

# Excel Solutions for Accountants: Book 3

Duncan Williamson



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# Excel Solutions for Accountants

Book 3



Excel Solutions for Accountants: Book 3

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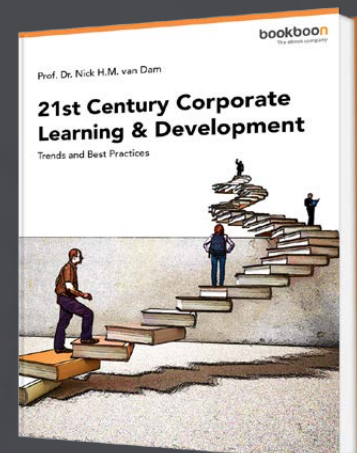
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# 1 Introduction

This is the third in a series of three books with the title of *Excel Solutions for Accountants*.

The essence of the book is that we have chosen a series of topics that we believe are of direct interest and relevance to accountants: we know that from the work we do every day. That is not to say that everything an accountant ever needs or does is included in this book; rather it's a general book aimed at the accountant who knows that Excel can be made to do a lot more than it does but he just doesn't know what that might be.

We have taken a very hands on approach with this book and for everything we talk about there is something for you to do: there is a spreadsheet for you to work with, too, so that you can always check your work and your accuracy at every stage.

One of our over riding ambitions was to make this book both as direct and as easy to use as possible. You will not find massive files with hideously complex formulas in them, each of which might take you an hour or two just to begin to unravel. What we have done is to give you straightforward examples with non complex lists and databases so that you come to learn the techniques and functions rather than worrying about the database.

**Part Three** of the book comprises the following

---

Accountant Specific 3

Dashboarding

Pivot Tables 3

Forecasting

Budgeting

AGGREGATE, OFFSET and SOLVER

---

You can see immediately from the titles of these chapters that the accountant is the target here! Secondly you should see that four of the chapters have the number 3 after them: that tells you that in books 1 and/or 2 there is another chapter or chapters on the same topic. Take a look at the contents of books 1 and 2:

<b>Part One</b>	<b>Part Two</b>
Accountant Specific 1	Accountant Specific 2
Excel Tables	Compound Interest and Discounting: the time value of money
Depreciation	Data Validation and Form Controls
Ratio Analysis 1	Ratio Analysis 2
Graphs 1	Graphs 2
Pivot Tables 1	Pivot Tables 2

**More than one way to skin a cat!** We present one or more solutions to the problems we present in this book and from time to time we say: Excel provides more than one way to solve this problem. If you already know a better way to solve a problem than we are presenting, stay with it. Even if you think our method is better but are happy with your own method, stick with it if it doesn't mean you are wasting time or being inefficient. Don't be stubborn though: like the cost accountant who saw our solution to his problem but preferred not to follow our advice: that meant he preferred to wait 20 minutes every morning for his main Excel file to open and then wait a further 45 seconds or so **every time he pressed the Enter key**. Our solution meant no waiting time at all as we replaced his 30,000 volatile function workbook with a Pivot Table based solution that provided almost instant responses.

**Templates:** we have tried at every stage of every chapter of this book to provide templates for you to work with and/or create. After all, what's the point of programming a spreadsheet over and over again when you shouldn't have to? Excel deals with some of the most predictable things you can do and templates are consistent with that. Therefore, take each of our examples either as a template or as your template in the making. We stress **PPP** too: **paper, pencil, plan**. The PPP approach means, don't just dive in to a spreadsheet problem, take your time and plan it out on paper first. Then develop your solution. Then derive your template if appropriate.

**A total of 18 chapters** and by the end of all three books we believe you can easily call yourself an intermediate user of Excel. We also feel that you will have unlocked so much potential in Excel that you will want more and more from it.

This book has been written with **Excel 2013 for Windows**: that will mean that some of the things we have done will be a little bit different sometimes from what any other version of Excel might do. We have kept such differences to a minimum, however. Nevertheless, we would encourage you to upgrade to 2013 soon anyway.

### **Excel Files Available**

All of the Excel files mentioned in this book can be found on this book's page at:

<http://bookboon.com/en/excel-solutions-for-accountants-book-3-ebook>

**Other sources of help for Excel:** there are many sources of help other than Excel itself. Here are just a few examples of where to get help: just search for these online to get there!

**excelmaster.co:** my own Excel Blog

**Excel-G:** online/email based discussion list for general level questions on Excel. There are about 1,000 members of this group and they are friendly and really helpful people. Please note, this is a general level list and anything too advanced should be directed at...

