three tables combined as one. They are combined only because they can have a common axis. In this case the y axis.

1. Table 1 is used to provide the labels for the prompts so that when you choose the factor you want to study (C8), the other three factors are displayed, and the words “no entry” appears where the factor you chose normally would.

2. TBL 1 is referred to in each one of the prompt locations, A9, A10, A11 and A12. Looking at one of the prompt formulas A9, which is +TBL(F7,C8,F6:J10) will illustrate the mechanism.

Since this slot will say either “Fixed:” or “no entry”, the y axis is not searched, but LUCID goes directly to the words Fixed Costs because of the F7 entry in the TBL formula. If C8 is the word “Fixed”, LUCID searches on the x axis to fixed costs and returns the words “no entry” to cell C9. If C8 has any other of the 3 words, it will return the word Fixed to A9 which is the prompt we want.

3. Table 2 (F6:K10) is a part of Table 1 only because it would be a single column table, and it shares the same y axis words as Table 1. We put it at the end, and just used x in cell K6 on the x axis, because it is referred to specifically as a coordinate in the formula that looks at this table.

Table 2 only really takes up column K, but is referred to as F6:K10 because the y axis words are in column F.

4. The cell that uses table 2 is B13. This cell supplies the words that make the report’s conclusion line correspond to the factor that is being calculated. We could have made this more simple by making cell B13 just read +C8. But we wanted to show you some capabilities, and therefore made the report a little more elegant, making it read with com-

plete sentences, that are not so terse as just the input words. This way instead of saying Breakeven fixed:78, it says Breakeven fixed costs are 78.

5. Look at the formula for cell B13, `+TBL(C8,K6,F6:K10)`. What happens is that when LUCID looks at Table 2, it goes to the factor that is chosen in cell C8 for the y axis search, and then directly to the last column because the x axis reference cell is K6.

Therefore, whatever factor is chosen, LUCID returns to cell B13 a nice complete readable version of that term, but in nouns and verbs.

6. Table 3 is combined with Table 1 as well, because it uses the same y axis terms.

7. Table 3 is used solely by D13 to calculate the numbers for whatever factor you entered in C8. D13 is `+TBL(C8,L6,F6:L10)`. LUCID merely looks up whichever of the four factors on the y axis was specified in C8, and goes directly to L6 on the x axis. Again like table 2, this is not a search, but specifically the column heading is called out.

In each of the locations on table 3, from where responses are returned, are formulas which are the result of examining the breakeven equation that we described earlier. Each entry is merely the breakeven equation solved for the particular factor for which you would be seeking the breakeven amount.

On the “Fixed costs” row in L7 is the formula `B12*(B10-B11)`. B12 is the value the user enters for volume, B10 is the value the user enters for price, and B11 is the value the user enters for variable expenses. This is because we solved the equation described earlier. The result was: Fixed costs at breakeven = volume times (sales price minus variable expenses). Each one of the other formulas in L8, L9, L10 are the equations solved for the respective factor the row represented on the y axis.

Only one of these calculations has any validity at a time, because only three inputs have meaning when you are solving for a fourth. That is why D13 only seeks out the one that is being solved for at the time, and the other calculation results are not made visible to the user.

Application Example #3

Profit and Loss Study

A profit and loss study uses the same relationship as in application example 2, but with other factors as well. The arrangement of data and the structure of calculations is different, because breakeven is not our concern but profit.

The example we show will have five case studies, each of which will represent the same given unit of time, like a month or a year.

Objective: to create a work sheet that will allow you to

1. Input a price and see the profit or loss over a range of sales volume.
2. Have a section for variable costs compilation.
3. Have a breakdown of fixed expenses.
4. Be able to experiment with different sales volumes to study the effect on profit or loss.
5. Show the effect of an incremental sales volume increase over the five case studies, and be able to input different growth rates.
6. Have two primary inputs, sales price and starting sales volume.
7. Be able to also input changes in your Fixed Cost and Variable Cost breakdowns and automatically affect the rest of the sheet.

Type in the cell contents that follow and study the methods that were used to create this profit and loss study.

Goto	Type
A1	P&L STUDY
A2	Enter variables and press F2
A4	Product name:
A5	Time period:
A6	Enter Sales vol:
A7	Enter price/unit:
A8	Enter growth %:
A9	Case study:
A10	Sales in units:
A11	Fixed costs:
A12	Var. costs/unit:
A13	Sales in \$'s:
A14	P or L/unit:
A15	Total P or L:

C4 Trunions (or any product name)
 C5 week (or any time period)
 C6 100 (or any number)
 C7 87 (or any number)
 C8 10 (or any number)
 C9 ^a
 C10 +C6
 C11 +I8
 C12 +\$M7 (Replicate to G12)
 C13 +C10*\$C7 (Replicate to G13)
 C14 +\$C7-(C11/C10+C12)
 (Replicate to G14)
 C15 +C14*C10 (Replicate to G15)
 D9 ^b
 D10 +C10*(1+\$C8/100)
 (Replicate to G10)
 D11 +C11*(1+.33*\$C8/100)
 (Replicate to G11)
 E9 ^c
 F9 ^d
 G2 Fixed costs:
 G3 Utilities (or any category)
 G4 Property taxes (or any category)
 G5 Depreciation (or any category)
 G6 Administration (or any category)
 G7 Interest (or any category)
 G8 TOTAL:
 G9 ^e
 I3 235 (or any number)
 I4 120 (or any number)
 I5 68 (or any number)
 I6 1200 (or any number)
 I7 1598 (or any number)
 I8 +SUM(I3:I7)
 K2 Variable costs/unit:
 K3 Shipping (or any item)
 K4 Commission (or any item)
 K5 Direct Labor (or any item)
 K6 Materials (or any item)
 K7 TOTAL
 M3 2.5 (or any number)
 M4 .15*C7 (or any commission rate)
 M5 4.8 (or any number)
 M6 18.85 (or any number)
 M7 +SUM(M3:M6)

How to use this sheet:

You can use this P&L sheet, or one like it of your own design, to study any single product. You, of course, need to put in the sales price of your item per unit, the time period, and your starting sales volume, along with the items and numbers for the cost of fixed and variable expenses that would relate to your operation.

