Formulas in Microsoft Excel

An Introduction to Creating and Managing Formulas
in Microsoft® Excel
For Microsoft® Excel 2010, 2007, and 2003

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Formulas in Microsoft Excel

Formulas are the main reason for wanting to learn to use Microsoft Excel. This monograph is an introduction to the basic concepts underlying the use of formulas. It is prepared as a handout for the class "Excel 2010 Basics" taught at Tamalpais High School in Mill Valley, California, through the Tamalpais Union High School District Adult and Community Education Department.

This monograph deals specifically with Excel 2010, but the concepts discussed do apply to earlier versions. Diagrams and screen shots used as illustrations show, when necessary, separate images for Excel 2010 (and 2007) on the left and Excel 2003 (and earlier versions) on the right. Where the appearance of the newer and older versions and their behavior are sufficiently similar, only the Excel 2010 illustration is used.

Data Types

A cell on an Excel spreadsheet can contain a great deal of information. Its contents consist, in essence, of a string of readable, printable characters, all of which are available on the computer keyboard. In principle, any cell's contents could be entered strictly from the keyboard, but in practice we use various methods (menu commands, toolbar/ribbon buttons, keyboard shortcuts, and mouse operations) to automate portions of the process of entering contents, especially formulas, into a cell.

Regardless, however, of what a cell contains, whatever its keystroke-typed contents may be, for each and every cell those contents always fall into exactly one of a limited set of possible "kinds" of information (a computer programmer would say "data types"):

Number   Includes *Date*, *Time*, and *Boolean (True/False)* as special cases
Text
Formula

Some other cell content "types" exist, but for the purposes of an introduction to entering valid, syntactically correct formulas, they play no immediate roles:

Error   Consequence of an error in the syntax of a formula
Blank Cell   Lots of these in a worksheet, but not very useful on their own

Which Data Type Is It?

Excel makes a decision about what "data type" category a cell's contents fit into at the moment editing of the cell's contents concludes. Here are the rules it uses:

Rule 1: *Examine the first character typed into the cell. If it is the equals sign ("="), then the cell contains a formula. End of discussion.*

Once Excel determines a cell is a formula, a considerable amount of processing can (and usually does) ensue depending on the complexity of the formula, including whether or not the formula as written leads to an error. But the decision about data type is made, and the remaining data-type-decision rules are ignored. Note, however, that for purposes of referring to the formula's *result* in another formula somewhere else on the sheet (and assuming the formula does not lead to an error) the result of the formula will in turn carry either a Number or a Text data type.

Rule 2: *If the cell does not contain a formula, then examine the entire string to see if each character can somehow be interpreted as part of a number, or a numeric expression. If a single character is encountered that cannot be part of a number, then the cell's contents are Text. End of discussion.*

Valid numeric characters include the decimal digits ("0" to "9"), the decimal point ("."), the plus and minus signs ("+" and "-"), and several characters used as valid formatting indicators (examples: "$" for a number to indicate a currency value; "/" to indicate parts of a standard date format).

Rule 3: *If the cell's contents made it through rules 1) and 2), then by definition it consists exclusively of numeric (or numeric-interpretable) characters, and is therefore a Number. End of discussion.*

Formatting Numbers and Text

How Numbers and Text are displayed in their cells is a complete discussion in itself, one we will skip here inasmuch as we want to concentrate on formulas. Suffice for the moment to say that all we care about when referencing a cell that contains a Number or a Text value is how that referenced value plays into the result generated by the formula that contains the reference.

There is one caveat here. By typing a Date, Time, or Boolean value directly into a cell, you can do so in a way that conforms to convention (for example, typing "3/12/2012" to insert a Date value of March 12th, 2012 into a cell) and Excel will display it as typed while still considering it a numeric (specifically, a Date) data type. More about Dates and Times later.

Formula Syntax

 "Syntax" means, essentially, grammar. Formulas in Excel have explicit and strict rules that must be followed to construct them so that they will lead to the results you're looking for, so that they are logically and arithmetically correct, and so that they do not produce errors.

Every formula starts with the equals sign ("="), which, per the data type decision rules (above), is what makes it a formula. The remaining contents of a formula consist, in general, of a collection of operands (think "things," or "nouns") tied together by operators (think "instructions," or "verbs"), all of which eventually boil down to a single result that the cell (the one that contains he formula) can display.

Arithmetic

The simplest Excel formula operators are the same ones you are familiar with for doing ordinary arithmetic:

Operator(s)	Description	Arithmetic Operation	Standard Symbol(s)
"(" and ")"	Left and Right Parentheses	Used to group operations	(and)
"^"	Caret (or Hat—Shift-6)	*Exponentiation	7^2
"*"	Asterisk (or Star—Shift-8)	Multiplication	×
"/"	Forward Slash	Division	÷
"+"	Plus Sign (Shift-"=")	Addition	+
"-"	Hyphen (or Minus Sign)	Subtraction	−

Table 1—Arithmetic Operators in Excel—and on Paper

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* In standard arithmetic notation, exponentiation has no explicit operator symbol—it is indicated by writing the exponent as a superscript, as in the example (7^2). Editing the character sequence in a cell containing a formula does not really allow for superscripting, so an explicit exponentiation symbol is needed, hence the use of the "^" character. If exponentiation is not a term you grasp, or if you never do any exponential arithmetic, then you may safely ignore this footnote.

The "+", "-", "*", and "/" (add, subtract, multiply, and divide) characters appear both on the main keyboard and on the numeric keypad to the right of the keyboard. It does not matter which key you use to type these symbols.

