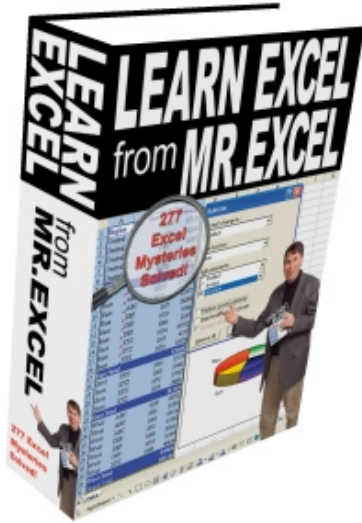




Free Preview – Week #8

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This Week: topics on relative, absolute, and mixed references.

COPY A FORMULA THAT CONTAINS RELATIVE REFERENCES

Problem: You have 5,000 rows of data. After entering a formula to calculate Gross Profit Percent for the first row, as shown in Fig. 167, how do you copy the formula down to other rows?

**Part
II**

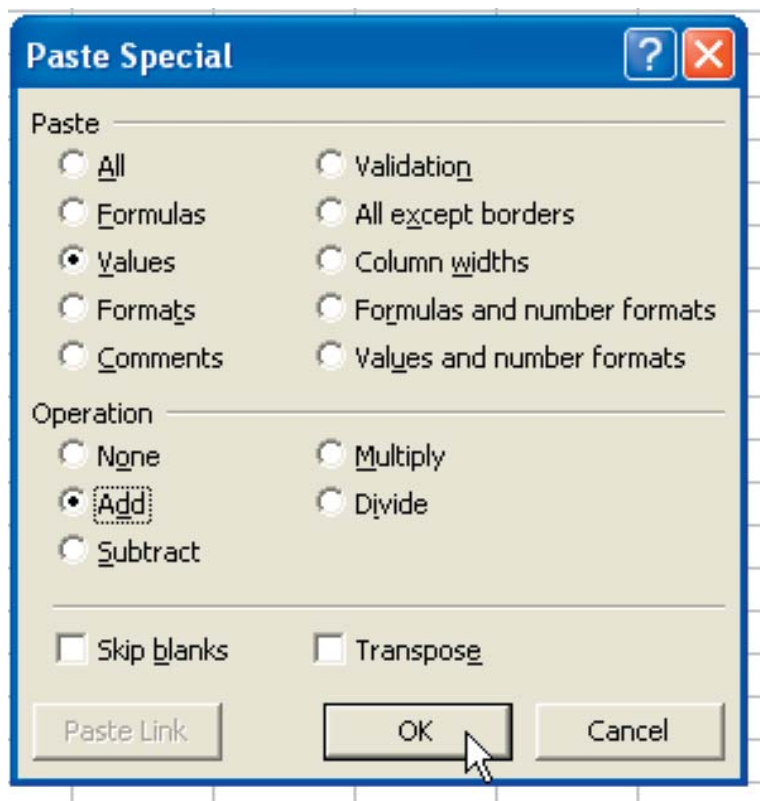


Fig. 167

Strategy: All of the cell references in the formula are known as relative references. The amazing thing about Excel is that when you copy a formula, all of the relative cell references are automatically adjusted. If you copy a formula from row 2 down to row 3, as shown in Fig. 168, then every reference pointing at row 2 will change to point at row 3.

G3		=IF(E3>0,1-F3/E3,"NA")					
	A	B	C	D	E	F	G
1	Region	Product	Date	Quantity	Unit Price	Unit Cost	GP%
2	East	XYZ	1/1/04	10000	22.81	10.22	55.2%
3	Central	DEF	1/2/04	1000	22.57	9.84	56.4%

Fig. 168

So, the solution to the problem is simply to copy the formula down to all the other rows. A shortcut for doing this is to select the cell and then double-click the Fill handle to copy the formula down to all rows with values in the adjacent column.

Additional Details: Relative references will move in all four directions. In Fig. 169, if you copy the formula in cell F7 to E6, the referenced cell will change from D3 to C2.

	A	B	C	D	E	F
1						
2						
3				1		
4						
5						
6						
7						=D3
8						

Fig. 169

In Fig. 170, you can see how the formula copied from F7 to E6:G8 will change.