The sheet will automatically show case studies of sales volumes rising whatever percent that you indicate as the growth rate. Also note that it takes into consideration that your fixed expenses aren't really so fixed, and that they will rise at a rate of $\frac{1}{3}$ of your sales increase percentage.

You can experiment with "what ifs", and see how it shows your profit or loss levels at various prices, volumes or expense amounts.

Figure #3, Application example 3

	A	B	C	D	E	F	G	H	I	J	K	L	M	
001	P&L STUDY													
002	Enter variable and press F2													
003													Variable costs/unit:	
004	Product name:	Trunions							\$235				Shipping	\$3
005	Time period:	week							\$120				Commission	\$13
006	Enter Sales vol:	100.00							\$68				Direct Labor	\$5
007	Enter price/unit:	\$87							\$1,200				Materials	\$19
008	Enter growth %:	10							\$1,598				TOTAL	\$39
009	Case study:	a							\$3,221					
010	Sales in units:	100		b										
011	Fixed costs:	\$3,221		\$3,327		c								
012	Var. costs/unit:	\$39		\$39		\$3,437		d						
013	Sales in \$'s:	\$8,700		\$9,570		\$10,527		\$11,580						
014	P or L/unit:	\$16		\$18		\$19		\$21						
015	Total P or L:	\$1,559		\$1,931		\$2,347		\$2,812						
016														
017														

NOTE: On this example, decimal places are at zero, so many of these calculations show rounded values. For example, shipping was entered at \$2.50, and is shown as \$3. However, rounded values still calculate at their actual amounts.

Application #3-NOTES

The P and L study layout can be used for budgets and forecasting as well as financial reporting. We have made the structure as simple as possible, but you can expand it for any of these other applications.

The P and L study is a classic “what if” worksheet. This example does not use the table function although there are many ways it could be used.

1. This study has five case studies represented by headings a, b, c, d and e.

The sales in column a (C10) are entered by the user in cell C6. Each other case study shows a change from each other as indicated by the growth % entry in C8. For example, look at the formula in D10, for sales in case study b: $+C10*(1+\$C8/100)$. This means that the sales volume in case study a is multiplied by the growth factor from C8. $1+C8/100$ merely converts a whole number % amount to a multiplying factor. This same formula is then replicated across the other 3 case studies. Note that we designated C8 as absolute and C10 we left as relative, so the C10 will change respectively (D10,E10 etc.) on each new case so as to refer to the column to the left.

2. The sales in \$'s are simply calculated by multiplying the price per unit times the sales in units. This formula is set up in case study “a” and merely replicated for the other four.

3. This study has two breakdown tables. Although we don't use the TBL function with them you certainly could use it to call entries from either breakdown.

These two tables or breakdowns serve to allow you to input specific expenses, and see their effect on the P&L study. The totals of each, feed the calculations in the case study columns. Variable costs per unit are considered the same in each case study. Therefore, the total of the variable cost breakdown (M7) is the value in C12. This amount is replicated across the columns. So if any change is made in the variable cost tally it will affect the whole sheet without making other entries.

4. The fixed cost breakdown table is handled exactly like the variable cost table in that the total (I8) feeds the appropriate fixed cost amount (C11) in case study “a”.

The difference here is that across the five studies, the fixed costs are shown to increase in response to sales growth, which is defined by the user in C8. However, since fixed expenses accelerate with sales growth at a rate that is fractional to the sales growth we have built in a formula that shows increase of fixed expenses at a rate of $\frac{1}{3}$ of the sales growth. Observe that in D11 we show fixed expenses as $+C11*(1+.33*\$C8/100)$. Note the similarity between this growth formula, and the sales growth formula in D10. The .33 defines it as $\frac{1}{3}$ of the rate.

This formula is then replicated across the remaining three columns. Notice the \$C8, because the growth rate from C8 is absolute.

5. P or L per unit (C14) is a simple calculation, $\$C7-(C11/C10+C12)$. We take the price per unit (C7), and subtract the expenses per unit. To obtain expenses per unit, first we divide the total fixed expenses (C11), by the units sold (C10) giving the fixed expenses per unit and to that amount add the variable expenses per unit (C12).

This formula is replicated across the other four case studies with C7 (price per unit) being the only absolute value.

6. Total P or L is calculated merely by multiplying P or L per unit times sales in units. You could also get total P&L also by writing the relationship this way.

Total sales in dollars minus (total fixed costs + variable costs
unit x sales in units) = P or L

7. You can experiment by expanding the principles and concepts outlined here in the P&L study to include complete corporate budgeting and forecasting.

