GOOF-PROOFING YOUR SPREADSHEET

Nipping errors in the bud when setting up your own spreadsheet.

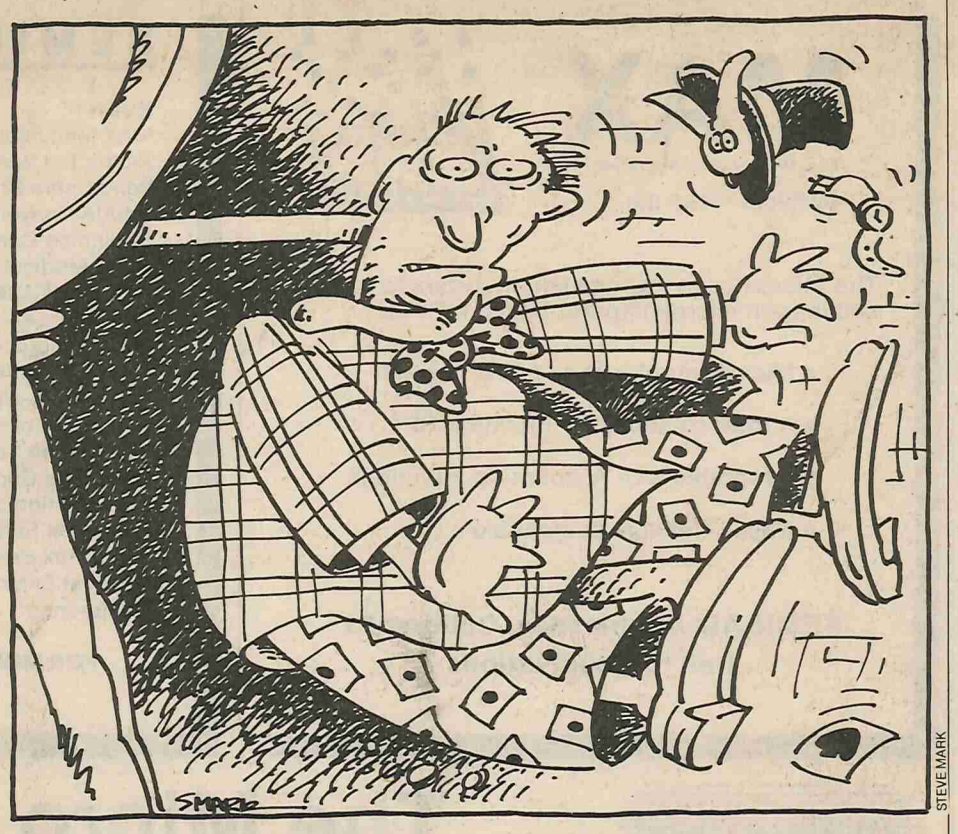
by Vincent D. O'Connor

Although it may come as quite a shock, if you use spreadsheets at all, the odds are that one or more of them contains mistakes. It could be as simple as a typing error, or as serious as a model-design flaw, but research has shown that one out of every three business spreadsheets has an error of some kind in it, and the more you push a spreadsheet to its limits, the more likely it is that errors will occur. Despite this, and despite the fact that people entrust their payroll, balance sheets and often their businesses to a spreadsheet's results, too few do more than make a casual check for mistakes. The time most users allot for creating a spreadsheet simply doesn't include time for verification and error checking, unless a mistake is made that's so large it's impossible to ignore.

What's sad about this fact is that it really takes only a little extra time and effort to verify that a spreadsheet is error free. And the time spent can save you money and heartache. The controller of James A. Cummings, a Florida construction firm, entered in a line for $245,000 for overhead in a bid on a $3-million office complex, failing to notice that he entered it outside the range of numbers to be added by the @SUM function in his formula. This caused the company to underbid the project by the $245,000. (Cummings then sued the software producer, claiming that the software was inherently flawed. The construction firm lost the case.)

The most common mistakes found in spreadsheets are simple keystroke errors like those made by Cummings; keying in data, formulas or macros incorrectly. In larger spreadsheets such errors are almost guaranteed to occur, but you can defend against them. When building formulas or macros, use pointing instead of typing. Although some people object to pointing on the grounds that it's slower, if you use all the cursor-pad keys, such as Page Up and Page Down, it really isn't that slow, and you save time in the long run because you reduce the chance for error.