	A	B	C	D	E	F	G
1							
2							
3							
4							
5							
6					=C2	=D2	=E2
7					=C3	=D3	=E3
8					=C4	=D4	=E4

Fig. 170

Hint

Fig. 170 was shot in Show Formula mode. To enter Show Formula mode, hit Ctrl+=. To toggle back to regular mode, hit Ctrl+= again.

Part II

Gotcha: It is possible to copy a formula so that it will point to a cell that does not exist. As shown in Fig. 171, what would happen if you copied C4 to B3?

	A	B	C
1	2		
2			
3			
4			=A1
5			

Fig. 171

The reference to A1 would have to point to the cell one row above and one column to the left of A1. This cell does not exist, so Excel will return a #REF error, as shown in Fig. 172.

	A	B	C
1	2		
2			
3		=#REF!	
4			=A1
5			

Fig. 172

Look at the formula in the formula bar in Fig. 174. As you copied the formula, the references to D4 and E4 changed as expected. However, the reference to C1 moved to C2. You need to find a way to copy this formula and always have the formula reference C1.

Frankly, this is the most important technique in the entire book. I once had a manager who would enter every formula by hand in the entire dataset. I didn't have the heart to tell him there was an easier way.

Strategy: You need to indicate to Excel that the reference to C1 in the formula is Absolute. Do this by inserting a dollar sign before the C and before the 1 in the formula. The formula in F4 would change to `=ROUND((D4*E4)*$C$1,2)`.

As you copy this formula down to other rows in your dataset, the portion that refers to `$C$1` will continue to point at `$C$1`, as shown in Fig. 175.

**Part
II**

	A	B	C	D	E	F	G
1	Sales Tax Factor:		106.5%				
2							
3	Region	Product	Date	Qty	Unit Price	Total	
4	East	XYZ	1/1/04	4	22.81	97.17	
5	Central	DEF	1/2/04	10	22.57	240.37	
6	East	ABC	1/2/04	8	20.49	174.57	
7	Central	XYZ	1/3/04	8	22.48	191.53	
8	Central	XYZ	1/4/04	8	23.01	196.05	
9	East	DEF	1/4/04	7	23.19	<code>=ROUND((D9*E9)*\$C\$1,2)</code>	
10	East	XYZ	1/4/04	2	22.88	48.73	
11	Central	ABC	1/5/04	6	17.15	109.59	

Fig. 175

Additional Details: See the next chapter to understand the effect of using just one dollar sign in a reference instead of two. Read “Simplify Entry of Dollar Signs in Formulas” a few chapters after that to learn a cool shortcut for entering the dollar signs automatically.

Summary: Entering dollar signs in a reference will lock the reference and make it absolute. No matter where you copy the formula, it will continue to point to the original cell.

Functions Discussed: `=ROUND()`

Cross Reference: Create a Multiplication Table; Simplify Entry of Dollar Signs in Formulas

CREATE A MULTIPLICATION TABLE

Problem: Create a multiplication table to help your kids in school. In Fig. 176, you want to enter a single formula in cell B2 that can be copied to the entire table.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1		1	2	3	4	5	6	7	8	9	10	11	12
2	1												
3	2												
4	3												
5	4												
6	5												
7	6												
8	7												
9	8												
10	9												
11	10												
12	11												
13	12												

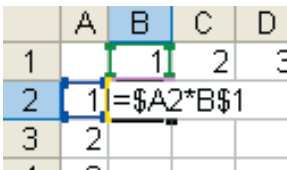
Fig. 176

Strategy: In the last chapter, you learned how to use an absolute reference, such as \$C\$1, so that Excel would not change from column C or row 1 as it copied the formula. To create a multiplication table, you need to use a mixed reference. A mixed reference, such as \$B1, will lock the formula to column B, while allowing the row to change. A mixed reference, such as B\$1, will lock the row to row 1, while allowing the column to change.

The formula that you need for the multiplication table is a formula that will multiply whatever is in row 1 above the cell by whatever is in column A to the left of the cell.

To have a reference that always points to row 1, use something in the format of B\$1. To have a reference that points to column A, use a reference in the format of \$A2.

- 1) As shown in Fig. 177, the formula you want to enter in B2 is $=\$A2*B\1 .