Application Example #4

Amortization Schedule

Amortization schedules are easily performed with LUCID. The formulas are simple. Look at the example that follows as you read this explanation. We start with the input variable prompts in cells A3 through A5. Enter any number in B3 for the principal. Note that the cell contents listing shows that the interest was entered in B4 as 13.5/1200. This indicates an annual percentage rate of 13.5%, converted to decimal by dividing by 100, and into a monthly rate by dividing by 12. If you prefer you could have a cell B2 for entering annual interest rate with A2 as your prompt: Annual rate. Then in cell B4 you could put B2/1200 to get the monthly interest rate. This way you could input any amount rate into B2. The payment is calculated with the same formula as we used before in Chapter XIII, page 80.

The schedule consists of five columns. The first is the payment number or month. This is a formula incrementing by 1, and is copied down the column using Sel, Copy and PASTE like this. Since A8 is a label, its value is zero. Then to create a formula we can replicate. Type the formula 1+A8 into cell A9. Press F7(Sel), then ENTER, then F5(Copy). Move the cursor to cell A10, and press the PASTE key. Press F1(Edit) and change the range to A10:A44, then press ENTER. The formula is replicated down to the 36th month. You could make the display more attractive by selecting the range A9:A44 and then F1(Disp). Press the decimal display key F2 and specify 0 decimal places. Press F8 to get back to the spreadsheet. The second column is the principal remaining. Since at the beginning of the first payment period nothing has been paid, we put into cell B9 a direct reference to the cell where the principal was typed in, cell B3. Next we move to cell B10, and enter a formula for the amount of the principal remaining after the first payment. This is +B9-C9, namely the principal at the beginning of the first period less the amount of principal paid off in the first payment. We can replicate this formula down to cell B44 in the same way as we replicated column A.

Next we move to cell C9. In this column we list the dollar amount of the payment that is applied to the principal. The formula is +\$F5-D9. F5 is the cell containing the amount of the monthly payment. We put a \$ sign in front of it so that when we replicate the formula down the column, it is not adjusted relative to each new cell, but stays pointing at the cell

containing the payment amount. From the payment amount, we are subtracting the amount of interest paid in this month. That is what will be in cell D9, $B4*B9$. Replicate this formula down to cell D44.

The current month's interest is the interest rate times the principal remaining this month. In our example the formula for this is $+\$B4*B9$. B4 is the cell containing the interest rate, and we put a \$ sign in front of it to make it an absolute reference, one that won't be adjusted when we paste the formula down the column. The second reference in the formula, B9, is the remaining principal at the beginning of the payment period. Since this will change each month, we leave this as a relative reference. when you have pasted the formula down column D, press control and up arrow to get to cell A1, and try entering some other values for the amortization schedule.

Example of Cell Contents:

	A	B	C	D	E	F	G
001	AMORTIZATION SCHEDULE						
002							
003	Principal	5,000.00					
004	Interest	13.5/1200					
005	Term	36.00			Payment	$+B3*B4/(1-(1+B4)^{-B5})$	
006							
007			Amounts paid				
008	^Month	^Balance	Principal	Interest			
009	1+A8	+B3	+\$F5-D9	+\$B4*B9			
010	1+A9	+B9-C9	+\$F5-D10	+\$B4*B10			
011							
012		Replicate to 44th row					
013							
014							

Application Example #4

Amortization Schedule

Amortization schedules are easily performed with LUCID. The formulas are simple. Look at the example that follows as you read this explanation. We start with the input variable prompts in cells A3 through A5. Enter any number in B3 for the principal. Note that the cell contents listing shows that the interest was entered in B4 as 13.5/1200. This indicates an annual percentage rate of 13.5%, converted to decimal by dividing by 100, and into a monthly rate by dividing by 12. If you prefer you could have a cell B2 for entering annual interest rate with A2 as your prompt: Annual rate. Then in cell B4 you could put B2/1200 to get the monthly interest rate. This way you could input any amount rate into B2. The payment is calculated with the same formula as we used before in Chapter XIII, page 80.

The schedule consists of five columns. The first is the payment number or month. This is a formula incrementing by 1, and is copied down the column using Sel, Copy and PASTE like this. Since A8 is a label, its value is zero. Then to create a formula we can replicate. Type the formula $1+A8$ into cell A9. Press F7(Sel), then ENTER, then F5(Copy). Move the cursor to cell A10, and press the PASTE key. Press F1(Edit) and change the range to A10:A44, then press ENTER. The formula is replicated down to the 36th month. You could make the display more attractive by selecting the range A9:A44 and then F1(Disp). Press the decimal display key F2 and specify 0 decimal places. Press F8 to get back to the spreadsheet. The second column is the principal remaining. Since at the beginning of the first payment period nothing has been paid, we put into cell B9 a direct reference to the cell where the principal was typed in, cell B3. Next we move to cell B10, and enter a formula for the amount of the principal remaining after the first payment. This is $+B9-C9$, namely the principal at the beginning of the first period less the amount of principal paid off in the first payment. We can replicate this formula down to cell B44 in the same way as we replicated column A.

Next we move to cell C9. In this column we list the dollar amount of the payment that is applied to the principal. The formula is $+\$F5-D9$. F5 is the cell containing the amount of the monthly payment. We put a \$ sign in front of it so that when we replicate the formula down the column, it is not adjusted relative to each new cell, but stays pointing at the cell



containing the payment amount. From the payment amount, we are subtracting the amount of interest paid in this month. That is what will be in cell D9, $B4*B9$. Replicate this formula down to cell D44.

The current month's interest is the interest rate times the principal remaining this month. In our example the formula for this is $+\$B4*B9$. B4 is the cell containing the interest rate, and we put a \$ sign in front of it to make it an absolute reference, one that won't be adjusted when we paste the formula down the column. The second reference in the formula, B9, is the remaining principal at the beginning of the payment period. Since this will change each month, we leave this as a relative reference. when you have pasted the formula down column D, press control and up arrow to get to cell A1, and try entering some other values for the amortization schedule.