**Excel-L:** online/email based discussion list for Excel Developers. This is the more advanced list and seems to concentrate mainly on VBA problems and solutions.

**OzGrid:** this is a free and commercial site offering some brilliant resources.

**chandoo.org:** this is another really useful site whose founder, Chandoo, has the objective of making you *awesome in Excel!* A lot of the materials on this site are free but some of them are commercial. Chandoo also offers online and offline courses.

**Jon Peltier:** Jon seems to be the world's foremost authority on graphs and charts. Again, this is a combined free and commercial site but there are many wonderful free resources on there.

**Mr Excel:** Bill Jelen is a prolific Excel materials developer and explainer! Bill provides a lot of free and highly commendable materials, again both free and commercial.

**Charley Kyd:** Charley has specialised in the past in dashboarding and whilst he still does that, he offers a lot of free Excel based materials too. Well worth searching out.

**John Walkenbach:** John has been around for ages and he writes the *Excel Bibles*, among other Excel based titles. John is always comprehensive and has a lot of useful things to offer

**YouTube:** there are many thousands of videos on YouTube now and more appear every day. Some of them are really very good and others will leave you wondering what on earth they were trying to say. It's pot luck really but once you find a good YouTube provider, stick with them!

There are many more people/organisations/lists that can help you so these are just a few of the ones we recommend.

# 2 Accountant Specific 3

## Introduction

In this third of three chapters in which we work through a series examples and techniques that accountants need for their everyday work, we will discuss:

- Centring v Merging Cells
- Population Pyramids
- SOLVER
- Scenario Manager
- Simultaneous equations

Not all accountants need all of these but every accountant needs some of them!

### 2.1 To Merge or not to Merge?

I have been as guilty as many of you when it comes to using the merge utility in a spreadsheet. However, you will read that merging cells is bad for your spreadsheet health. The arguments include the phrase that merging is the work of Satan and others say that once you have merged, it is not obvious which cell has been merged: that is, if you have merged cells A1, B1 and C1, should you address cell A1 or B1 or C1 in any formula from now on?

When merging cells where each or all cells contain information, the spreadsheet will tell you that merging cells will mean that only the information in the upper leftmost cell in the range will be retained. THAT can be a problem and pressing OK far too quickly must have caught us all out at some time or another: if you are too hasty you could lose a lot of information or cause yourself a lot of extra typing.

Here are the steps you need to take to use Excel's **Centre Across Selection**: it LOOKS as if the cells are merged but they are not! What follows is a table of data with a title that initially is left justified in cell A1. What we want to do is to show the title centred across the whole table but NOT merged! We have already selected cells A4:B4 ready to do what we want.

	A	B	C	D
1	Goal Seek			
2	Loan Calculations: buying a vehicle			
3				
4	Inputs			
5	List price of a vehicle	50,000.00		
6	Deposit I am going to put down	25.00%		
7	Length of the loan: months	48		
8	Interest rate (annual) the loan company will charge me	5.00%		
9				
10			Calculations	
11			Amount of Loan	37,500.00
12			Monthly repayment	\$863.60
13			Total Repayments	41,452.73
14			Total Interest	3,952.73

Figure 1 Centre Ready

The Home tab on the ribbon has the Alignment section that we need to use. Click on the icon at the bottom right of the Alignment area:

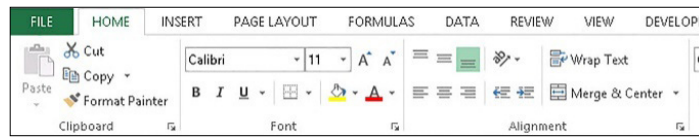


Figure 2 How to Start the Centring Process

We now need to make our selection in the Text Alignment...Horizontal drop down box where it currently says *General*:

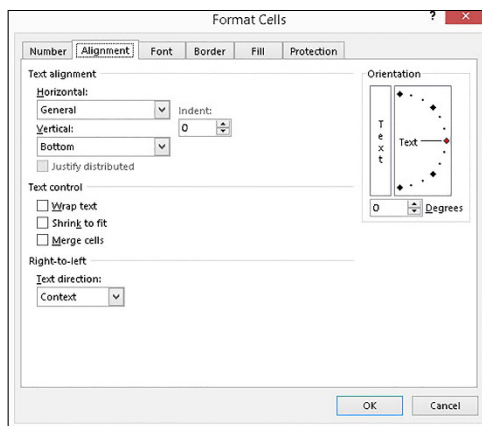


Figure 3 Format Cells Alignment

Click on the arrow to open the drop down menu and select **Centre Across Selection** then click OK