Arithmetic expressions in Excel formulas are written pretty much the way you'd write them on a sheet of paper, and operations are done pretty much in the order you write them. Here are some examples of formulas carrying out simple arithmetic operations and their results:

Formula	Result Displayed in the Cell
=1+2	3
=19.2/7	2.742857143
=(14.2+8)*3.5	77.7

Table 2—Examples of Simple Arithmetic Formulas

Note that the third example uses left and right (or "opening" and "closing") parentheses to group the addition ahead of the multiplication. If the parentheses were not there the multiplication (8 × 3.5) would happen first, and its result, 28, would be added to 14.2, yielding 42.2 instead of 77.7 (oops!).

There is a classic mnemonic "rule of thumb" for recalling the precedence order of arithmetic operations: "Please Excuse My Dear Aunt Sally" (Parentheses, Exponentiation, Multiplication and Division, Addition and Subtraction). The mnemonic tells you what order to do things in as you read an arithmetic expression from left to right.

Parentheses indicate grouping of operations. Parenthetical groups can be nested inside one another. For each set (if any) of opening and closing parentheses (every opening parenthesis must be matched somewhere by a closing parenthesis), work your way out from the innermost group.

Starting with the innermost matched pair of parentheses (if there are any), perform all of the following steps as indicated.

Do all exponentiations ("^") indicated, and do them in the order (left-to-right) that you find them.

With the results of exponentiations (if there are any), do all multiplications ("*") and divisions ("/"), and do them in the order (left-to-right) that you find them. Multiplication and division have equal status in the hierarchy.

With the results (if any) of multiplications and divisions, do any additions and subtractions, and do them in the order (left-to-right) that you find them. Addition and subtraction have equal status in the hierarchy.

If you have more outer sets of parentheses, repeat this procedure until everything boils down to a single result. This is exactly the procedure Excel uses to evaluate formulas consisting of nested groups of parentheses, numeric operands, and arithmetic operators.

Single Cell References

Arithmetic is well and good, but formulas like the ones illustrated above could be done much faster, and with no less precision using a pencil, a sheet of paper, and a pocket calculator. The first major advantage formulas in Excel provide is the ability to use references to individual cells as operands, instead of literal numbers.

A cell reference is a cell's column letter[*] followed by its row number. Every cell on an Excel spreadsheet is identified uniquely by just such a cell reference. In a formula, any

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[*] Excel columns start with the letter A and extend to the two-letter sequence IV (the three-letter sequence XFD in Excel 2007/2010 ".xlsx"-format workbooks), a total of 256 columns (16,384 columns in the Excel 2007/2010).

sequence of characters that appears where the formula interpreter expects to find an operand and that is a valid cell reference makes Excel look up the current contents of the referenced cell and insert that value into the formula in place of the cell reference before continuing with the calculation.

Here's an example of a cell containing a formula that in turn references three other cells, each of which contains a number:

Fig. 1—Formula with Single Cell References

Cells D1, D2, and D3 contain, respectively, the numbers 14.2, 8, and 3.5. Cell D4 contains the formula =(D1+D2)*D3 (note that the *contents* of cell D4—the actual formula—is displayed on the Formula Bar, while the formula's *result* is displayed in the cell). D4 displays the same result as the third example in Table 2 (above), 77.7. It performs the same arithmetic operations in the same grouped order. What's different is that if we want to carry out a similar calculation with, as a minimum, one of the operands changed, all we have to do is edit the corresponding cell (D1, D2, or D3) to reflect the new value we want to use. The result of the formula is immediately updated. In the earlier example we would have had to edit the formula itself, and we would not have had as flexible or general purpose a tool.

When we're in the process of entering a formula into a cell (or perhaps, editing it later on), Excel displays cell references in the formula and their corresponding cell borders in a color-coded fashion like this:

Fig. 2—Formula with Cell References Being Entered or Edited

So. Anywhere in a formula that you can, in principle, insert a number, you can alternatively (and preferably) insert *a reference to a cell that contains a number*. Even better, you can insert *a reference to a cell that contains a formula that in turn generates a numeric result*.

Cell Range References

The logical syntactic extension of a single cell reference is a means whereby a single operand can refer to a range of cells occupying a contiguous area on the sheet. We do this by taking the cell references of the upper left and lower right corners of the range

of cells we're interested in and separating them with a colon (":") character. In the example below, the formula in cell C4 refers to the range of cells starting at cell A2 and extending down and to the right, to and including cell C3 (a total of 6 cells). The cell range reference is the argument to a SUM function (more about which later), that in turn performs an addition operation on all its arguments, yielding the displayed result, 44.7.

C4			f_x	=SUM(A2:C3)	
	A	B	C	D	E
1				14.2	
2	19.1	13.3	11.5	8	
3	3.6	-21.4	18.6	3.5	
4			44.7	77.7	
5					

Fig. 3—Formula Using a Cell Range Reference

Problems with Formulas

The Divide By Zero Error

The rules of arithmetic allow us to take any two numbers and combine them using any of the arithmetic operators listed in Table 1 (pg. 2, above). We can take any two numbers and add them together, subtract one from the other, multiply them together, divide one by the other, or use one of them as an exponent for the other. The one and only arithmetic operation we are not allowed to do is to divide any number by zero.

The reason is that to a mathematician, dividing any finite number by zero is equivalent to specifying infinity. Whether or not you're party to the philosophical debate, the fact remains that computers (at least the ones we mortals use) simply do not know how to cope with infinities. So any time an Excel formula attempts to carry out a division operation where the divisor (denominator) is zero, an error indicator will appear in the formula's cell, as well as in any cells with formulas that, in turn, depend on the cell that has the divide-by-zero error.