Example of Cell Contents:

	A	B	C	D	E	F	G
001	AMORTIZATION SCHEDULE						
002							
003	Principal	\$,000.00					
004	Interest	13.5/1200					
005	Term	36.00			Payment	$+B3*B4/(1-(1+B4)^{-B5})$	
006							
007			Amounts paid				
008	^Month	^Balance	Principal	Interest			
009	1+A8	+B3	+\$F5-D9	+\$B4*B9			
010	1+A9	+B9-C9	+\$F5-D10	+\$B4*B10			
011							
012		Replicate to 44th row					
013							
014							

Figure 4, Application Example 4

AMORTIZATION SCHEDULE

Principal	5,000.00		
Interest	0.01		
Term	36.00	Payment	169.68

Month	Balance	Amounts paid	
		Principal	Interest
1.00	5,000.00	113.43	56.25
2.00	4,886.57	114.70	54.97
3.00	4,771.87	115.99	53.68
4.00	4,655.88	117.30	52.38
5.00	4,538.58	118.62	51.06
6.00	4,419.96	119.95	49.72
7.00	4,300.01	121.30	48.38
8.00	4,178.71	122.67	47.01
9.00	4,056.04	124.05	45.63
10.00	3,932.00	125.44	44.23
11.00	3,806.56	126.85	42.82
12.00	3,679.70	128.28	41.40
13.00	3,551.42	129.72	39.95
14.00	3,421.70	131.18	38.49
15.00	3,290.52	132.66	37.02
16.00	3,157.86	134.15	35.53
17.00	3,023.71	135.66	34.02
18.00	2,888.05	137.19	32.49
19.00	2,750.86	138.73	30.95
20.00	2,612.14	140.29	29.39
21.00	2,471.85	141.87	27.81
22.00	2,329.98	143.46	26.21
23.00	2,186.51	145.08	24.60
24.00	2,041.43	146.71	22.97
25.00	1,894.72	148.36	21.32
26.00	1,746.36	150.03	19.65
27.00	1,596.33	151.72	17.96
28.00	1,444.62	153.42	16.25
29.00	1,291.19	155.15	14.53
30.00	1,136.04	156.90	12.78
31.00	979.15	158.66	11.02
32.00	820.48	160.45	9.23
33.00	660.04	162.25	7.43
34.00	497.79	164.08	5.60
35.00	333.71	165.92	3.75
36.00	167.79	167.79	1.89

CHAPTER XV

ADDITIONAL LUCID[®] INFORMATION

A. Long Formula Construction

LUCID allows you to write any length formulation that you desire. Any individual cell is limited to 36 characters, and at first thought you might feel that this is a restriction as far as complexity of formula construction.

LUCID was intentionally designed to limit the cell contents length to an amount which can be displayed on the screen, so that formulas and other cell contents can be scanned using the SCAN (LABEL) key, as described often in this manual.

Complex formulas are made by simply doing your formula writing in a structured manner, dividing the calculation into two cells, or as many as necessary. A complex calculation is made by interfacing parts of the formula together, referencing to the cell or cells containing the other modules that make up the total formula.

Modular or structured programming is considered today to be the logical and most intelligible way to write computer code. We recognize that writing formulas in spreadsheets is truly legitimate code construction, and the same good rules should apply to formula composition as with any other form of programming. In most cases long detailed expressions in a single cell are extremely difficult to follow even by the originator, especially after some time has elapsed and the trail has gone cold. Revisions and modifications become virtually impossible.

With modular structured formula building, as you must do with LUCID, the interfacing formula sections resident in several cells permit a more logical examination of the sequence of steps and arguments involved in a calculation.

If you will observe in studying the several spreadsheet examples that we have shown in this manual, we have achieved some interacting relationships of some elegance. None of these required longer formulations, although they could have been written that way, were it possible. But an examination of the formulas, and the organization of these examples shows that to have written them as long single formulas would have been an inferior solution.

Because LUCID is designed to require modular construction of larger formulas, you will become a better spreadsheet author quicker, and you will find that your thinking and planning will take on a structured pattern, which those with experience will tell you is most desirable.

B. Write Date Automatically

LUCID has a very convenient feature not found on other spreadsheet programs. You can write the date automatically in any cell simply by doing CTRL D when you are editing that cell.

If you just move the wide bar cursor to a cell, and press CTRL D, nothing will happen. This is because you must be in the edit mode for CTRL D to write the date.

As you recall, with LUCID you are instantly in the edit mode without any command simply when you type any character. Therefore, if you want just the date in a cell or the date as your first entry in a cell you can

- a. press the space bar prior to pressing CTRL D or
- b. press the F1 (Edit key) prior to pressing CTRL D.

At that moment the date is written as

Jan 01, 1985

The date first appears on the edit line (bottom line) as though you had typed it in. If you had pressed the space bar to get into the edit mode a space will appear on the edit line prior to the date. Press ENTER, or up or down arrows, or CTRL left or CTRL right arrows to record the date in the cell.

LUCID of course, gets the date from the setting on your Model 100. If for some reason your date is not correct you will need to go into BASIC and reset it.

Setting the date in your Model 100 is quite easy. From the main menu put the cursor on BASIC and press ENTER. The screen says OK.

Type **Date\$="01/15/85** (final quotation marks not necessary)

Press ENTER to set date as

Jan 15, 1985

Month/day/year are all in two digits each.