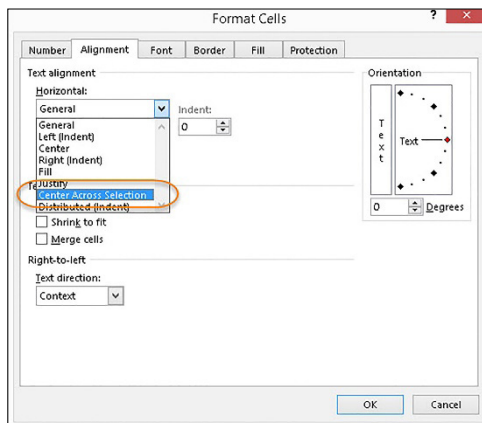


Figure 4 Centre Across Selection

And here is your title looking just how you want it!

1	Goal Seek			
2	Loan Calculations: buying a vehicle			
3				
4	Inputs			
5	List price of a vehicle	50,000.00		
6	Deposit I am going to put down	25.00%		
7	Length of the loan: months	48		
8	Interest rate (annual) the loan company will charge me	5.00%		
9				
10			Calculations	
11			Amount of Loan	37,500.00
12			Monthly repayment	\$863.60
13			Total Repayments	41,452.73
14			Total Interest	3,952.73

Figure 5 Everything Centred now NOT Merged

The text is contained in cell A4 and the other cell in your selection, B4, is still available if you want to make changes. However, if you do type in any of the other cells, your results will NOT be so attractive or even predictable.

**Centre Across Selection** is a nice and easy function to work with and it is better than merging cells in just about every way despite its own shortcomings.

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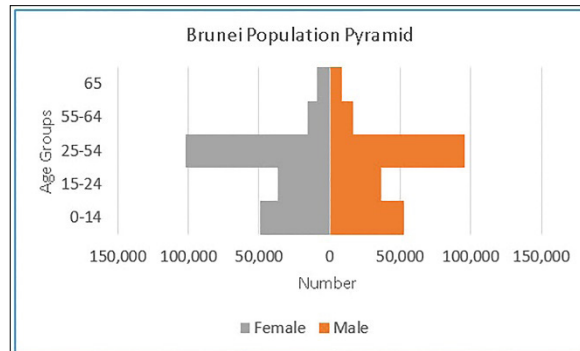
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## 2.2 Creating a Population Pyramid Style Chart

The population pyramid is a very effective way of presenting data in situations in addition to reporting populations. The following example shows how true this is when we compare some basic data for Brunei’s male and female populations:



This is a very effective form of presentation, don’t you think? It is! After all, there are times when you may well want to compare this year with last, one company with another, male with female...and a table of data or even a line or ordinary bar chart just aren’t effective enough.

How did we prepare that chart, then, using Excel? What follows is all you have to do!

Firstly, derive, find or grab your data. As you are working along with this example, just copy and paste the following into a blank Excel work sheet:

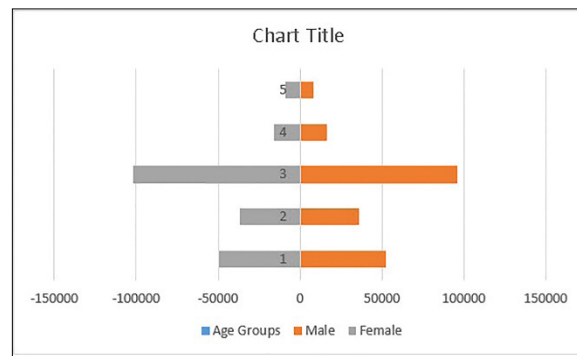
	A	B	C	D	E	F	G	H	I	J
1	<b>Brunei Population Pyramid</b>									
2	Data from: <a href="http://www.indexmundi.com/brunei/demographics_profile.html">http://www.indexmundi.com/brunei/demographics_profile.html</a>									
3								<b>Age Groups</b>	<b>Male</b>	<b>Female</b>
4	0-14	years	24.2%	male	52,753	female	49,548	0-14	52,753	49,548
5	15-24	years	17.3%	male	36,187	female	36,965	15-24	36,187	36,965
6	25-54	years	46.9%	male	96,006	female	102,028	25-54	96,006	102,028
7	55-64	years	7.6%	male	16,542	female	15,589	55-64	16,542	15,589
8	65	years and over	4%	male	8,301	female	8,756	65	8,301	8,756

To begin with, make all Female values NEGATIVE. Just put a minus sign in front of them all. It will become obvious why we do this shortly. Please note: we have disguised their negativity by custom formatting that column this way: #,##0;#,-##0.