Avoid adding figures outside a formula's range by always including extra blank rows in @SUM formulas. For example, if you plan to add rows 5 through 20 in column C, then have your formula include rows 4 and 21. This gives you two extra empty cells in column D should you need to insert an item later. Also make sure you don't include labels in a range used for an average or count function. The labels will be evaluated to zero, and the results made inaccurate.



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You can reduce mistakes by being consistent when building your spreadsheet. Always go from left to right, and from top to bottom. Set cell formats and column widths to catch errors, so that mistakes in calculations cause the results to exceed the cell limitations. This will cause the errors to be flagged, and make them easier to locate. Another way to visually catch mistakes is to graph your results. Mistakes aren't always easy to see when you're staring at 20 columns of numbers; graphing the results can make errors practically jump out at you. This won't tell you where the error occurred, or if you have a model flaw, formula flaw or bad data, but you can't find errors that you don't know exist.

First steps

Macros also invite mistakes. Users often forget to place quotation marks around a macro command, or forget to add a tilde (~), which tells the spreadsheet program to execute a Return. For example, in *Lotus 1-2-3* (Lotus Development Corp., 55 Cambridge Pkwy., Cambridge, MA 02142; 617/557-8500) if you forget to put the cursor-movement command in quotes, instead of moving the cursor the macro will print the word in the current cell. All macros should be tested in a blank, unrelated cell, rather than the cell the macro is in. If you don't, and the macro erases a current cell, or places the result of the macro in the current cell, you'll destroy the macro. It's also a good idea to use range names in your macros, rather than cell addresses. This way the macros still work correctly even if you change the structure of the spreadsheet by adding a row or column.

Check your spreadsheet as you go along, not just after all the formulas have been entered. Check each formula as it's entered to make sure it works correctly. This is especially true if you're building a large spreadsheet, since the larger the spreadsheet, the more difficult it is to locate and correct errors. Test it using a one (1) for every data entry; this makes checking the calculation easy. Alternately, use data for which you already know the answer, or which can be easily figured using a hand calculator or pencil and paper. You should check your entire spreadsheet in the same manner once you've finished. You should also learn the accountants' method of cross footing totals to double check your models. This involves using two sets of formulas that perform identical operations on the data, in complementary directions. If the two totals are not identical, then there's an error somewhere in your spreadsheet.

Errors also occur when the person using the spreadsheet is not the person who designed it, and there is little or no documentation. This lack of documentation becomes critical when the person who designed the model is no longer working for the company, and someone else is given the job of modifying it. Make sure your spreadsheets include labels that explain exactly what you've done. You can do this cell by cell in a separate section of the spreadsheet. In addition to helping others, it will help you if you find the results aren't what you expected, but you can't find any structural errors. It also will help you if you only use the model occasionally. You can't be expected to remember exactly how a spreadsheet was designed even after being away from it only a few weeks. You can also use the documentation to allow an independent review of the underlying assumptions in your model. This can help catch design mistakes early on, where correction is easier.

Make sure you understand how the spreadsheet works. Failure to take into account how a spreadsheet does its calculations is probably the second biggest source of errors. Most spreadsheets, like *Lotus 1-2-3*, do calculations in what's known as the standard order of operation. This means that exponents are calculated first, then multiplication and division and finally addition and subtraction. You can override this order by putting operations into parentheses, causing these operations to be calculated first. For example, let's suppose you wanted to calculate the formula $30 + 5 \times 4$. If you enter this into your worksheet just as it is, the answer will be 50. If you add parentheses to make the formula $(30 + 5) \times 4$, the answer changes to 140.

Because of this, if you're unsure of the order of calculation, always use parentheses to specify the order.

The way spreadsheets handle rounding, whether through use of the @ROUND function or in formatting, can also be a trouble area. Make sure you understand how numbers are rounded, and how rounded numbers are handled. Let's assume you have a row formatted with a fixed format, and the number of decimal places set to zero. If you enter 241.49 in one cell, 176.49 in the next cell, then add them, what you'll see is 241, 176, and 418 as an answer. Why? Most spreadsheets, including *Lotus 1-2-3*, *Multiplan* (Microsoft, 16011 NE. 36th Way, Box 97017, Redmond, WA 98073; 206/882-8080) and *Appleworks* (Apple Computer, 20525 Mariani Av., Cupertino, CA 95014; 408/996-1010), display the rounded numbers, but calculate the numbers that were actually entered. In the preceding example, the actual result is 417.98, but because of the format, it's shown as 418. And if you use the @ROUND function, rounding each number to zero with two decimal places, you'll get a still different result, 417. Thus you can have three different answers for a calculation, yet all three are correct. In a large spreadsheet, with many calculations, these little differences can quickly add up. Make sure you're aware of how your formatting and rounding affects your figures, and that you're getting the results you want.