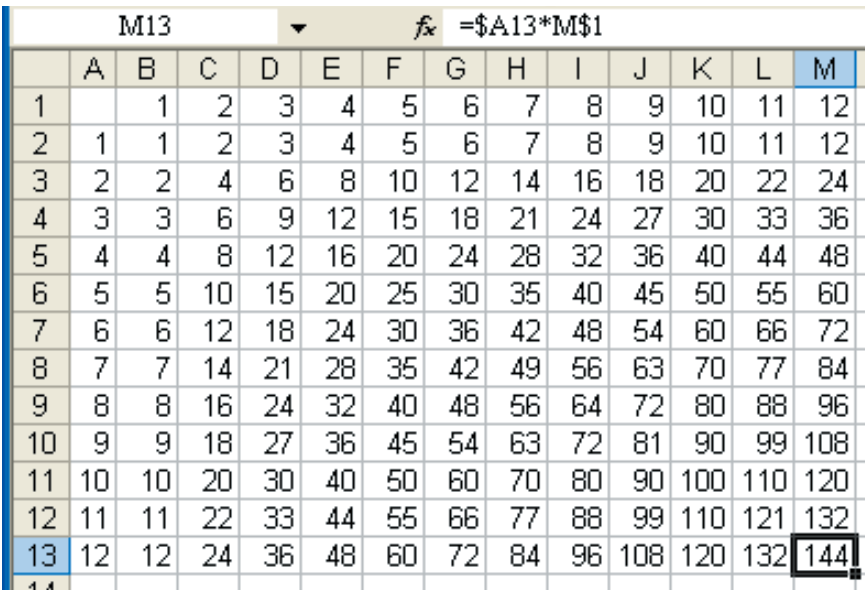


The image shows a small portion of an Excel spreadsheet. The columns are labeled A, B, C, and D. The rows are numbered 1, 2, and 3. Cell B2 contains the formula `=A2*B$1`. Colored lines (green, blue, yellow) highlight the cell references: A2, B, and B\$1.

	A	B	C	D
1		1	2	3
2		<code>=A2*B\$1</code>		
3				

Fig. 177

- 2) Copy the formula in B2 to the entire range, and it will always properly multiply row 1 by column A as shown in Fig. 178.



The image shows an Excel spreadsheet with a multiplication table. The formula bar at the top shows `=A13*M$1`. The table has columns A through M and rows 1 through 13. The values in the table are the products of the row and column indices. The formula in cell M13 is `=A13*M$1`, which calculates 13 * 11 = 143. The cell M14 is highlighted with a black border and contains the value 144.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1		1	2	3	4	5	6	7	8	9	10	11	12
2	1	1	2	3	4	5	6	7	8	9	10	11	12
3	2	2	4	6	8	10	12	14	16	18	20	22	24
4	3	3	6	9	12	15	18	21	24	27	30	33	36
5	4	4	8	12	16	20	24	28	32	36	40	44	48
6	5	5	10	15	20	25	30	35	40	45	50	55	60
7	6	6	12	18	24	30	36	42	48	54	60	66	72
8	7	7	14	21	28	35	42	49	56	63	70	77	84
9	8	8	16	24	32	40	48	56	64	72	80	88	96
10	9	9	18	27	36	45	54	63	72	81	90	99	108
11	10	10	20	30	40	50	60	70	80	90	100	110	120
12	11	11	22	33	44	55	66	77	88	99	110	121	132
13	12	12	24	36	48	60	72	84	96	108	120	132	144

Fig. 178

Summary: Using a single dollar sign in a cell reference will create a mixed reference. Only the row or column will be fixed as you copy the formula.

CALCULATE A SALES COMMISSION

Problem: The VP of Sales in your company dreamt up the most convoluted sales plan in the history of the world. Rather than just pay the reps a straight commission, this plan involves a base rate of 2 percent, bonuses based on the product sold, and the monthly profit sharing bonuses. For the spreadsheet shown in Fig. 179, using Relative, Mixed, and Absolute formulas, create a formula that can be copied to all rows and all months.

	A	B	C	D	E	F	G	H	I	J
1	Base Rate	2%		Bonus Factor:	102%	100%	104%			
2										
3					SALES			COMMISSION		
4										
5	Rep	Product	Prod Rate	Customer	Jan	Feb	Mar	Jan	Feb	Mar
6	Jones	ABC	5%	General Motors	8132	25350	18904			
7	Jones	DEF	8%	Molson, Inc	17136	25140	17136			
8	Doe	DEF	8%	Verizon	2042	25140	19368			

Fig. 179

Strategy: This formula will contain all four reference types. While entering the first formula in H6, you will want to base the commission calculation on the January sales in E6. As you copy the formula from January to February, you will want the E6 reference to be able to change to F6. As you copy the formula down to other rows, you will want the E6 to change to E7, E8, etc. Thus, the E6 portion of the formula needs to be a relative reference and will have no dollar signs.