Then select these data, in I3:J8 and click Insert Chart

Choose **Stacked Bar Chart**, the second chart from the left

Click OK and you should see something like the following:



Right click on the chart and select Source Data and click on the Series tab. Select the Horizontal (Category Axis) Labels Edit button and select H4:H8

Format the chart in terms of title and axes labels as you wish and then we need to do some formatting:

- Keep or add the Legend
- Right Click the Horizontal Axis and click Format Axis
- Scroll down to Number under Axis Options
- Deselect Linked to Source
- Category...Custom...Type #,##0;#,##0...this makes both sides of the horizontal axis appear positive
- Right click Vertical Axis and click Format Axis
- Scroll down to Labels under Axis Options
- Label Position...change it to Low
- Finally, increase the width of the bars:
  - Right click any bar
  - Format Data Series
  - Set Width to 0% and all bars will expand in size

That's it: you've now got a population pyramid of your dreams! Change the colours of the bars as you wish. Change the font and the font size and colour too.

We have taken you through this process step by step and in Excel 2013 it is relatively very simple to do: in earlier versions of Excel this process is a lot more complicated!

## 2.3 Solving Simultaneous Equations with Excel

**Simultaneous equations** (SEs) are often a nightmare for many people: they cannot or will not do them. If you know SEs you know there are several ways of solving them. We are not mathematicians so we are not going to explain Cramer's rule, matrix algebra or even substitution... just show you how Excel can help.

### What are Simultaneous Equations?

Simultaneous equations get their name from the fact that in two or three or more equations, X has the same value for each equation, Y has the same value for each equation and so on. For example, here are two simultaneous equations:

$$X + 3y = 8 \dots\dots\dots(1)$$

$$X - 2y = -3 \dots\dots\dots(2)$$

In this case we know that  $x = 5$  and  $y = 1$  and we can prove that by putting 5 where x is and 1 where y is in either of the two equations, such as in equation (1):

$$5 * 1 + 3 * 1 = 8 \dots 5 + 3 = 8 \dots 8 = 8 \dots \text{QED!}$$

Try it yourself for equation (2) if you wish.



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## 2.4 Three Ways of Solving Simultaneous Equations

We are going to use **three methods** for solving simultaneous equations: feel free to open the file *simult.xlsx* but we are really encouraging you to create everything from scratch in this case.

**Indirect Method:** Using the two array functions **MINVERSE()** and then **MMULT()** separately: this is essentially an entire problem or matrix solution that gives us the values of each variable

**Direct Method** Using the two array functions **MINVERSE()** and then **MMULT()** together in the form **=MMULT(MINVERSE())** .. this is essentially a single cell solution per variable.

The names indirect and direct are our own and we are classifying them as different methods although in reality they are not!

**SOLVER solution:** using the SOLVER add in to provide the values for the variables.

### Method 1: Indirect Method

Set up a worksheet as follows:

This is a two variable set of simultaneous equations and we have left column C blank to allow us to develop three variable examples. All you do is type in, hard code, the entries in the range A3:D5 in this example.

The range A8:E9 includes the solution using firstly the **MINVERSE()** array function and then the **MMULT()** array function. See Figure 6 that follows:

	A	B	C	D	E	F
1	Solving Simultaneous Equations: using MINVERSE and MMULT					
2						
3	x	y		rhs		
4	1	3		8		
5	1	-2		3		
6						
7	indirect method					
8	0.4	0.6		5 = x		
9	0.2	-0.2		1 = y		
10						
11						
12	5.000	3.000		8		
13	5.000	-2.000		3		

**Figure 6** Setting up for two Simultaneous Equations

The range A12:D13 contains the **Proof area** in which we test the solution that  $x = 5$  and  $y = 1$ .