Having the character sequence "/0" somewhere in a formula, or having a cell reference that points to a cell with the number 0 in it, are both pretty easy to spot and fix. Where most Excel users run afoul of divide-by-zero is in a formula that references a cell that is blank. Here's an example:

B2			f_x	=A1/B1	
	A	B	C	D	E
1	12.5				
2	◇ ▾	#DIV/0!			
3					

The formula or function used is dividing by zero or empty cells.

| 5 | | | | | |

*Fig. 4—Formula Referencing a Blank Cell Causes a Divide-by-Zero Error*

Note that cell B1 is a blank cell. When the formula in cell B2 (the "=A1/B1" visible in the Formula Bar) attempts to divide A1's value (12.5) by B1's value, the blank in cell

B1 supplies a numeric value of 0, and the divide-by-zero error happens. The fix is to make sure that B1 is not blank, and that its value is any number other than zero.

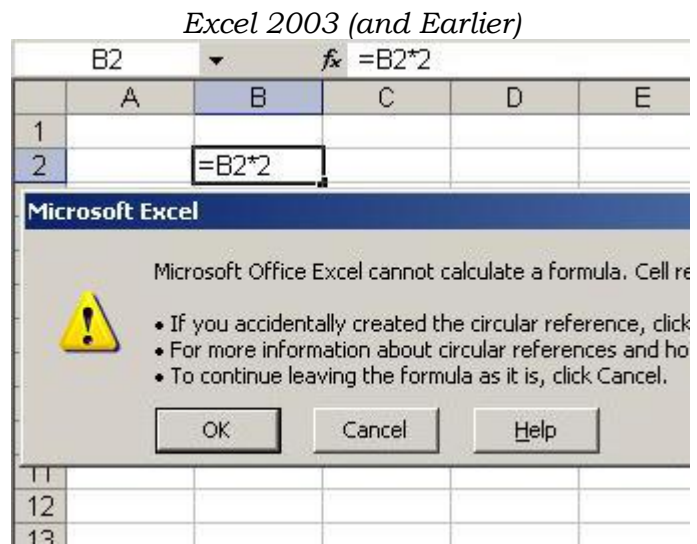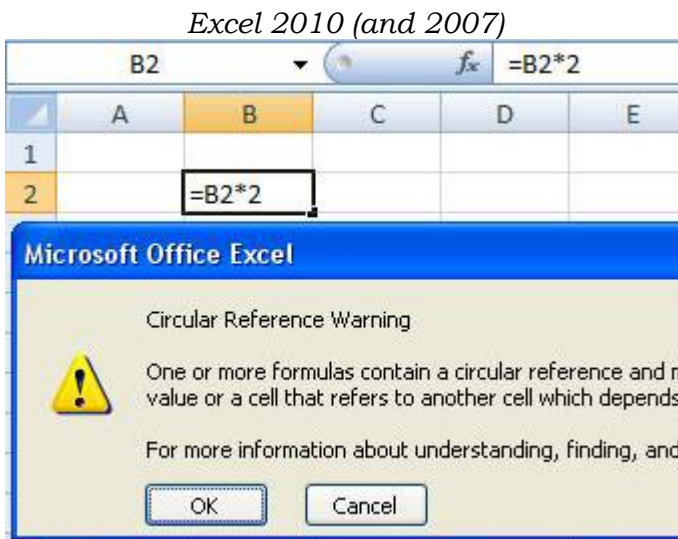### The "Circular Reference" Tar Pit

An Excel spreadsheet that is more than trivially complex will, typically, have many instances of cells with formulas that refer to other cells, which in turn contain formulas that refer to other cells, which in turn contain formulas that refer to other cells, which in turn…you get the idea. In every instance, this "reference chain" has at least one beginning point (there may be more), and one or more ending points. Whenever the content of a cell anywhere in a reference chain is altered, Excel immediately recalculates all of the formulas in the chain that depend upon the changed cell (i.e., that are closer to the end of a chain). In general, Excel starts calculating at the beginning point(s) of the chain, and then follows the chain one reference step at a time, performing each calculation in the order the reference chain dictates until it reaches the end point(s).

A serious (but subtle) class of problem arises any time a cell's formula refers to itself. In the example shown in Fig. 5, below, the formula being entered into cell B2 ("=B2*2") contains a reference to cell B2. When the [Enter] key is pressed (or the "✓" button on the Formula Bar is clicked), Excel will attempt to multiply the value in cell B2 by two, and then display the result in cell. But wait a minute…how can cell B2 be multiplied by 2, then displayed in cell B2 without having to be multiplied by two again, and so on…?
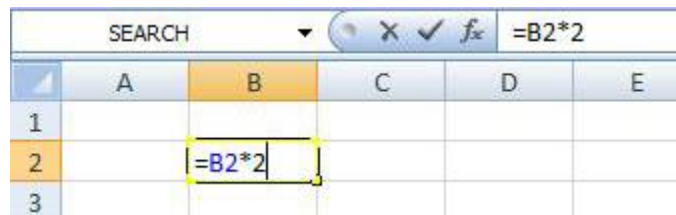
Fig. 5—A Circular Reference In The Making

Computer programmers call this sort of thing an "infinite loop" or an "infinite recursion," and they avoid it like the plague. Excel immediately detects the attempt to create what it refers to as a Circular Reference, and displays a dialog box with an error message:

Fig. 6—Excel's Circular Reference Warning

Regardless which button you click, Excel will display a zero value in cell B2. Clicking the [OK] button opens a window with help information about finding and resolving Circular References. If you do nothing else and enter any other formulas that refer to cell B2, you'll find the zero value propagating as though it were the valid result of the formula in cell B2.