You will multiply the sales times the base rate in B1. As you copy the formula to other months and rows, it always needs to point to B1. Thus, you need to use dollar signs to before the B and before the 1: \$B\$1.

To incorporate the product bonus, you will need to multiply sales by the Product Rate in column C. All of the months in row 6 will have to refer to C6. All of the months in row 7 will have to refer to C7. Thus, you need a mixed reference where column C is locked. Use the address of \$C6.

Finally, the VP of Sales added the monthly profit sharing bonus. The entire commission calculation is multiplied by the bonus factor shown in row 1. The January commission calculation uses the factor in E1. The February factor is in F1. The March factor is in G1. In this case, you

need to allow the formula to point to different columns but always to row 1. This requires a mixed reference of E\$1.

Now that you have the four components of the formula, you can enter this formula in E6, as shown in Fig. 180: `=E6*($B$1+$C6)*E#1`.

	A	B	C	D	E	F	G	H	I	J
1	Base Rate	2%		Bonus Factor:	102%	100%	104%			
2										
3					SALES			COMMISSION		
4										
5	Rep	Product	Prod Rate	Customer	Jan	Feb	Mar	Jan	Feb	Mar
6	Jones	ABC	5%	General Motors	8132	25350	18904	=E6*(\$B\$1+\$C6)*E#1		
7	Jones	DEF	8%	Molson, Inc	17136	25140	17136			

Fig. 180

Result: As shown in Fig. 181, you have created one single formula that can be copied to all columns and rows of your dataset.

**Part
II**

J7					fx =G7*(\$B\$1+\$C7)*G\$1					
	A	B	C	D	E	F	G	H	I	J
1	Base Rate	2%		Bonus Factor:	102%	100%	104%			
2										
3					SALES			COMMISSION		
4										
5	Rep	Product	Prod Rate	Customer	Jan	Feb	Mar	Jan	Feb	Mar
6	Jones	ABC	5%	General Motors	8132	25350	18904	580.6	1775	1376
7	Jones	DEF	8%	Molson, Inc	17136	25140	17136	1748	2514	1782
8	Jones	DEF	8%	Molson, Inc	17136	25140	17136	1748	2514	1782

Fig. 181

Summary: The concept of relative, absolute, and mixed references is one of the most important concepts in Excel. Being able to use the right reference will allow you to create a single formula that can be copied everywhere.

SIMPLIFY ENTRY OF DOLLAR SIGNS IN FORMULAS

Problem: It is a pain to type the dollar signs in complex formulas such as the formula shown in Fig. 182.

`=E7*($B$1+$C7)*E$1`

Fig. 182

Strategy: Use the F4 key as you are entering the formula. The F4 key will toggle a reference through the four possible reference types.

As shown in Fig. 183, start to type the formula `=E7*(B1`.

Mar	Jan	Fel
136	=E7*(B1	
168		

Fig. 183

Immediately after you type B1, hit the F4 key. Excel will insert both dollar signs in the B1 reference, as shown in Fig. 184.

Mar	Jan	Feb
6	=E7*(\$B\$1	
8		

Fig. 184

As an illustration, hit the F4 key again. Excel changes from an absolute reference to a mixed reference, with the row portion of the reference locked, as shown in Fig. 185.

Mar	Jan	Feb
3	=E7*(B\$1	
3		

Fig. 185

Hit the F4 key again. Excel changes to a mixed reference, with the column portion of the reference locked, as shown in Fig. 186.

Mar	Jan	F
17136	=E7*(\$B1	
19768		

Fig. 186

Hit the F4 key once more. Excel changes back to a relative reference, as shown in Fig. 187.

Mar	Jan	I
136	=E7*(B1	
768		

Fig. 187

**Part
II**

Here are the steps for entering the complex formula shown in Fig. 182.

- 1) Type =E7*(B1.
- 2) Hit the F4 key once.
- 3) Type +C7.
- 4) Hit the F4 key 3 times. Your formula will now appear as shown in Fig. 188.

r	Jan	Feb	M
3	=E7*(\$B\$1+\$C7		
2			

Fig. 188

- 5) Type the parentheses, an asterisk for multiplication, and E1, as shown in Fig. 189.