After you have set the date in BASIC, the new date will show in the upper left of your main Menu. Now wherever you want the date in a cell in LUCID, just press CTRL D when you are in the edit mode.

It is interesting to note that if you are typing a title or other screen message, you can insert the date after other text is written, or you can also type more text in the same cell after you have put in the date. It is as though you had typed it in from the keyboard.

C. Print Cell Contents

As you design various spreadsheets to perform different tasks you will often want a printed listing of your cell contents. A listing of cell contents serves two purposes. During the creation of a spreadsheet it allows you to study all your formulations at a glance and better determine what is needed to improve the mechanisms and correctness of your formulas and their calculations. Secondly, when you have completed your worksheet it is very nice to have a hardcopy printout that you can file. This way, if you ever lose your magnetic media copy (cassette or diskette), you can reconstruct the sheet merely by typing in the listing.

To print cell contents press the PRINT command key, just like when you print out one of your worksheets.

The bottom line clears and new function key labels appear.

Go	Rnge	Outp	Page	List	Ctrl		Exit
1	2	3	4	5	6	7	8

Make sure your printer is properly connected and on. Refer to the chapter on printing and reset the output and page setting functions, if you are not satisfied with the default settings.

Set the range for printing your listings the same as if you were printing a copy of the worksheet itself.

When you are ready to list, press F5 (List). The printer will start and all the cell contents will be printed out exactly as they are positioned on the sheet.

Just like when you print, you may have text in cells that has been overlapped by entries in adjacent right hand cells.

When you list, also the formulas will not be printed in their entirety if the length of the formula would cause an overlap to an adjacent cell that is occupied. Therefore you need to widen you column widths prior to printing in order to accomodate the length of your formulas. It is a good procedure, prior to listing to SCAN through your cell contents and then adjust the columns that need widening.

Summary: To show completely all formula entries that would be overlapped, simply change your widths to settings that will expose any overlapped portions.

D. Paste Buffer Retention

The paste buffer in LUCID, like TEXT, will retain whatever you have copied last even though you have pasted and typed in new material since you pasted.

However LUCID has a rather unique feature in that it actually has two paste buffers. One is for the text pasting of your spreadsheet into TEXT files, and the other is for formula transfer to other parts of a worksheet or into a new ".CA" file.

This means that you can do a copy or cut in LUCID, go into TEXT and paste the spreadsheet section that you want in your document file, and then do other copies or cuts and pastes in TEXT. Then when you go back into any LUCID file, you can paste again the last item you copied or cut from LUCID, because the TEXT copy and paste did not affect the formula paste buffer.

E. Moving Formulas With Absolute References to a New File

Occasionally you will be faced with a situation where you want to copy a part of a spreadsheet file to another file, but to a different location than it had in the first file. Sometimes, when you move it to the new file it produces an ERR message in some of your formula cells. What happened is that you had absolute references internally to the section you were moving, and when they were moved to the new location they referred to the wrong cells.

You can, of course, resolve this problem by going back into every cell with a formula, in the original location, and changing any absolute reference to relative by removing the dollar sign designation. Another, easier way is to paste the section into the new file in exactly the same location as it was copied from the old. Then with delete row or column move the section to the top or left of the sheet. All cell references will be adjusted automatically even though they are shown as absolute.

G. Automatically Fits Wide Spreadsheets to Printer Width

LUCID has a fantastic feature that makes printing out any spreadsheet quite easy. LUCID automatically fits your spreadsheet to your printer width when it is too wide or too long for the paper.

For example, if you are printing on 8½ x 11" paper, and you want to print out a worksheet that would be 17 inches wide, or any width, you don't have to concern your self about picking out ranges that will fit.

If you want to print the entire sheet, just specify a range that includes the entire sheet, A1:Lower right cell. LUCID will print the left hand portion all the way down the rows to the bottom, then the next right hand portion that fits all the way to the bottom and so forth even if it's wider still.

You will find that other spreadsheets will "wrap" a too long line, i.e. print the too wide portion on the next line. This makes a printout that is useless and the user has to adjust the print range to fit the paper. LUCID's automatic "fit to the paper" feature is something you will enjoy, because LUCID exactly positions the second and other sections on the paper so that you can use clear tape and join the pages to produce a spreadsheet copy for presentation that is as wide as you have written.

H. Control Key Combinations

Some people like to use CTRL/key combinations rather than some of the specific feature keys like left arrow or DEL/BKSP. The reason these people find CTRL key combinations useful is because they like to be able to perform these actions with a typing motion. They maintain that for them it makes keyboard usage easier. We considered leaving this information out of the manual as an undocumented LUCID feature, but decided to include it for the few who want it.

If you are one of those, or if you occasionally would like the option of having an alternative method of executing some of the features provided by special keys, here is what LUCID provides.

Control Key Combinations	Performs
CTRL B	Shift down arrow
CTRL T	Shift up arrow
CTRL F (while editing or not)	Shift right arrow
CTRL A (while editing or not)	Shift left arrow
CTRL W (while not editing)	go to A1
CTRL W (while editing)	Wander mode

CTRL H (while editing)	Backspace
CTRL J (while editing or not)	ESC
CTRL M (while editing)	ENTER
CTRL D (while editing)	type date
CTRL R (while editing)	CTRL right arrow - enters contents and moves to cell to right
CTRL Q (while editing)	CTRL left arrow - enters contents and moves to cell to left
CTRL Left arrow (while editing)	Enters edit line, exits to cell to left
CTRL Right arrow (while editing)	Enters edit line, exits to cell to right

I. Other Software From PCSG

After experiencing LUCID, most users ask "what else do you have". PCSG is the foremost developer of software for the Model 100. You should have received a catalog describing some of our other excellent packages, but if you did not please call or write for an information packet.