Seeing a circular reference in a single cell is not difficult—just pay attention to the warning message when it appears. What's harder to see (and what is much more likely to be the cause of a circular reference error) is the case where a chain of formula references starting at one cell works its way around the spreadsheet until eventually a formula in a different cell winds up depending upon (referring to) the cell at the start of the chain. This will also generate a circular reference error, as illustrated in Fig. 7, below. Note that even though cell B2 does *not* contain a reference to itself (it does not contain a cell reference to "B2"), the chain of references built up (B2 refers to C2, C2 refers to D2, and D2 refers back to B2) ultimately causes a Circular Reference error.
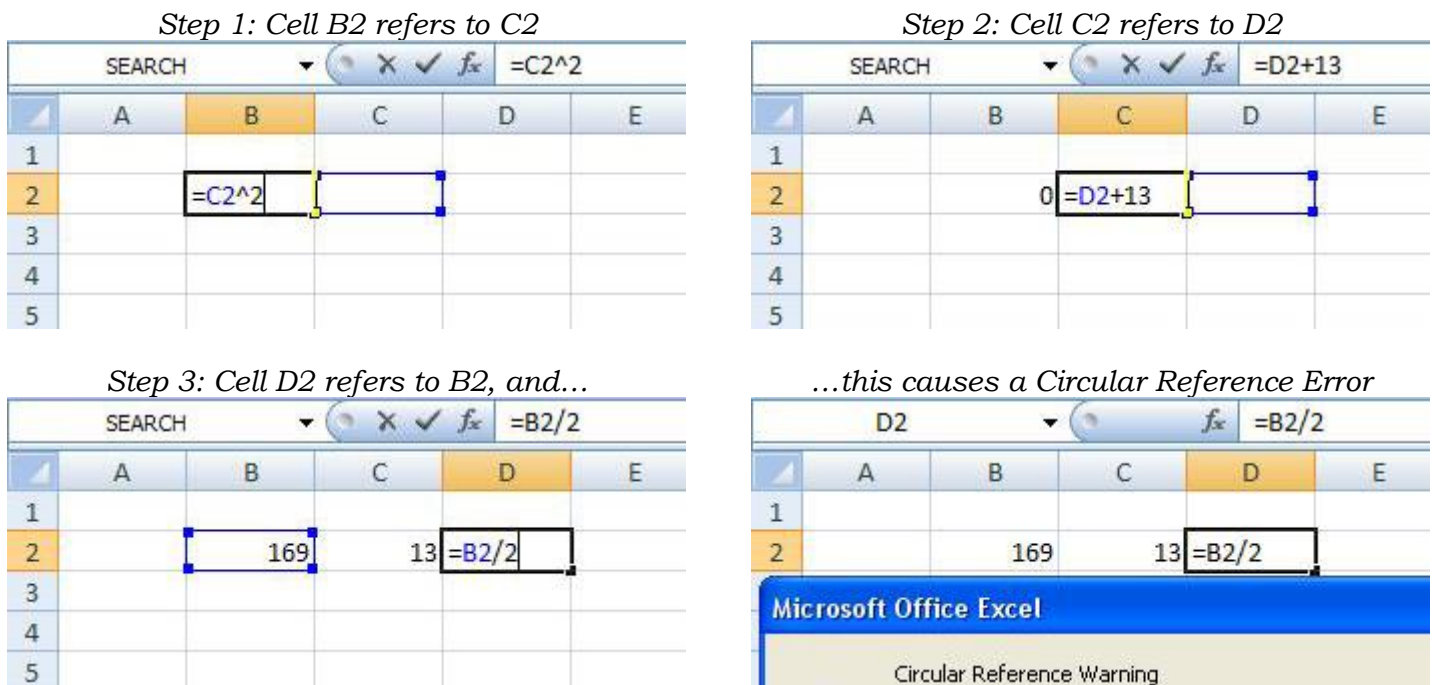
Step 1: Cell B2 refers to C2

Step 2: Cell C2 refers to D2

Step 3: Cell D2 refers to B2, and…

…this causes a Circular Reference Error

Fig. 7—Circular Reference Error in a Reference Chain

Get into the habit of *always* resolving circular references *immediately* when they occur. The risk in waiting is that you'll forget, and then the spreadsheet you've worked so long and hard on will have a fatal defect buried in its middle somewhere, and you'll have the devil's own time rooting it out.

Functions—Building Blocks for Formulas

The next puzzle piece we encounter in Excel formulas is the Function. Functions are a means to write what would otherwise be much more elaborate (and usually harder to understand) formulas in a more concise fashion.

A *function* is a building block that can be inserted into a *formula* anywhere you would use an operand. Functions by themselves do not constitute formulas; you need as a bare minimum that "=" in front of a function name for the whole works to qualify as a formula.

Every *function* contains of the following elements in the following order:

Element	Description	Example
Name	The function's name (in all CAPS)	SUM
(	Opening parenthesis (required in all cases)	
...	Arguments (depends on the particular function – if more than one, they are separated by commas – some functions have no arguments at all!)	
)	Closing parenthesis (required in all cases)	

Table 3—Structural Elements of Functions

Arguments are themselves operands, just like (and including as possible examples) the numbers and cell references we've seen so far. Most function definitions call for one or more (usually not more than a few) arguments. The function library includes help information about the required data type for each of a function's arguments, and what the function is supposed to compute. Note that the opening and closing parentheses are *not* optional. They are included in a function's definition even if the particular function uses no arguments (there *are* a few such functions).

Out of the box, Excel includes over 400 pre-defined functions (see Appendix I: The Excel 2010 Function Catalog on page 15). No two of them have the same name, nor use precisely the same set of arguments (if any), nor do precisely the same kinds of calculations. Most functions return numeric results. Some return text results. Some return so-called Boolean (yes or no, "True" or "False") values that can in turn be used within a formula to make decisions about what else to calculate.

But with every function you put into a formula, there is a name, there are opening and closing parentheses, and there may or may not be (but usually are) one or more arguments.