Mar	Jan	Feb	Mar
136	=E7*(\$B\$1+\$C7)*E1		
768			

Fig. 189

- 6) Hit the F4 key twice to change E1 to a reference with the row locked, as shown in Fig. 190.

	Jan	Feb	Mar
6	=E7*(\$B\$1+\$C7)*E\$1		

Fig. 190

- 7) Hit Ctrl+Enter to accept the formula without moving the cell pointer to the next cell, as shown in Fig. 191.

Mar	Jan	F
7136	1748	
9368		

Fig. 191

- 8) With the mouse, grab the Fill handle (the square dot in the lower right corner of the cell) and drag it to the right for two cells, as shown in Fig. 192.

Mar	Jan	Feb	Mar
136	1748		
368			
712			

Fig. 192

This will copy the formula from January to the other two months, as shown in Fig. 193.

	Jan	Feb	Mar
6	1748	2514	1782

Fig. 193

- 9) Double-click the Fill handle. This will copy the three cells down to all of the rows with data, as shown in Fig. 194.

Jan	Feb	Mar	Jan	Feb	Mar
17136	25140	17136	1748	2514	1782
2042	25140	19368	208.3	2514	2014
11700	25140	17712	835.4	1760	1289
15856	25140	12690	1617	2514	1320
16008	25140	17160	1143	1760	1249
2157	25060	16696	220	2506	1736

Fig. 194

Additional Information: You might find mixed references confusing. As you work on building the first formula, you might know that you need to point to C7. Enter C7 in the formula and then use F4 to toggle between the various reference types. Say to yourself, “OK. There is a dollar sign before the C that will lock the column and let the row change – is that what I need?”. As long as you say this to yourself without your lips moving, your officemates won’t think any less of you.

Further Information: If you did not add the dollar signs as you typed the formula, you can still use the F4 trick later.

Using the mouse, highlight the proper reference in the formula bar, as shown in Fig. 195.



fx =E6*(B1+C6)*E1

Fig. 195

After the reference is highlighted, you can hit the F4 key to toggle that particular reference through the four states, as shown in Fig. 196.



fx =E6*(\$B\$1+C6)*E1

Fig. 196

Summary: Master the F4 key to easily add dollar signs to a reference in order to toggle it from relative to absolute to mixed to mixed.

LEARN R1C1 REFERENCING TO UNDERSTAND FORMULA COPYING

Problem: All of a sudden, the column letters along the top of your spreadsheet have been replaced by numbers, as shown in Fig. 197. None of the formulas that you enter will work.

	R6C4			fx	=+R[-1]C+RC[-1]-RC[-2]	
	1	2	3	4	5	6
1	Loan	8,000		Term	24	
2	Rate	5%		Pmt	\$350.97	
3						
4	# Pmt	Amt	Interest	Balance		
5				8,000		
6	1	\$350.97	33.33333	\$7,682.36		
7	2	\$350.97	32.00984	\$7,363.40		
8	3	\$350.97	30.68084	\$7,043.11		

Fig. 197

Strategy: Relax. There are two ways of naming cells. Someone has turned on the R1C1 style of addressing. To return to the normal A1 style of cell addressing, go to Tools – Options. On the General tab, uncheck the box for R1C1 Reference Style, as shown in Fig. 198.

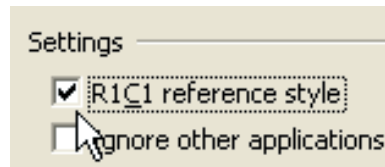
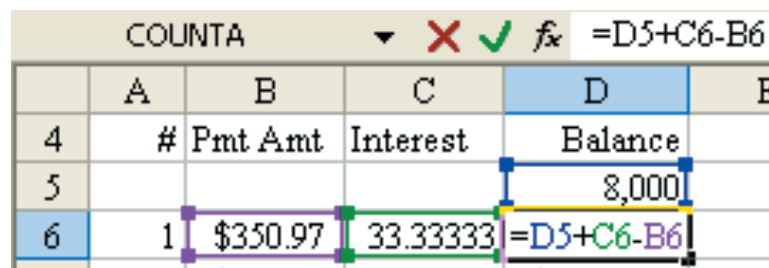


Fig. 198

But wait – while you are here, you can learn something fascinating about spreadsheets. In the topic “Copy a Formula That Contains Relative References”, I suggested it was miraculous that Excel could automatically change a formula as you copied it. If you take two minutes to learn about this other method of cell addressing, you will understand that it may not be so amazing after all.