The following screenshot shows you our formulas...again, just copy them as you see them here but remember, array functions are not ordinary functions. So for the MIVERSE() function entry you must do the following, Figure 7:

	A	B	C	D	E	F	G
1	Solving Simultaneous E						
2							
3		x	y		rhs		
4	1	3		8			
5	1	-2		3			
6							
7	indirect method					direct method	
8	=MINVERSE(A4:B5)	=MINVERSE(A4:B5)		=MMULT(A8:B9,D4:D5)	= x	=MMULT(MINVERSE(A4:B5),D4:D5)	
9	=MINVERSE(A4:B5)	=MINVERSE(A4:B5)		=MMULT(A8:B9,D4:D5)	= y	=MMULT(MINVERSE(A4:B5),D4:D5)	
10							
11							
12	=A4*D\$8	=B4*D\$9		=SUM(A12:C12)			
13	=A5*D\$8	=B5*D\$9		=SUM(A13:C13)			

Figure 7 The ARRAY Functions you need

Select the range A8:B9 and keep it selected then type =MINVERSE(A4:B5) then press Control and keep it pressed, press Shift and keep it pressed as well then press Enter, now let go of all three keys we will call this CSE from now on!. And you should get the inverse matrix that you see in the range A8:B9... it if doesn't work, do it again carefully and if it still doesn't work, check your typing. If it still doesn't work, open the example file!

For the MMULT() array function, do the following:

Select the range D8:D9 and keep it selected then type =MMULT(A8:B9,D4:D5)...CSE...if it doesn't work...check your typing...

The MMULT() array function gives you the answer, as we have labelled here the first number, 5, is the value of x and the second number, 1, is the value of y.

**Try This**

Repeat the above as you try to solve these equations for x and y:

2 + 5 = 15.....(1)  
 -3 + 1 = 7.....(2)

Don't worry about all of the decimal places you might see because Excel is doing all of the work for you; and your answers should be x = -1.176470588 and y = 3.470588235

Carry out the proof to make sure your answers are correct...don't look at the solution in the Excel work book until you are happy with your own!

**Method 2: Direct Method**

Whilst this really is the same as the Indirect method, we are flagging it here so that those of you who are confident in your own abilities and/or who don't need to see the inverse matrix, can go straight to the solution Figure 8:

	A	B	C	D	E	F	G
1	Solving Simultaneous Equations: using MINVERSE and MMULT						
2							
3		x	y		rhs		
4		1	3		8		
5		1	-2		3		
6							
7	indirect method						direct method
8		0.4	0.6		5 = x		5
9		0.2	-0.2		1 = y		1
10							
11							
12		5.000	3.000		8		
13		5.000	-2.000		3		

**Figure 8** The Solutions

Select the range G8:G9 and keep it selected then type the following =MULT(MINVERSE(A4:B5),D4:D5)... CSE...

There you are, straight to the answers, x = 5 and y = 1.

Repeat this for the equations

2 + 5 = 15.....(1)

-3 + 1 = 7.....(2)

And prove your method and answers!

You've now got a template for solving any two variable set of simultaneous equations where there is a solution.

### Simultaneous Equations with Three Variables

Many accountants can solve two variable simultaneous equations but then get stumped by three and more variables. Figure 9 is a screenshot of a three variable set of simultaneous equations:

	A	B	C	D	E	F	G
1	<b>Solving Simultaneous Equations</b>						
2							
3		<b>x</b>	<b>y</b>	<b>z</b>	<b>rhs</b>		
4		1	2	-1	3		
5		3	1	0	6		
6		2	1	0	1		
7	<b>indirect method</b>					<b>direct method</b>	
8		0	1	-1	5	<b>x</b>	5
9		0	-2	3	-9	<b>y</b>	-9
10		-1	-3	5	-16	<b>z</b>	-16
11							
12		5.000	-18.000	16.000	3		
13		15.000	-9.000	0.000	6		
14		10.000	-9.000	0.000	1		

**Figure 9** Solutions for Three Simultaneous Equations

You can see we have set it up in full for you and have colour coded the solutions since that part of the work sheet is getting a little crowded now.

# The Wake

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BEFORE you look at our solutions in our work book, try to work out how to solve a three variable simultaneous set of equations yourself.

You should have done this: indirect and direct methods both shown in Figure 10:

1	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
2	Solving Simultaneous Equations: using MINVERSE and MMULT						Using SOLVER									
3		x	y		rhs			x	y							
4		2	5		15			5	1							
5		-3	1		7						0 ... 1					
6											0 ... 2					
7		indirect method				direct method										
8		0.058823529	-0.29		-1.1765 = x			-1.176470588								
9		0.176470588	0.118		3.4706 = y			3.470588235								
10																
11																
12			-2.353	17.353		15										
13			3.529	3.471		7										

Figure 10 Direct and Indirect Solutions

Make it work, make sure it works before you move on. In the workbook there are additional questions for you to work on.