Cell Range References Redux

More often than not, arguments to functions (the things inside the functions' parentheses) are cell range references. Cell range references can sometimes be used as direct operands in formulas, but in practice this is relatively rare. Inside a *function's* parentheses, however, a cell range reference behaves as though it were a series of comma-delimited arguments, each of which were a reference to one of the individual cells in the range. In Fig. 8, below, the cell range reference "B1:B3" (in the SUM function in cell B4) behaves as though it were written "B1, B2, B3". The result displayed in cell B4 is the arithmetic sum of the numeric values in the range of cells beginning at B1 down to and including cell B3 (as the example shows, 2.9 – 12.97 + 44.2 = 34.13).

The SUM Function

The single most commonly used function in Excel is the SUM function. Its definition calls for its arguments all to be numeric values. There must be at least one argument.

If there are multiple arguments, they are separated by commas. An argument to the SUM function can be a literal number, it can be a single cell reference, or it can be a cell range reference (see below). Here's a typical example that (as discussed in the previous section) uses a cell range reference as its only argument:
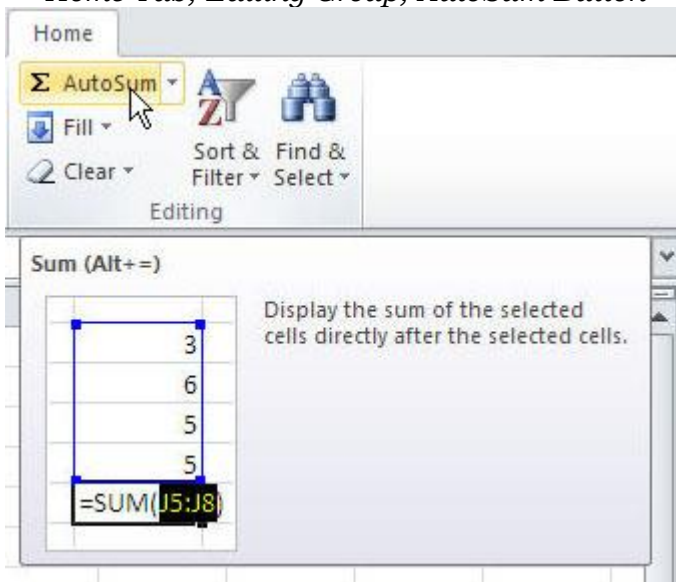

Fig. 8—The SUM Function At Work

The AutoSum Button

If you have a range of cells with numbers in them, or formulas that compute numeric results, Excel provides an easy shortcut to insert a formula that computes their arithmetic sum: the AutoSum button.

Excel 2010 (and 2007)
Home Tab, Editing Group, AutoSum Button

Excel 2003 (and Earlier)
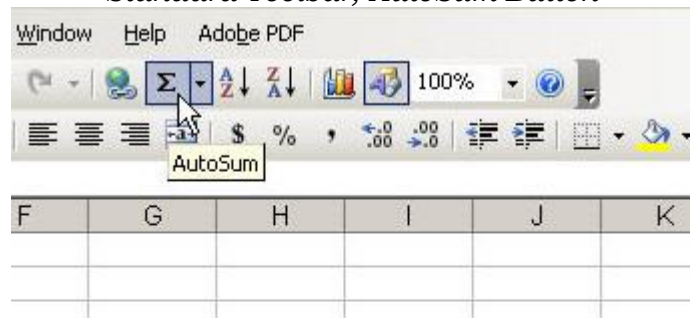*Standard Toolbar, AutoSum Button*

Fig. 9—The AutoSum Button

(As an aside, note that the tooltip displayed by Excel 2010 leaves the one displayed by Excel 2003 in the dust!)

The AutoSum button's icon is the capital Greek letter sigma ("Σ"), which mathematicians use to indicate summation. The procedure is simple. Either select the range of cells you wish to sum (making sure ahead of time that the cell immediately below them is blank, or simply position the active cell indicator on the blank cell at the bottom of the range. Then click the AutoSum button:
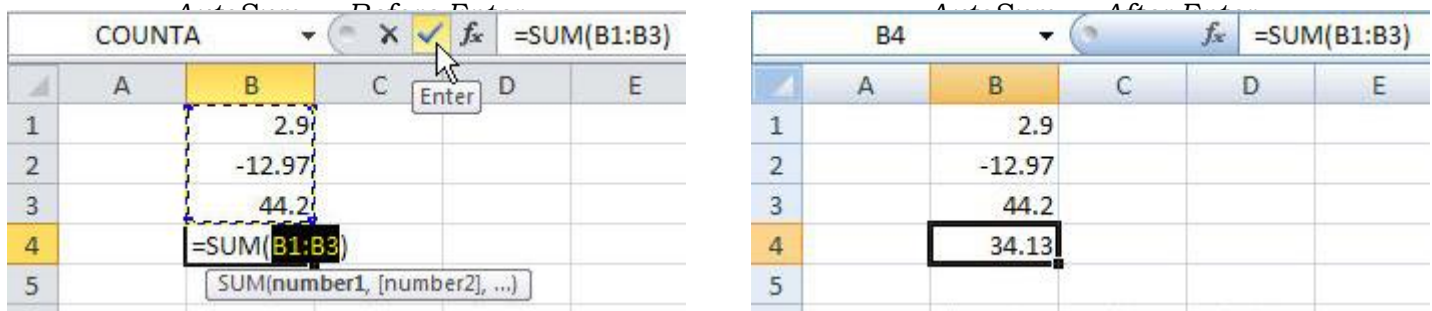
Fig. 10—AutoSum At Work

AutoSum will go into Excel's data entry mode and construct a formula using the SUM function. If you pre-selected the range of cells you wanted to be summed, the job is complete. If you simply highlighted the cell where you wanted the formula with the SUM function to appear, AutoSum will pause after constructing its proposed formula and give you an opportunity to alter the cell range reference argument before you finish entering the formula. The example above (Fig. 10) follows the latter sequence.

