

# Using Spreadsheets for Modelling Calculations

Spreadsheets are used for organising numerical data and are ideally suited to making multiple calculations from a few inputs. The spreadsheet I'm using for this tutorial is provided by Open Office, and can be downloaded for free from [www.openoffice.org](http://www.openoffice.org)

Other spreadsheets are freely available. The techniques shown in this tutorial will almost certainly be transferable to any others you might come across.

## A Simple Scale Calculator

Any of the cells can contain various numbers, text, images etc. and formulae. Lets start off by making a simple spreadsheet to calculate various scales.

To start, we need to input two numbers: the measurement and the scale we want. The cells we are going to input the data into can be labelled with text. We also want a cell in which the output will appear.

	A	B	C	D	E
1					
2					
3		Measurement			
4					
5					
6		Scale (1:64 enter 64)			
7					
8					
9		Output			
10					
11					
12					

Fig.1

In fig. 1, text has been entered into cells B3, B6 and B9. It doesn't matter which cells you use. Organise the spreadsheet to suit you. Column B has been made wider to accept a line of text that exceeds its width. Make columns wider by clicking on the dividing line between columns and dragging to the required width.

The cells that will contain the inputs and output have been given a background colour (fig.2).

1. Highlight the cell or cells you wish to change. To select multiple cells, hold down the control key while you click.
2. Right click inside one of them. Select 'Format Cells' from the context menu that appears.
3. Select the 'Background' tab.
4. Choose the desired background colour.

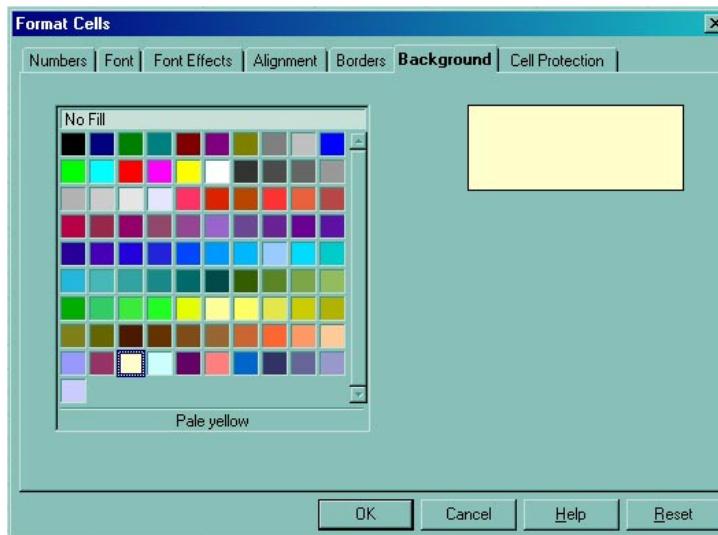


Fig. 2

Now we're going to enter a formula into cell C9.

We want to take a measurement and divided it by the scale to get the required scaled measurement. So, the figure entered into cell C3 needs to be divided by the scale entered into C6. The result needs to appear in cell C9.

1. Select C9
2. Enter the formula: =C3/C6

The '=' means a formula will be entered in this cell. The '/' means divide. Don't worry about the #VALUE! message that might appear in the cell. It just means a formula is waiting for data.

Let's test the formula. Enter '128' into cell C3 and '64' into cell C6. Using simple figures let's us easily test the formula to make sure it's working as we intended. The output of '2' shows us that it is (Fig. 3).

	A	B	C	D
1				
2				
3		Measurement	128	
4				
5				
6		Scale (for 1:64 enter 64)	64	
7				
8				
9		Output	2	
10				
11				

Fig. 3

## A More Advanced Scale Calculator

Let's take the spreadsheet a stage further. This time we're going to take a measurement in feet and convert it to millimetres, and then scale it. Set up the spreadsheet as shown in fig. 4 and enter the following formula into cell E5:

= $(C3*12+E3)*25.4$

	A	B	C	D	E	F
1						
2						
3		Feet	2	Inches	0	
4						
5				Millimeters	609.6	
6						
7						
8						

Fig. 4

An explanation of the formula:

'=' means we're entering a formula

' $(C3*12+E3)$ ' means we're converting the feet entered in cell C3 to inches by multiplying by 12, and then adding on the inches entered in cell E3.