When Dan Bricklin and Bob Frankston invented VisiCalc, they used the A1 style of cell naming. When Mitch Kapor started selling Lotus 1-2-3, he used the same style. When Microsoft came out with their first spreadsheet product – Microsoft Multiplan – they used a very different method of cell addressing. This method is known as R1C1. In the Microsoft system, the rows are numbered just as in the A1 system. However, the columns are also numbered. Each cell is given a name, such as “R4C8”. This name stands for the cell at Row 4, Column 8. This is the cell that you and I know as H4.

In the R1C1 style, the formulas are interesting. Look at this formula in cell D6, as shown in Fig. 199.



	A	B	C	D	E
4	#	Pmt Amt	Interest	Balance	
5				8,000	
6	1	\$350.97	33.33333	=D5+C6-B6	

Fig. 199

The formula in the formula bar says `=D5+C6-B6`. But when you think about this formula in plain language, what it really means is “Take the cell just above me, add the interest in the cell just to the left of me, and subtract the payment in the cell two cells to the left of me”.

Formulas in R1C1 style are more like the plain language description above. If you want to enter a formula in D6 that points to the cell just above, it would be `=R[-1]C`. The number in square brackets after the R indicates to how many rows ahead or back you are referring. In our case, row 5 is one row above row 6, so you would put a `-1` in the square brackets. There is no number after the C portion of the address, which means that you are referring to the same column as the cell that contains the formula.

If you want to refer to a cell that is two cells to the left of the cell with the formula, you would use `=RC[-2]`.

As shown in Fig. 200, the formula from Fig. 199 can be restated in R1C1 style as follows:

=R[-1]C+RC[-1]-RC[-2]

COUNTA ✖ ✔ fx =R[-1]C+RC[-1]-RC[-2]						
	1	2	3	4	5	6
4	#	Pmt Amt	Interest	Balance		
5				8,000		
6	1	\$350.97	33.33333	=R[-1]C+RC[-1]-RC[-2]		
7	2	\$350.97	32.00984	\$7,363.40		
8	3	\$350.97	30.68084	\$7,043.11		

Fig. 200

So, all relative references in R1C1 style have a number in square brackets, either after the R or after the C or both.

It is very interesting to see how this style does absolute addresses. As shown in Fig. 201, the formula in B6 is an absolute formula that always points to cell E2. The formula in A1 style is =\$E\$2.

COUNTA ✖ ✔ fx =\$E\$2						
	A	B	C	D	E	
1	Loan	8,000		Term	24	
2	Rate	5%		Pmt	\$350.97	
3						
4	#	Pmt Amt	Interest	Balance		
5				8,000		
6	1	=E\$2	33.33333	\$7,682.36		
7	2	\$350.97	32.00984	\$7,363.40		
8	3	\$350.97	30.68084	\$7,043.11		

Fig. 201

To enter a similar absolute reference in R1C1 style, you do not include square brackets in the address. As shown in Fig. 202, a formula of =R2C5 will ALWAYS point to cell E2.

COUNTA ✖ ✔ fx =R2C5					
	1	2	3	4	5
1	Loan	8,000		Term	24
2	Rate	5%		Pmt	\$350.97
3					
4	#	Pmt Amt	Interest	Balance	
5				8,000	
6	1	=R2C5	33.33333	\$7,682.36	
7	2	\$350.97	32.00984	\$7,363.40	

Fig. 202

It is also possible to have mixed references. Flip back to Fig. 177 in the multiplication table topic. Fig. 203 shows that formula in R1C1 style:

Part II

COUNTA ✖ ✔ fx =RC1*R1C							
	1	2	3	4	5	6	7
1			1	2	3	4	5
2	1	=RC1*R1C	2	3	4	5	6
3	2		2	4	6	8	10

Fig. 203

Additional Details: Now that you understand the basics of R1C1 style formulas, you can appreciate the amazing part. Remember that Microsoft invented this method for their Multiplan product. Lotus 1-2-3 was the dominant spreadsheet in the late 1980s and early 1990s. Microsoft was battling for market share. Everyone using spreadsheets was familiar with the A1 style. No one would want to learn the R1C1 style in order to switch to Microsoft. So, in their Microsoft Excel product, they developed an elaborate system to actually store the formulas in R1C1 style, but then to translate the R1C1 formulas to A1 style to make it easier for all the Lotus fans to understand.