One of the difficulties of buying software that you haven't seen is that often it simply is not as advertised. Many amateur programmers will offer their wares with professional advertising that states claims of functionality and ease of use that simply are not true. At PCSG you can be assured that the programs are well designed, well documented and they really perform the way you would expect them to.

At your Radio Shack Store you will find that a number of the programs for the Model 100 are by PCSG.

We are the authors of

A) Scripsit 100, the text formatter that turns the Model 100 into a true word processor.

B) Barcode driver software that operates the Model 100 barcode wand.

C) Barcode generator - prints barcodes on paper or on peel and stick labels from any text or numbers that you enter. Works on any dot matrix printer, shows barcode above, English below.

D) Data/Sort - data base record manager program. Has on screen searches. User defines input screens as easy as typing from TEXT. Has amazing report generating capability. Records merge with Scripsit 100 documents. Takes barcode entries directly from wand.

E) Expense/Graph - expense report and budget tool. Prints spreadsheet. All math built in, no formulas are entered. Graphs pie, bar or line graphs for row or column totals on any Radio Shack dot matrix printer or CGP115 color pen plotter.

F) Remote Disk - File transfer program that turns your other computer into a disk storage device for the Model 100. TEXT, program and LUCID files transferred instantly with a function key. You look at disk directory directly on Model 100 screen, looks just like main menu. All text files compatible on other computer or from other computer to Model 100.

Remote disk is available for computers not carried by Radio Shack directly from PCSG.

J. Model 100 book from McGraw Hill

McGraw Hill has just published a new book for the Model 100 written by the founders of PCSG, Sam Redman and Michael Stanford (listed alphabetically). The book is titled "User Friendly Guide to Lap Portables" and is priced at \$16.95. It features the Model 100 and the Olivetti M10, which is virtually identical to the Model 100.

This book is the book to have if you are not a computer professional, but a user. It takes the reader step-by-step through the operations of the Model 100. It is instructional but without being condescending. All the built in programs we described in a way that the Model 100 manual does not so that the user can follow along and be taught completely how to use them. All of the PCSG programs sold at the Radio Shack stores are also covered with easy to understand instructions. The manuals that accompany programs in the store are brief and the user really gains from having the good documentation that the McGraw Hill book provides. If you can't find the User Friendly Guide to Lap Portables in your bookstore you can contact PCSG for your copy.

K. Natural Order of Recalculation

How a spreadsheet recalculates can really determine its accuracy and usefulness. Many spreadsheets will calculate simply forward from left to right. Others allow the user to specify order of recalculation. Either of

these cases can result in errors of recalculation on many worksheets, or if not, certainly the inconvenience of having to specify how you wish the sheet to recalculate and rearrangement of formulas to fit that order.

If a spreadsheet calculates a formula that is out of sequence it will produce an error in mathematics and wrong answers will appear. Visualize this, if a conventional spreadsheet is calculating forward from A1 and it comes to a formula that refers to a cell in M4 it will produce errors, because it needed that other cell reference in order to correctly calculate the prior formula.

LUCID utilizes a technique known as natural order of recalculation. This means that you don't ever have to

- a. specify what order of calculation you want.
- b. arrange formulations in any kind of sequence so they will calculate properly.
- c. be concerned that there might be errors on your report, because of order of calculation problems.

LUCID natural order of recalculation works like this:

LUCID calculates any sheet forward from cell A1 across the row, then row two and so forth. But when LUCID reaches any cell that has a formula that refers to any other cell that has not yet been calculated, it will suspend calculation of the current cell and evaluate the forward reference, then return to the suspended calculation with the correct value. The only limit on the number of calculations suspended at any time is the amount of free memory in your Model 100.

LUCID will then move on through the spreadsheet following the same sequence, but naturally does not recalculate cells that it has already calculated as a result of a forward reference.

Of course this recalculation can be quite complicated because you can have cells that refer to many other cells and those cells can have multiple cells that are dependent on other cells both previous and forward. LUCID arranges them all in their proper order of calculation and completes the calculation correctly putting the appropriate values in each cell. The wonderful aspect about this feature is that not only does it assure accuracy and it takes no user procedure at all other than pressing function key F2 (Calc), but it is performed lightning fast.

LUCID is so incredibly fast at recalculations that it beats most desktop

spreadsheets in sample typical worksheet usage. See the benchmark comparison at the end of the manual. What is truly significant is to observe that LUCID is performing these feats on the Model 100's 8085 microprocessor chip and the other comparisons are done on the IBM PC which utilizes an 8088 chip that is a device inherently faster in handling data. LUCID is amazing.

L. Error Messages

1. **ERR** - can appear in the cell location after you have pressed F2(Calc).

1. If you have a mathematical error in a formula such as division by 0. The formula will remain intact in the cell.

2. If you have a TBL function reference and the table has not yet been written or if you refer past the TBL. This tells you that you need to install a sentry or extend your TBL range. This ERR message does not affect cell contents. It will disappear when the correction is made.

3. If you paste a cell that had a relative reference that is now changed to be beyond the spreadsheet boundaries.

For example in cell A4 type +C3+C8 press ENTER. The cell reference C3 obviously refers to the row above it.

Now press F7 (Sel), screen says Range A4:A4. Press ENTER.

Press F5 (Copy). Move the cursor to cell A1 press paste and then ENTER. Cell says ERR.