' $*25.4$ ' is the conversion factor to get from inches into millimetres.

Notice that when you select a cell that contains a formula, the formula also appears in the input line above the column letters. Formulae can also be entered here.

Now we can scale the measurement in millimetres using the method we used in the first example. Notice the formula for cell E9 in the input line. This spreadsheet shows us that 2 feet is equivalent to 9.53mm at 1:64 scale.

E9	f(x)	$\Sigma$	=	=E5/E7
1	A	B	C	D
2				E
3		Feet	2	Inches
4				0
5			Millimeters	609.6
6				
7			Scale	64
8				
9			Output	9.53
10				
11				

Fig. 5

Lets do a bit of tidying up. It's unlikely that you'll need to measure to the nearest hundredth of a millimetre, so the final output can be formatted to display to the nearest required figure, in this case tenths of a millimetre. Fig. 6 shows the dialogue box for formatting numbers. Note the other tabs for other ways in which the cells can be formatted.

1. Right click the output cell and select 'Format Cell' from the context menu.
2. Click on the 'Numbers' tab
3. Change the number of 'Decimal places' to 1

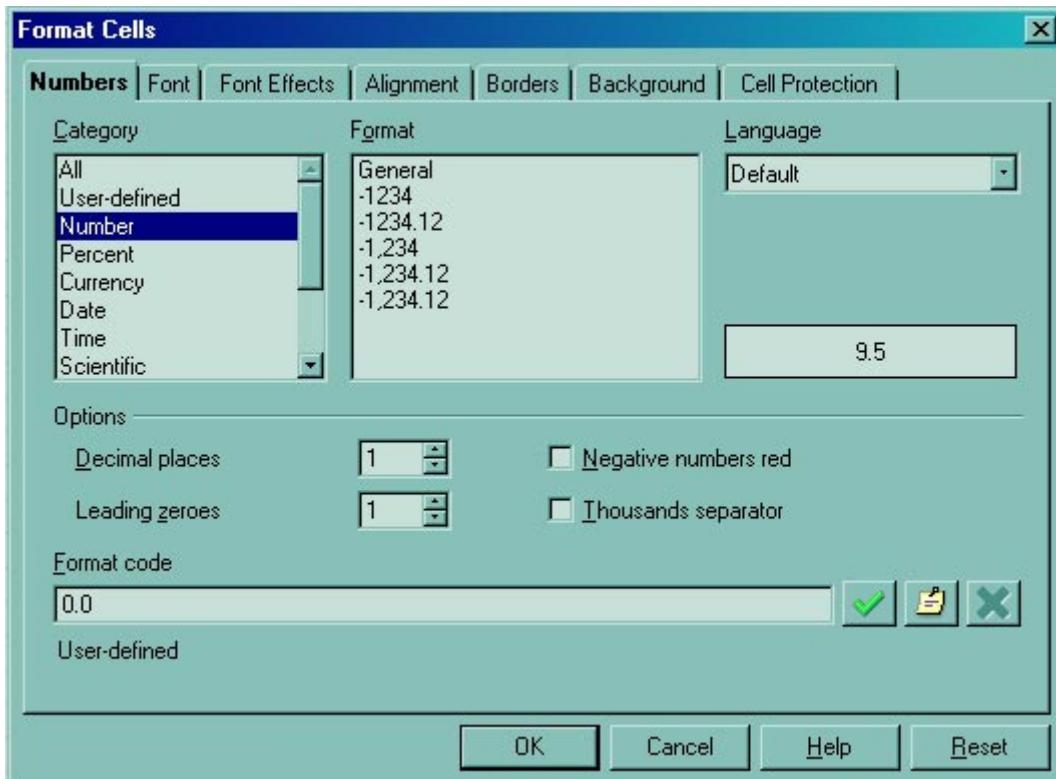


Fig. 6

Next, we're going to label the units of the output figure to show millimetres. Still on the formatting menu we want to select 'User-defined' from the Category list, and enter "mm" to the 'Format code' (fig. 7). Any text that is entered between inverted commas (" ") will appear after any data entered in the cell.