The recalculation blues

One of the most confusing areas to new users, especially if an older spreadsheet such as *Visicalc*, *Supercalc3* (prior to release 2) or *Appleworks* is being used, is the order of recalculation. The order of recalculation determines whether calculations are done across rows, then down columns or down columns, then across rows. In older worksheets this is set manually, with the default normally being down columns, then across rows. You must make sure that when cells are dependent on other cells, the cells with the source material are calculated first. For example, if you have values in row 5 that are dependent on values in row 12, your order of calculation must be across rows, then down columns. This also means that your spreadsheet needs to be consistent; don't have sections that require rows to be calculated first, while other sections require columns to be calculated first. Even with a spreadsheet such as *1-2-3* or *Multiplan*, which automatically determine the order of calculation required, you'll have values that aren't calculated correctly.

Most spreadsheets also allow the user to manually recalculate, rather than have recalculation occur every time a new value is entered. This allows the user to enter data much more rapidly, especially in very large spreadsheets where recalculations often can take a long time, even with increased clock speeds and math coprocessor cards. But even experienced users sometimes forget to recalculate the spreadsheet after new data has been entered or formulas have been changed. Or else they manually recalculate, but only recalculate once, which won't be enough if there are simultaneous equations in the spreadsheet.

Recalculation and simultaneous equations also present the opportunity for error. An example of a simultaneous equation would be the determination of net profit of a sale after the cost of the sale and the salesman's commission, where the saleman's commission is a percentage of the net profit. The net profit is dependent on the salesman's commission, and the salesman's commission is dependent on the net profit. Some spreadsheets, such as *Supercalc3* (Computer Associates, 2195 Fortune Dr., San Jose, CA 95131; 408/942-1727), automatically handle this type of equation by recalculating until the dependent variable changes less than 1 percent from one calculation to the next, unless a different value has been specified by the user. With *1-2-3*, however, you must specify the number of calculations to be performed. Specify too few, and the calculation won't be correct; specify too many, and you waste time. And some spreadsheets, such as *Appleworks*, won't do repeated recalculations automatically. You must manually recalculate the spreadsheet until the variables no longer change, even if you have the automatic-recalculation feature active.

Size is another important factor in spreadsheet mistakes. As mentioned earlier, the larger the spreadsheet, the more likely it is that errors will occur, and the more difficult it will be to find them. With the extended-memory standard, 1- and 2-megabyte spreadsheets are possible. Yet there is very little reason to have spreadsheets this large. Larger spreadsheets usually consist of numerous models all crammed into one: budgeting, financial planning, receivables, even payroll. Should there be a major problem with the spreadsheet, you have a potential for disaster.

A good way to find errors is to use a spreadsheet auditor such as *The Spreadsheet Auditor* (Consumers Software, 314 E. Holly St., Suite 106C, Bellingham, WA 98225; 800/645-5501). Using an auditor will help you find errors such as formulas that have references to labels, cells outside the worksheet, blank cells and formulas with reversed ranges. It will also help you find circular reference—formulas that loop back on themselves (refer to themselves either directly or indirectly), making the results of the formula artificially high. The disadvantage of most auditing programs is that once you use them, you have to decipher the resulting cell references and list of formulas. However, with an auditor like *Cell/Mate* (Clarity Software Group, 13276 Research Blvd., Austin, TX 78750; 512/331-5356), the formulas and cells are translated into their English equivalent.

You must remember that an auditor will not locate errors in the logic of the spreadsheet, as opposed to the structure. It's up to the user to verify that the underlying assumptions of the spreadsheet are correct. If they're not, no amount of error-checking software will help. Spreadsheets are powerful tools, but like any tool, you need to spend the time necessary to understand how to use them properly. Time spent learning your spreadsheet and checking your models may save your company embarrassment and money, and may even save your job. **CU**

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