**Method 3: Using SOLVER**

SOLVER is a powerful add in that you might need to install before you read on:

- File
- Options
- Add Ins
- Manager...Excel Add Ins...Go
- Select SOLVER Add In
- Go

The link to SOLVER will appear in the top right hand corner of the Data tab just click on it to start it.

Back to question 1

Set up the SOLVER area as you can see here in the range H3:I4 and J5:j6:

The entries in H3:I4 are just typed and you do NOT need to enter anything in cells H4:I4 since SOLVER will over write anything in there with the solutions to the problem. Alternatively, type in any numbers you like to test whether your entries in J5:J6 seem to work:

We do two things here: first the mathematics and then the Excel.

Mathematics: rearrange both equations to make them = 0, like this:

$$x + 3y = 8 \dots\dots\dots(1)$$

$$x - 2y = -3 \dots\dots\dots(2)$$

Becomes

$$x - x + 3y = 8 - x \dots\dots\dots(1)$$

$$x - x - 2y = 3 - x \dots\dots\dots(2)$$

Which becomes

$$0 = 8 - x - 3y \dots\dots\dots(1)$$

$$0 = 3 - x + 2y \dots\dots\dots(2)$$

You need to understand why we did what we did there...subtracting x from the LHS AND the RHS to make the equations both = 0

Then in J5:J6 you can see what we did in the screenshot above, Figure 10. For example, in J5: =8-3\*I4-H4.

SOLVER will have found the answer to this question when it puts the correct values in cells H4 and I4 in this example and J5 = 0 and J6 = 0...exactly in line with the work we have just done.

Set up SOLVER in this way:  
Click Data tab...SOLVER

You will see this:

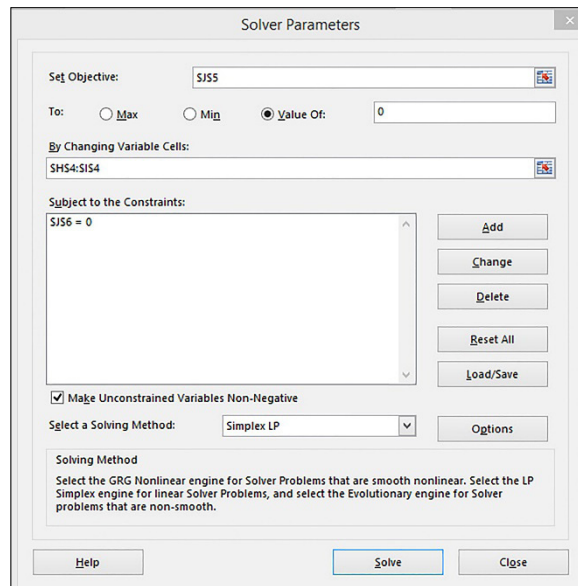


Figure 11 Setting up the SOLVER Solution

Enter what you see there in the various boxes in case they are empty! Ensure you understand what we have done because you are going to do it yourself in a minute for different and bigger questions: three and four variables.

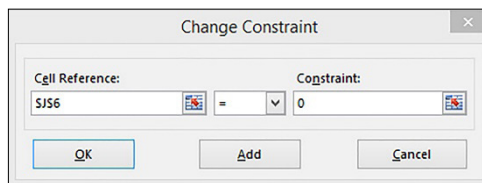
Set Objective cell to J5...SOLVER makes it read \$J\$5

To: value of 0...this is vital

By changing variable cells, H4:I4...again SOLVER adds the \$\$ and these are the cells that will give you your answer

Subject to the constraints:

In this case there is only one and that is J6...click Add...and make it look like Figure 12:



**Figure 12** Change a Constraint in SOLVER

Click OK

Now click Solve and SOLVER should tell you it has found a solution, put the solution in H4:I4 AND shown that J5 and J6 are both = 0. THAT is your answer.  $x = 5$  and  $y = 1$ .

**Try This**

Repeat the above as you try to solve these equations for x and y:

$$2 + 5 = 15 \dots\dots\dots(1)$$

$$-3 + 1 = 7 \dots\dots\dots(2)$$

You have already solved this problem but use SOLVER as well, for practice.

**Simultaneous Equations with Three Variables using SOLVER**

Use SOLVER to solve the three variable problem we explored above and Figure 13 is a repeat of Figure 9 of that three variable set of simultaneous equations:

	A	B	C	D	E	F	G
1	Solving Simultaneous Equations						
2							
3	x	y	z	rhs			
4	1	2	-1	3			
5	3	1	0	6			
6	2	1	0	1			
7	indirect method					direct method	
8	0	1	-1	5	x		5
9	0	-2	3	-9	y		-9
10	-1	-3	5	-16	z		-16
11							
12	5.000	-18.000	16.000	3			
13	15.000	-9.000	0.000	6			
14	10.000	-9.000	0.000	1			

Figure 13 Three Variable Solutions

BEFORE you look at the solutions in the work book, try to work out how to solve this problem using SOLVER yourself.