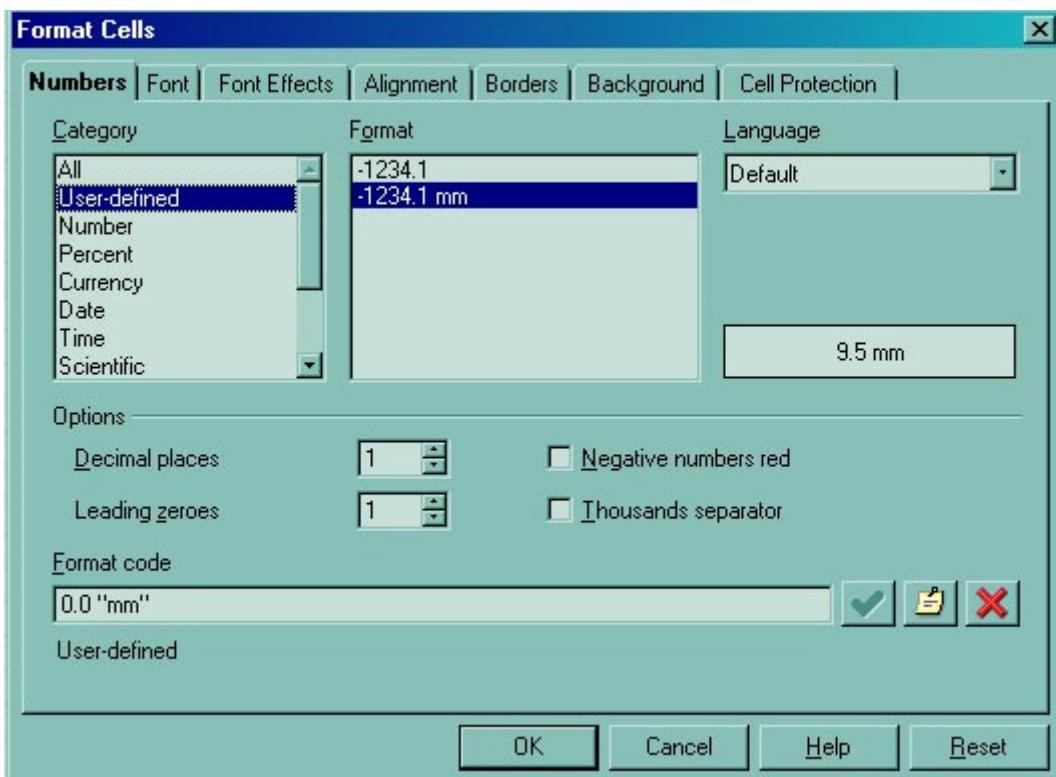


Fig. 7

This is the re-formatted cell E9 in the spreadsheet. The result of the calculation is displayed to one decimal place and labelled with millimetres (fig. 8)

	A	B	C	D	E
1					
2					
3		Feet	2	Inches	0
4					
5			Millimeters		609.6
6					
7			Scale		64
8					
9			Output		9.5 mm
10					

Fig. 8

Now we're going to take what we've learned so far and apply it to making a spreadsheet to work out mast tapers.

## Using the spreadsheet to work out mast tapers

Depending on the vessel and period, masts and yards were tapered according to formulae. Steel's *The Elements and Practice of Rigging and Seamanship Vol. 1* has tables of data showing the measurements worked out for various diameters of mast. This reference work can be found online at <http://www.hnsa.org/doc/steel/index.htm>

The length of mast determines its diameter at the partners (where the mast is at its greatest diameter as it passes through the upper deck). The diameter of the mast at the partners determines the diameters at the various quarters, the head and the heel.

From Steel *The Elements and Practice of Rigging and Seamanship Vol. 1* p39

*The diameters in proportion to the length, in the royal navy, are as follow: viz.*

*The main and foremasts of ships of 100 to 64 guns inclusive, are one inch in diameter at the partners to every yard in length. Ships of 50 to 32 guns inclusive, 9/10 of an inch to every yard in length. And ships of 28 guns and under, 7/8 a of an inch to every yard in the length.*

*The main-mast of brigs to be one inch to every yard in length, and the foremast 9/10 of the diameter of the main-mast.*

The following table is from Steel *The Elements and Practice of Rigging and Seamanship Vol. 1* p42