AutoSum Options

To review, the AutoSum button, when clicked, produces a formula with the SUM function operating on either a pre-selected range of cells, or on a contiguous range of cells adjacent to the cell that was active when the AutoSum button was clicked. But is a formula with a SUM function the only thing that can be created this way? The answer (pretty obviously, since I bothered to ask) is no. The AutoSum button in both its Excel 2010/2007 and 2003-and-earlier incarnations has a small downward-pointing triangle next to it that, if clicked, shows a menu of function choices other than the SUM function. (The [More Functions…] menu item activates the Insert Function dialog box, more about which later.)
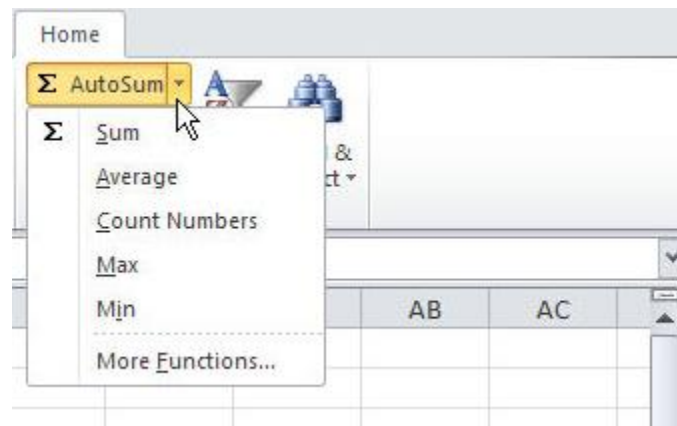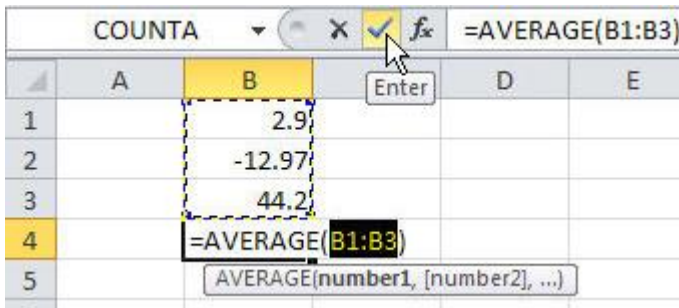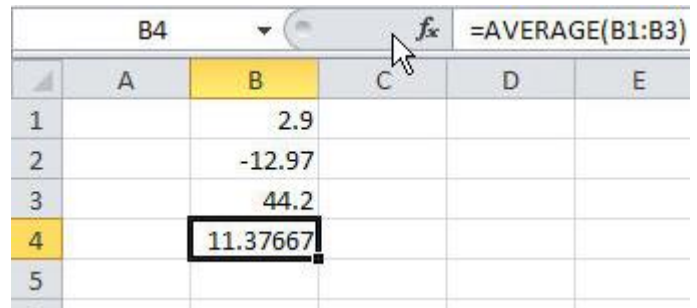

Fig. 11—Other AutoSum Function Choices — The AutoSum Menu

With the scenario in Fig. 10, selecting [Average] from the AutoSum menu instead of just clicking the AutoSum button will yield a result like this:

Average (via AutoSum) — Before Enter   *Average (via AutoSum) — After Enter*

Fig. 12—Use The Average Function From The AutoSum Menu

Comparable results can be obtained if instead of summing or averaging a list of numbers, you'd like to count how many of them there are ([Count numbers]), determine which is largest ([Max]), or determine which is the smallest ([Min]).

The Insert Function Dialog

The Average, Count, Max, and Min choices on the AutoSum Menu, expand the possibilities away from just computing sums. To explore the limits of what Excel provides, however, you must make use of the Insert Function dialog.

The Insert Function dialog can be activated at any time, editing the contents of a cell or navigating about a spreadsheet, by clicking the "*fx*" symbol at the left edge of the Formula Bar.

The Insert Function dialog presents a list of all 415 functions available in Excel. You may constrict the list of function names somewhat by choosing an option from the "Select a Category" drop-down list:
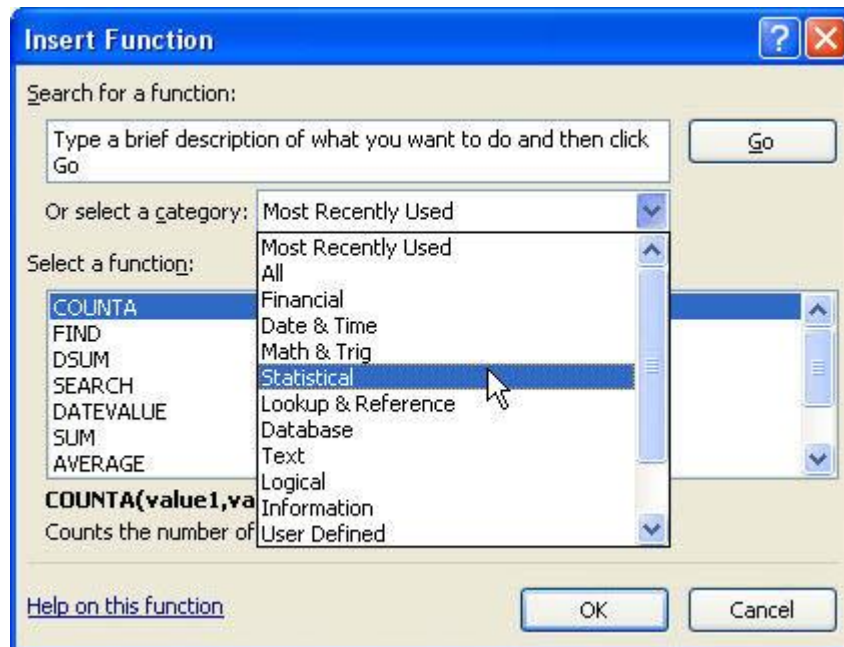