That's it! Get this to work and it is a real time saver. If you can make the equations work but not SOLVER don't worry, at least you've found one way that works. And vice versa: if you can use SOLVER but not the equations ...

We have also included in this file this formula that you might be interested in exploring:  
 =SUMPRODUCT(A4:D4,TRANSPOSE(\$E\$9:\$E\$12))...CSE

 [Click on the ad to read more](#)

You will see that formula in the four variable questions but you can just as easily use it for the two and three variable questions as well.

That's it! Hope this works for you!

## 2.5 SOLVER and the Scenario Manager Again?

Let's consider another problem that you can use SOLVER to sort out for us: set out in formal, **linear programming** style:

**Maximise profits**  $4a + 3b$

**Subject to:**

$$21a + 16b \leq 336$$

$$13a + 25b \leq 325$$

$$15a + 18b = 300$$

What this means is, in summary, there are two products, 'a' and 'b', for us to consider. Product 'a' earns us £4 per unit contribution (or profit) and product 'b' earns us £3 per unit contribution.

There are three **constraints**, such as raw materials, direct labour and cash; or constraints such as skilled labour, unskilled labour and machine time. In any case, for example, raw materials might be available only up to a total of 336 kilogrammes and each unit of 'a' uses 21 kg of the raw material and each unit of 'b' uses 16 kg of that raw material...hence  $21a + 16b \leq 336$ .

That's the problem: SOLVER will tell us how many units of 'a' to make and how many units of 'b' to make in order to maximise profits: it will also tell us if we have used all of the resources available to us.

There are four tasks for this problem

- a) solve this problem using SOLVER and make a note of the profit earned; AND when Excel offers to save your model as a scenario, say yes and type a name like **scenario 1**.
- b) change the contribution per unit of b to £4 and ask SOLVER to rework the problem and make a note of the profit earned; AND save this attempt as a new scenario...**scenario 2**.
- c) with your solution to part b) you will find an answer such as x.xxxx units of a and y.yyyy units of b: let's assume that we cannot make fractions of a product and make a note of the profit earned...use the integer setting in SOLVER to force it to give us our answers for a and b as integers or whole numbers. Save this as **scenario 3**.
- d) this is a **profit maximisation problem**: change it to a problem in which the profit MUST be, say £70...rework the problem and see what happens...

The problem is not complex but it is rich in the ideas and feedback it provides. We hope you like the scenario manager addition, by the way. By selecting

Data

Data Tools

What-If Analysis

Scenario Manager

you can compare the three scenarios you will be able to save during this exercise.

Try it!

### **Conclusions**

In this chapter we have worked through a series of accountant related problems: not all accountants need all of these but you might find that one of these problems hits you from time to time.

Merging cells has become a habit for most spreadsheet users but it doesn't conform to spreadsheet best practise so you should learn to centre across selection now. We like population pyramids for things other than populations: we demonstrated a population pyramid for the population of Brunei but think of two other data sets that you might want to compare that such a graph can be used for: there are many!

Simultaneous equations are the bane of school children all over the world but Excel can solve them with ease: having read this chapter, so can you! SOLVER helps with simultaneous equations and it helped with resource allocation, linear programming, too. The final chapter in this book, book 3 contains several more problems that SOLVER can solve for us.

This is the third of three chapters called Accountant Specific: books one and two contain their own Accountant Specific chapters too: Accountant Specific 1 and Accountant Specific 2.

### **Excel Files Available**

All of the Excel files mentioned in this book can be found on this book's page at:

<http://bookboon.com/en/excel-solutions-for-accountants-book-3-ebook>

# 3 Dashboarding

## Introduction

Accountants were born to prepare dashboards and this chapter is the destination of the two chapters **Graphs 1** and **Graphs 2** which were concerned with drawing graphs. We discussed about 20 graphs and graphing techniques in those two chapters and in this chapter we will add some more.

A **Dashboard** is the modern term for what we used to call **management by eye**. However, since we can program spreadsheets and lots of other software to prepare dashboards now, they are not necessarily only concerned with graphs.