	QUARTERS.			HEAD.		HEEL.
	1 ft.	2d.	3d.	Lower part.	Upper part.	—
Standing Masts that are checked { fore and aft. athwartships.	$\frac{6}{7}$	$\frac{14}{15}$	$\frac{6}{7}$	$\frac{3}{4}$	$\frac{2}{3}$	$\frac{6}{7}$
Standing Masts that head themselves . . . . .	$\frac{6}{7}$	$\frac{14}{15}$	$\frac{6}{7}$	$\frac{6}{7}$	$\frac{2}{3}$	$\frac{6}{7}$
Top-masts, Gallant-masts, and Royal-masts . . . . .	$\frac{6}{7}$	$\frac{14}{15}$	$\frac{6}{7}$	$\frac{3}{4}$	$\frac{5}{6}$	$\frac{6}{7}$
Mizen-yard { Lower-arm . . . . .	$\frac{6}{7}$	$\frac{11}{12}$	$\frac{3}{6}$	$\frac{2}{3}$	—	—
{ Upper-arm . . . . .	$\frac{30}{31}$	$\frac{7}{8}$	$\frac{7}{10}$	$\frac{2}{5}$	—	—
Yards in general . . . . .	$\frac{30}{31}$	$\frac{7}{8}$	$\frac{7}{10}$	$\frac{3}{7}$	—	—
Bowsprit . . . . .	$\frac{6}{7}$	$\frac{11}{12}$	$\frac{4}{5}$	$\frac{5}{9}$	Outer End. } $\frac{6}{7}$	
Driver booms . . . . .	$\frac{40}{41}$	$\frac{11}{12}$	$\frac{5}{6}$	$\frac{2}{3}$	—	—
Main booms . . . . .	$\frac{40}{41}$	$\frac{12}{13}$	$\frac{7}{8}$	fo. end. af. end.	Middle	
Gaffs . . . . .	$\frac{40}{41}$	$\frac{11}{12}$	$\frac{4}{5}$	$\frac{2}{3}$	$\frac{3}{4}$	$\frac{11}{12}$
Heeling { Standing masts . . . . .	$\frac{7}{12}$	$\frac{1}{2}$	athwartshp.	—	$\frac{1}{2}$	fo. & aft.
{ Bowsprits . . . . .	$\frac{7}{12}$	$\frac{1}{2}$	athwartshp.	$\frac{2}{3}$	up and down.	
LENGTHS OF						
The cheeks $\frac{3}{5}$ if oak, and $\frac{8}{9}$ if fir, of the length of the mast.						
The head of the main and fore masts, $\frac{5}{7}$ inches to every yard of the mast's length.						
The head of the mizen-mast, and main and fore topmasts, $\frac{4}{5}$ inches to every yard of the length.						
The head of the mizen topmast, and all topgallant-mast, $3\frac{1}{2}$ inches to every yard of the length.						
Long pole-heads to topgallant-masts $\frac{2}{3}$ of the length of the stop, (that is, when the $3\frac{1}{2}$ inches to a yard is taken out of the whole length). Proper pole-heads to be $\frac{3}{5}$ of that length; and stump pole-heads $3\frac{1}{2}$ inch to every yard in length.						
The hounds of all lower-masts $\frac{2}{3}$ of the length of the head.						
The topmasts $\frac{1}{2}$ of the length of the head.						

So, knowing the diameter of the mast at the partners, we can get the spreadsheet to work out the various diameters throughout the length of the mast. Note that there are fore and aft, and athwartships dimensions for the heads, which were wider athwartships ( $6/7$  of the diameter at the partners) than they were fore and aft ( $3/4$  of the diameter at the partners).

Okay – let's get this information into a spreadsheet. I've set mine up as shown in fig. 9. By now, you should be able to work out the formulae to enter into the relevant cells. I've listed them next to the example spreadsheet for the work-shy. I've also highlighted the cells that require input in green.