This would have produced a cell reference that is off of the sheet. Now when you look at the contents of cell A1 the cell says ERR+C5. The second relative cell reference was OK because when it changed it still referred to a cell on the sheet. The erroneous cell reference however is now obliterated from the new cell contents.

How to prevent and correct:

a. This type of error nearly always is caused when you are moving a formula with a cell reference that has been left as relative, and it should have been designated as absolute.

Go back to where you copied from and change the reference accordingly.

b. Occasionally you might have cut the formula from its original cell rather than just copied it. It produces quite a panic when you see your formulas you just pasted have been affected and some of the cell references are permanently gone with just ERR in their places.

If this is the case remember that your last paste is still in the paste buffer. Go back to the location of the cut, repaste into the original location. The original formulas are intact. Now change the references to absolute or so that they won't be off of the sheet.

2. **Bad Range** - This message appears on the bottom line and can only appear during a paste. This means that you have attempted a paste range beyond the boundaries of the spreadsheet. This is different than the previous example where the ERR message occurs when a cell is pasted that contains a relative reference that would be changed to refer off the sheet.

Bad range means you have tried to paste an area past the boundaries of the spreadsheet.

3. **System Error** - occurs during cassette loading and means you have had an input or output error. Probably a bad tape or faulty cassette player.

If you get the message "System error" at any other time this means that something was attempted that was not able to be handled by the Model 100 System ROM. Press any key to continue and advise us if you observe any procedure that would produce this message.

4. **Memory Full** - Press space bar for MENU. Whenever you are attempting a paste that fills up the memory, this message will appear at the moment that you no longer have RAM left. You will need to kill some files to make room or be satisfied with a smaller paste than you intended.

When you look back in the ".CA" file you will see that the paste was not cancelled; cells were pasted up to the point where the memory limitations prevented more.

5. **Circular!** - Reference was made to the same cell where the formula is being written. That is, a formula includes a direct or indirect reference to the cell in which it is written. This is not always an error. Sometimes circular references are used intentionally in for-

mulations to narrow in on approximations.

6. LUCID beeps, unable to exit from edit line.

a. When you are writing a formula in a cell and you write an incorrect formula such as `+A5+5C4` you will get a message telling you that you have written an improper formula syntax. The small edit line cursor will appear at the error point. In the example above the cursor will appear on the C telling you that you are missing an operator (+, * etc) between the 5 and the C.

b. Incorrect range typed.

7. **Beep** - When you attempt to move cursor past the cell boundary or when you attempt to type more than 36 characters.

8. **Protected** - appears on bottom line when you attempt to type into a protected cell.

M. Shift Break

. To get you out of a printing operation return to the spreadsheet file at the main LUCID function keys.

b. To break out of a cassette load or save.

c. Acts as ESC key on any other operation.

N. ESC - the escape key will

a. abort any typed in range, or new cell text, formula or value prior to entering.

b. take you back to the main LUCID function key level from any place on the function key tree.

O. Utility Personality Modules F6 (Util)

Function key F6 enables access to the optional LUCID personality modules. These are accessed from the main function key level. Simply press F6 and immediately a new set of function keys appears if you have loaded into RAM one of the optional utilities.

The new function keys operate as though they are part of LUCID because they are interfaced with LUCID. They provide extensions that use the LUCID ROM. These modules are cryptically coded and require minimal RAM consumption, because they are designed to utilize many routines resident in the LUCID ROM.

You can sort, do pie, bar and line graphs, exhaustive financial reporting, DIF & SYLK conversions and other special utilities. All of these are available directly from PCSG. Write for more information on those that we are currently shipping.

P. Reference to a Cell with Text

We have talked about making formula references to cells that contain text when we covered the handling of the TBL function. There are other uses for this excellent LUCID feature than for use in the TBL function alone. One excellent application is for designing a report form that will repeat someone's name that was entered earlier or to repeat a city or other part of entry information.

To illustrate how this works in its simplest form, perform the following exercise:

Go to cell A2 type **hello**

Go to cell B5 type **+A2**

Now press ENTER, in cell B5 appears **hello**

No other spreadsheet has this capability. As we explained, the TBL function is a sophisticated application of this feature. But you will want to utilize it in simple ways to gain further benefit. If you were to program in a language such as BASIC you would have to define an input string and make a print statement in order to produce the same effect. LUCID performs the input and print statement with the ultimate in simplicity. Another example for its use is if you designed a budget or financial accounting form that had a number of specific category labels. These category labels might be repeated throughout the entire spreadsheet by making cell references to a master set of labels. You could revise your sheet or update it without having to change every mention of a particular label throughout the sheet.

You need to allow your imagination to bear fruit on the possibilities for this excellent feature.

Q. Ability to suppress zeros on printout

Many people prefer to print out certain financial reports or sales tallies and have compiled zeros show as blank spaces.

This is because some compilations will have many zeros which are not important for scrutiny, and only a few values which are significant.

Many persons have sought to be able to suppress the zeros on printouts of other spreadsheets so that “their numbers don’t get lost in all those zeros”.

LUCID is the only spreadsheet which permits zero suppression.

Here is how it is done:

For all cells where totals or calculations are reported that you want to have possible zeros suppressed you enter TBL formulas. These TBL formulas refer to a table that you position out of view from your report area. Formulas are moved to that table that would have normally calculated the cells where you want zeros suppressed.

This is the TBL formula setup that goes where you want a zero suppressed:

+TBL(cell in table that contains the formula that calculates the value for this cell, cell on x axis of table that heads the column that contains the formula for this cell, upper left blank cell of table: lower right cell of table)

Table setup:

	a	b	c
0.00	“space	“space	“space
10 ~ 50	formula 1	formula 2	formula 3

The “space entry means a quotation mark and a space. This is returned to the cell as a blank.