By default, Microsoft starts with the A1 style addressing. However, you can remember from Fig. 198 that you are just one checkmark away from switching back to R1C1 style addressing.

Finally, here is the amazing part. Examine the amortization table example in Formula View mode. (Hit Ctrl+~ to toggle into Formula View mode.) The Formula View mode in A1 style can be seen in Fig. 204. Every formula in column D is different.

	A	B	C	D	E
1	Loan	8000		Term	24
2	Rate	0.05		Pmt	=-PMT(B2/12,E1,B1)
3					
4	#	Pmt Amt	Interest	Balance	
5				=B1	
6	1	=\$E\$2	=D5*\$B\$2/12	=D5+C6-B6	
7	=1+A6	=\$E\$2	=D6*\$B\$2/12	=D6+C7-B7	
8	=1+A7	=\$E\$2	=D7*\$B\$2/12	=D7+C8-B8	
9	=1+A8	=\$E\$2	=D8*\$B\$2/12	=D8+C9-B9	
10	=1+A9	=\$E\$2	=D9*\$B\$2/12	=D9+C10-B10	
11	=1+A10	=\$E\$2	=D10*\$B\$2/12	=D10+C11-B11	
12	=1+A11	=\$E\$2	=D11*\$B\$2/12	=D11+C12-B12	
13	=1+A12	=\$E\$2	=D12*\$B\$2/12	=D12+C13-B13	

Fig. 204

The Formula View Mode in R1C1 style can be seen in Fig. 205.

	1	2	3	4	5
1	Loan	8000		Term	24
2	Rate	0.05		Pmt	=-PMT(RC[-3]/12,R[-1]C,R[-1]C[-3])
3					
4	#	Pmt Amt	Interest	Balance	
5				=R[-4]C[-2]	
6	1	=R2C5	=R[-1]C[1]*R2C2/12	=R[-1]C+RC[-1]-RC[-2]	
7	=1+R[-1]C	=R2C5	=R[-1]C[1]*R2C2/12	=R[-1]C+RC[-1]-RC[-2]	
8	=1+R[-1]C	=R2C5	=R[-1]C[1]*R2C2/12	=R[-1]C+RC[-1]-RC[-2]	
9	=1+R[-1]C	=R2C5	=R[-1]C[1]*R2C2/12	=R[-1]C+RC[-1]-RC[-2]	
10	=1+R[-1]C	=R2C5	=R[-1]C[1]*R2C2/12	=R[-1]C+RC[-1]-RC[-2]	
11	=1+R[-1]C	=R2C5	=R[-1]C[1]*R2C2/12	=R[-1]C+RC[-1]-RC[-2]	
12	=1+R[-1]C	=R2C5	=R[-1]C[1]*R2C2/12	=R[-1]C+RC[-1]-RC[-2]	
13	=1+R[-1]C	=R2C5	=R[-1]C[1]*R2C2/12	=R[-1]C+RC[-1]-RC[-2]	
14	=1+R[-1]C	=R2C5	=R[-1]C[1]*R2C2/12	=R[-1]C+RC[-1]-RC[-2]	
15	=1+R[-1]C	=R2C5	=R[-1]C[1]*R2C2/12	=R[-1]C+RC[-1]-RC[-2]	

Fig. 205

In A1 style, it seems AMAZING that Excel can change a reference from D10 to D11 when the formula is copied down. However, look closely at the formulas in each row of rows 7 and higher in the R1C1 style shown in Fig. 205. Each formula in a column is identical to the formula located just above it!

While VisiCalc and Lotus 1-2-3 made the formula replication seem amazing because of their A1 reference style, if the Multiplan invention of R1C1 style had taken hold, it would not seem amazing at all because, in fact, every formula is exactly identical as you copy it down through the rows.

If you ever plan on writing VBA macros in Excel, it is important to understand the R1C1 style of formulas. For general use in Excel, you never really need to totally understand the R1C1 style, but it is interesting to see how Microsoft's R1C1 style is actually superior to A1 when copying formulas in a spreadsheet.

Summary: Learn R1C1 style formulas to better understand how formulas are replicated across a worksheet.

Commands Discussed: Tools – Options – General