Fig. 13—The Insert Function Dialog—Category List

When you highlight a particular function name in the [Select a function] portion of the Insert Function dialog, you're shown an abbreviated example of the function's syntax and a brief description of what the function does. There's also a hot link at the

bottom left of the dialog labeled [Help on this function]—click the link, and Excel opens its help system and takes you to a detailed description of the function.
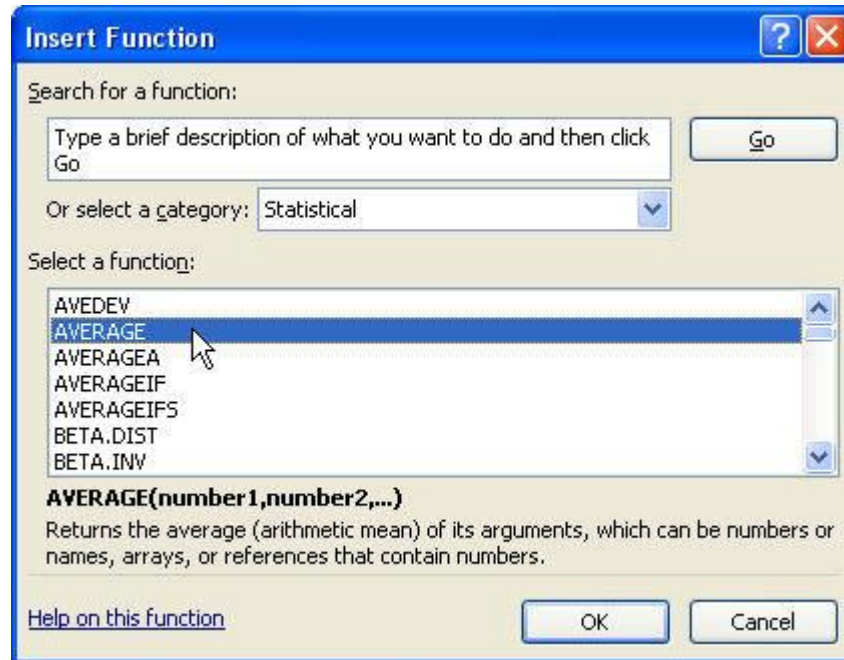

Fig. 14—The Insert Function Dialog—Detailed Function Help

Cell References Redux—Absolute vs. Relative Cell Referencing

Imagine you're standing on a city corner and someone walks up and asks, "Where do I find George's Deli?" You, being a long-time resident and an aficionado of metropolitan delicatessens immediately reply, "It's at Main and Everest." "I'm new to the city," the asker continues, "I don't really know where Main and Everest is." "Ah," you reply, "it's three blocks east and one north from here. "Thanks," says the asker, and goes on his way, grateful for your assistance in his pursuit of a Ruben sandwich.

If a different visitor had the same conversation with you but on the opposite side of town, its wording would be identical until your last reply. Regardless where you are in the city, George's is always at Main and Everest, but on an altogether different corner your final reply might be something like, "It's seven blocks south and three to the west." In Excel, this distinction is called Absolute vs. Relative Cell Referencing.

Cell Reference Syntax

We've already looked at the idea of a cell reference—a column letter followed by a row number (example: "C3"). Believe it or not (...and this is, hands down, one of the most egregiously *non*-intuitive things Excel has to offer...), the "C3" syntax is a *relative reference*. It is equivalent to the "three blocks east, one north" alternative in the directions-giving analogy. Sadly (...for hopes of things being intuitive, that is...), this means that "C3" used as a reference in a formula in, say, cell B9 does not have the underlying meaning of a reference to "C3" used in a formula in cell D1, *even though both of them draw the value from cell C3 and use it in their respective formulas*. From the point-of-view of cell B9, C3 is 6 rows up and one column to the right. From the point-of-view of D1, C3 is *2* rows *down* and one column to the *left*. So even though both B9's and D1's formulas point to cell C3, their formulas take radically different paths in order to retrieve the value in C3.

There are two main justifications for this intuitive nightmare. The first is that cell references need to be stored as *relative references* so that copy-and-paste operations between adjacent cells containing formulas that have similar "shapes" to the cell range (or ranges) they draw from work without having to go and edit every paste-destination cell after its paste operation. Second is that a syntax like "C3" is easier to read and grasp than a syntax like "ColumnPlus1,RowMinus6". The latter syntax would more likely be abbreviated something like "R[-6]C[+1]".

As it happens, Excel does in fact have a configuration option to replace the "C3" syntax with a syntax like "R[-6]C[+1]" called (surprisingly) the "R1C1" reference style. I cannot in good conscience recommend using this, however, since it makes "seeing" the cells a formula is referring to much more difficult, and it is not in widespread use, so most Excel users have never seen it. The good news is that if you open an Excel file created by someone using the "R1C1" style, but your Excel is configured for the "C3" style (the out-of-the-box default), the file will open and display in your style mode, not in his.

So if you want to get under the hood a bit, you must think of a reference to cell C3 inside a formula in cell B9 as being a relative reference to whatever cell is 6 rows up and 1 column to the right of B9. If you copy B9 and paste its formula into cell C9, the corresponding reference in the destination cell will say "D3" since D3 is 6 rows up and 1 column to the right of cell C9.