Formulas 1, 2 and 3 refer to the formulas that would have normally appeared in the cells where you want suppressed zeros. They will provide the calculated value of those cells.

You can see that each TBL formula will search on the y axis with the value that would normally appear in the cell. If that value is zero it will return a blank. If that value is greater than zero it will return whatever the value is.

You also may want zero values that are not compiled, but just recorded to show as blanks. Lucid handles this beautifully as well. Just leave those places as blank that you want to print out as blank. You don’t have to worry that those cells won’t feed zeros to other cells that contain formulas that refer to those blank cells. Lucid will regard any blank cell that is referenced from another cell as a zero.

R. Large number notation

Lucid has the ability to remember and record 14 digits. This is more than Visicalc or Lotus 1-2-3, (refer to the benchmark table which follows). Often however you will have reason to display numbers in excess of 14 digits. One trillion is a 13 digit number, so 14 digits will be satisfactory for most of your entries.

If you are involved in scientific work that would entail extremely large numbers, such as astronomical numbers or atomic particle weights, you will appreciate that LUCID will show large or small numbers as exponential power displays or E numbers.

For example a large number of 300 trillion would show as

% 3.0E14.

A positive E number means, move the decimal point that many places to the right.

A minus E number means move the decimal point that many places to the left.

E20 means move the decimal point 20 places to the right.

Minus E20 means move the decimal point 20 places to the left.

Speed and Precision Comparison

All bench marks performed on a spreadsheet occupied by 600 formulas.

All times in seconds.

	Visicalc on IBM PC	Lotus 123 on IBM PC	Multiplan on IBM PC	Lucid on Model 100
Sum of 600 cells	7.0	1.4	11.5	2.0
Insert column	6.0	2.4	11.0	0.5
Sqr root 600 cells	298	12.0	112	133
Replicate 100 rows	12.0	1.5	20.0	20.0
Decimal precision	12 digits	11 digits	14 digits	14 digits

CHAPTER XIV CONCLUSION

At this point you are aware that LUCID is truly excellent software for the Model 100. LUCID gives you the ability to prepare worksheets that have the power and scope of those that could have previously been prepared only on a desktop. LUCID, further provides capability and functionality not available on any other spreadsheet on any computer.

LUCID is a masterwork from Portable Computer Support Group. It is the result of a project that was dedicated to the development of a superior spreadsheet that would be considered a significant improvement over the current offerings on any computer. Secondly, this project was committed to designing a program on ROM that would not only be a logical extension of the Model 100, but would give it power and function far beyond what even the Model 100's designers thought possible.

LUCID is the flagship of an entire new generation of software on ROM for the Model 100.

Coming soon from PCSG are other ROMs with programs that are totally integrated with LUCID and its data files, that will give you even more big computer capability on your Model 100.

Appendix

Printer Control Codes

LUCID allows you to embed control characters in your printouts so that you can access your enhanced printer fonts, such as bold, compressed type, expanded type and underline. You do this by means of the GRPH characters in the Model 100 font, combined with F6 (Ctrl) in the Print menu. When Ctrl is on (showing in reverse video), any character with an ASCII value greater than 127 will have 128 subtracted from it before transmitting it to the printer. For example, to send ESC, minus, NUL (27,45,00) to the printer (causes Epson to stop underlining), you would put into the cell GRPH k (ASCII 155, ie 27 + 128), then - (a minus sign), then GRPH p (ASCII 128). This is only necessary for printing ASCII values less than 32, since all characters with an ASCII value greater than 31 are accepted and printed in the normal way by LUCID. The first 32 characters and their LUCID GRPH equivalents are given on the page following.

Note: LUCID does not know how these special characters affect your printer. This means that if you put a control code into a label, LUCID will assume that it was a printable character that took up one character width on the printout. For this reason, put printer control codes in a line on their own, or your column placement may get messed up.

Control	Character		GRPH	equivalent
0	CTRL-@	NUL	GRPH	p
1	CTRL-A	SOH	GRPH	m
2	CTRL-B	STX	GRPH	f
3	CTRL-C	ETX	GRPH	x
4	CTRL-D	EOT	GRPH	c
5	CTRL-E	ENQ	GRPH	a
6	CTRL-F	ACK	GRPH	h
7	CTRL-G	BEL	GRPH	t
8	CTRL-H	BS	GRPH	1 (one)
9	CTRL-I	HT	GRPH	r
10	CTRL-J	LF	GRPH	/
11	CTRL-K	VT	GRPH	s
12	CTRL-L	FF	GRPH	'
13	CTRL-M	CR	GRPH	=
14	CTRL-N	SO	GRPH	i
15	CTRL-O	SI	GRPH	e
16	CTRL-P	DLE	GRPH	y
17	CTRL-Q	DC1	GRPH	u
18	CTRL-R	DC2	GRPH	;
19	CTRL-S	DC3	GRPH	q
20	CTRL-T	DC4	GRPH	w
21	CTRL-U	NAK	GRPH	b
22	CTRL-V	SYN	GRPH	n
23	CTRL-W	ETB	GRPH	.
24	CTRL-X	CAN	GRPH	o
25	CTRL-Y	EM	GRPH	,
26	CTRL-Z	SUB	GRPH	1 (L)
27	ESC	ESC	GRPH	k
28		FS	GRPH	2
29		GS	GRPH	3
30		RS	GRPH	4
31		US	GRPH	5

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