	A	B	C
1			
2			
3			
4	Diameter at the partners	23.0 inches	
5			
6	Diameter in millimeters	584.2 mm	
7			
8	Scale (for 1:64 enter 64)	64	
9			
10	Scaled diameter at partners	9.1 mm	
11			
12	Heel (6/7)	7.8 mm	
13			
14	Partners	9.1 mm	
15			
16	First quarter (60/61)	9.0 mm	
17			
18	Second quarter (14/15)	8.5 mm	
19			
20	Third quarter (6/7)	7.8 mm	
21			
22	Lower part of head (%)	6.8 mm	
23			
24	Upper part of head 5/8	5.7 mm	
25			

The formulae:

$$\begin{aligned}
 C6 &= C4 * 25.4 \\
 C10 &= C6 / C8 \\
 C12 &= C10 * 6/7 \\
 C14 &= C10 \\
 C16 &= C10 * 60/61 \\
 C18 &= C10 * 14/15 \\
 C20 &= C10 * 6/7 \\
 C22 &= C10 * 3/4 \\
 C24 &= C10 * 5/8
 \end{aligned}$$

Fig.9

Next, consider that we need three masts. All of the cells can be copied to another part of the spreadsheet without worrying about the formulae we've entered. The cells named in the formulae are automatically updated to the new locations. We need to copy the table we've made twice, for the foremast and the mizzen. Simply highlight the areas to be copied (click and drag), copy (control C), click the top left cell of the area where they are to be pasted, and paste (control V).

We know the diameters of the masts at the partners from the data in Steel (p49), and these can be entered into the relevant green cells. Of course, Steel provides us with the various diameters of the masts too, but the spreadsheet automatically converts these to millimetres and at the required scale (fig. 10)

	A	B	C	D	E	F	G	H	I
1	<b>Lower Mast Tapers for a 74-gun Ship</b>								
2	<b>MIZZEN MAST</b>				<b>MAINMAST</b>			<b>FOREMAST</b>	
3									
4	Diameter at the partners	22.25 inches			Diameter at the partners	37.00 inches		Diameter at the partners	32.25 inches
5									
6	Diameter in millimeters	565.2 mm			Diameter in millimeters	939.8 mm		Diameter in millimeters	819.2 mm
7									
8	Scale (for 1:64 enter 64)	64			Scale (for 1:64 enter 64)	64		Scale (for 1:64 enter 64)	64
9									
10	Scaled diameter at partners	8.8 mm			Scaled diameter at partners	14.7 mm		Scaled diameter at partners	12.8 mm
11									
12	Heel (6/7)	7.6 mm			Heel (6/7)	12.6 mm		Heel (6/7)	11.0 mm
13									
14	Partners	8.8 mm			Partners	14.7 mm		Partners	12.8 mm
15									
16	First quarter (60/61)	8.7 mm			First quarter (60/61)	14.4 mm		First quarter (60/61)	12.6 mm
17									
18	Second quarter (14/15)	8.2 mm			Second quarter (14/15)	13.7 mm		Second quarter (14/15)	11.9 mm
19									
20	Third quarter (6/7)	7.6 mm			Third quarter (6/7)	12.6 mm		Third quarter (6/7)	11.0 mm
21									
22	Lower part of head (%)	6.6 mm			Lower part of head (%)	11.0 mm		Lower part of head (%)	9.6 mm
23									
24	Upper part of head 5/8	5.5 mm			Upper part of head 5/8	9.2 mm		Upper part of head 5/8	8.0 mm
25									
26									
27									
28									

Fig. 10

Some of the data in this spreadsheet are redundant – for example, the scale has been entered three times, and the diameter of the mast in millimetres before scaling isn't a required measurement for the model. It can, however, be useful to include such results in the design of your spreadsheet as it makes it easier to troubleshoot. I also think it's good practice not to have long formulae, for the same reason.

It's possible, given the way mast and yard dimensions are calculated, to design a spreadsheet that will produce all the required mast and yard dimensions upon entering very few figures.

Steel (p39) ...

*The length of the lower deck and extreme breadth being added together, the half is the length of the main-mast.*

If we know the length of the mainmast, then ...

*Fore-mast, 8/9 of the main-mast.*

*Mizen-mast, 6/7 of the main-mast.*

If we know the mast lengths, then ....

*Main-yard, 8/9 of the main-mast.*

*Fore-yard, 7/8 of the main-yard.*

*Etc, etc*

So, if anyone is feeling inspired ...

This example spreadsheet can be found in Excel file format (which can be imported into Open Office) at:  
[http://www.modelshipworld.com/userupload/70/mast\\_tapers.xls](http://www.modelshipworld.com/userupload/70/mast_tapers.xls)