In order to make a cell reference in a formula be an *absolute reference*—one that will always point to exactly the same cell regardless where the formula is copied and pasted, the syntax of the reference must be altered by placing a dollar sign in front of the column letter and the row number—"C3" becomes "C3". This is the equivalent to the 'Main and Everest' alternative in the analogy. *PLEASE NOTE* that the "$" symbols here have nothing whatever to do with whether or not the formula's result is formatted with a currency symbol. It is strictly a syntax requirement in order to force the cell reference to be *absolute*—to insure that no matter where on the spreadsheet the cell's formula is copied and pasted, the reference will *always* point to cell C3 and nowhere else.

So. "C3" doesn't really mean "C3". "C3" does. Confusing? Welcome to Excel. Trust me, you'll get used to this. Mainly because 99 times out of 100 the formulas you build will work just fine with relative references, will copy and paste just fine, and the references they contain will actually name the cells they point to. On the rare occasions where you need to use absolute references, you'll remember that we had this discussion and you'll look the subject up long enough to recall how to use it.

Excel Formula Examples

The following examples illustrate basic principles underlying Excel formulas as discussed in this monograph. Each example highlights some specific features of Excel formulas, and as you progress through them they will become more complex.

Doing Simple Arithmetic—The Dutch Treat Calculator

Making Decisions—The Dutch Treat Calculator, Version 2

Using Absolute Cell References—The Sales Commission Calculator

Using Financial Functions—Estimating a Mortgage Payment

Appendix I: The Excel 2010 Function Catalog

Excel 2010 includes 415 functions that can be used to build formulas (the list was a little shorter with Excel 2003). This appendix lists a few of the more commonly used functions, grouped in the manner Excel itself uses on the Insert Function dialog. This list is not exhaustive. For the complete list of functions available in an Excel spreadsheet, click the [Insert Function] button on the Formula Bar. Please note that descriptive information here is taken from Excel 2010's built-in and on-line help information. Where a syntax description shows an argument enclosed in square brackets ("[" and "]"), that argument is optional. All other arguments are required.

Financial

FV – Future Value

Returns the future value of an investment based on periodic, constant payments and a constant interest rate.

Syntax:

FV(Rate, Nper, Pmt, [Pv], [Type])

Arguments:

Rate Required. The interest rate per period.

Nper Required. The total number of payment periods in an annuity.

Pmt Required. The payment made each period; it cannot change over the life of the annuity. Typically, **Pmt** contains principal and interest but no other fees or taxes. If **Pmt** is omitted, you must include the **Pv** argument.

Pv Optional. The present value, or the lump-sum amount that a series of future payments is worth right now. If **Pv** is omitted, it is assumed to be 0 (zero), and you must include the **Pmt** argument.

Type Optional. The number 0 (zero) or 1; indicates when payments are due. If **Type** is omitted, it is assumed to be 0.

Set **Type** to:	If payments are due:
0 (or omit)	At the end of the period
1	At the beginning of the period

Returns:

The value of the investment at the end of the final period (a numeric value).

Notes:

Make sure that you are consistent about the units you use for specifying **Rate** and **Nper**. If you make monthly payments on a four-year loan at 12 percent annual interest, use 12%/12 for **Rate** and 4*12 for **Nper**. If you make annual payments on the same loan, use 12% for **Rate** and 4 for **Nper**.

For all the arguments, cash you pay out, such as deposits to savings, is represented by negative numbers; cash you receive, such as dividend checks, is represented by positive numbers.

PMT – Loan Payment

Calculates the payment for a loan based on constant payments and a constant interest rate.

Syntax:

PMT(Rate, Nper, Pv, [Fv], [Yype])

Arguments:

Rate   Required. The interest rate for the loan.

Nper   Required. The total number of payments for the loan.

Pv   Required. The present value, or the total amount that a series of future payments is worth now; also known as the principal.

Fv   Optional. The future value, or a cash balance you want to attain after the last payment is made. If fv is omitted, it is assumed to be 0 (zero), that is, the future value of a loan is 0.

Type   Optional. The number 0 (zero) or 1; indicates when payments are due. If **Type** is omitted, it is assumed to be 0.

Set **Type** to:	If payments are due:
0 (or omit)	At the end of the period
1	At the beginning of the period

Returns:

The fixed payment to be paid each period of the loan (a numeric value).

Notes:

The payment returned by **PMT** includes principal and interest but no taxes, reserve payments, or fees sometimes associated with loans.

Make sure that you are consistent about the units you use for specifying **Rate** and **Nper**. If you make monthly payments on a four-year loan at an annual interest rate of 12 percent, use 12%/12 for **Rate** and 4*12 for **Nper**. If you make annual payments on the same loan, use 12 percent for **Rate** and 4 for **Nper**.

Tip: To find the total amount paid over the duration of the loan, multiply the returned **PMT** value by **Nper**.

Date and Time

Mathematics and Trigonometry

SUM – Arithmetic Summation

*The **SUM** function adds all the numbers that you specify as arguments. Each argument can be a range, a cell reference, an array, a constant, a formula, or the result from another function. For example, **SUM(A1:A5)** adds all the numbers that are contained in cells A1 through A5. For another example, **SUM(A1, A3, A5)** adds the numbers that are contained in cells A1, A3, and A5.*

Please note that of the entirety of choices in Excel's function catalog, the SUM function is arguably the most often used.

Syntax:

SUM(Number1,[Number2],...)

Arguments:

Number1   Required. The first number argument that you want to add.

Number2   Optional. Number arguments 2 to 255 that you want to add.

Returns:

The arithmetic sum of all numbers in all arguments.

Notes:

If an argument is an array or reference, only numbers in that array or reference are counted. Empty cells, logical values, or text in the array or reference are ignored.

If any arguments are error values, or if any arguments are text that cannot be translated into numbers, Excel displays an error.

Statistical

Lookup and Reference

Text

Logical

Information

Engineering