In this chapter we will create dashboards or elements of dashboards that include

- Graphs
- Tables
- Words/discussions
- Statistics

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The aim of a dashboard is to provide a quick summary of a complex situation. On the one hand, we use a dashboard by looking at it and accepting what we see. On the other hand, we want to be able to accept the dashboard but then interrogate it by using such techniques as hyperlinking to other parts of a worksheet or workbook.

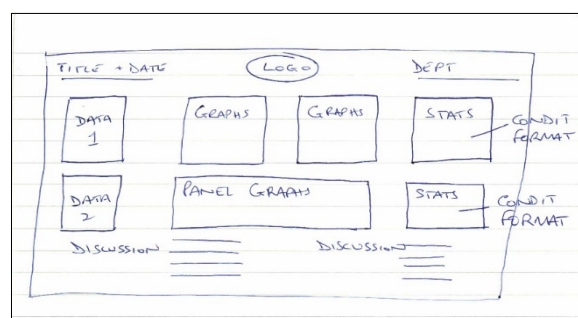
Because we want dashboards to be interactive and smart, they usually contain some relatively advanced programming. There is no VBA in this chapter but there are these functions being used:

- INDEX()
- MATCH()
- TEXT()
- IF(OR())
- SUMPRODUCT()
- SUMIFS()
- AVERAGEIFS()
- CONCATENATE()/&

### 3.1 PPP: paper, pencil, plan

When we deliver training courses on Excel, we always say at some stage that one of the secrets of successful spreadsheeting is **PPP: paper, pencil, plan**. That is, don't even turn on your computer until you have thought about and sketched out what you are trying to do. We think this is a vital aspect of dashboarding: yes, we can create a graph and a table and write some words and fit them all onto a screen and call it a dashboard; but that's probably not going to be as effective as asking people what they want and then mapping out a solution to deliver it.

You would do something like this to begin with, which you then pass around and it is accepted or amended or rejected and so on. Never forget this step! Let's prepare a dashboard like Figure 1 now.



**Figure 1** Paper, Pencil, Plan...PPP

One of the major requirements for dashboarding apart from an understanding of Excel is imagination: it is good to PPP and take advice so that you create the most effective dashboard you can think of.

### 3.2 Dashboard One

Our major concern here and throughout this book is that we work on relatively simple examples so that you can appreciate the techniques rather than worry about complex tables and data and so on. Complexity comes later!

In this dashboard you will see, among other things:

- Tables
- Graphs
- Panel Graphs
- The mean of classified data
- Custom Formatting
- Conditional Formatting
- Data Validation
- Combining the INDEX() and MATCH() functions to perform a lookup
- CONCATENATE()/&
- Formatting by use of the TEXT() function
- IF(OR())
- SUMPRODUCT()
- SUMIFS()
- AVERAGEIFS()

Open *dash.xlsx* **dash\_1** tab to see what we have done and what you might also do.

The dashboard you will find on the **dash\_1** tab looks like Figure 2: difficult to read here!

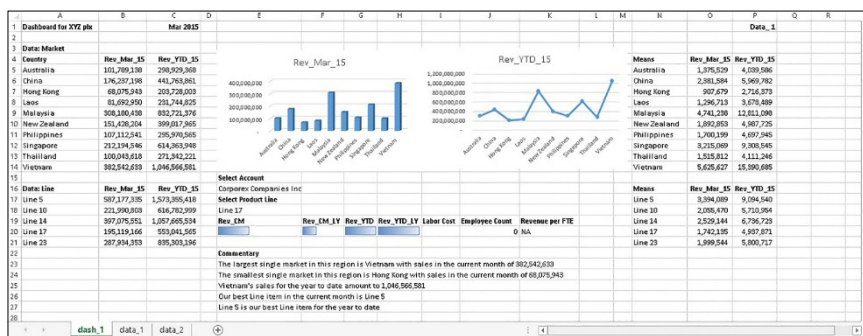


Figure 2 Our First Dashboard

At this stage we can evaluate our dashboard PPP and probably conclude that there are too many numbers and words and not enough visual impact. Never mind, let's see how this has been put together anyway.

Firstly notice that our source data are contained in an **Excel Table** and that's why our first formula contains **structured formulation**. Cell B5 contains a SUMIFS() formula

```
=SUMIFS(Table1[Rev_Mar_15],Table1[Market], "="&dash_1!A5)
```

This formula tells Excel to find the total sales for the month for, in this case, Australia. As we fill down Australia changes to China then Hong Kong and so on down to Vietnam.

Cell C5 contains a very similar formula which finds total sales for the year to date for Australia

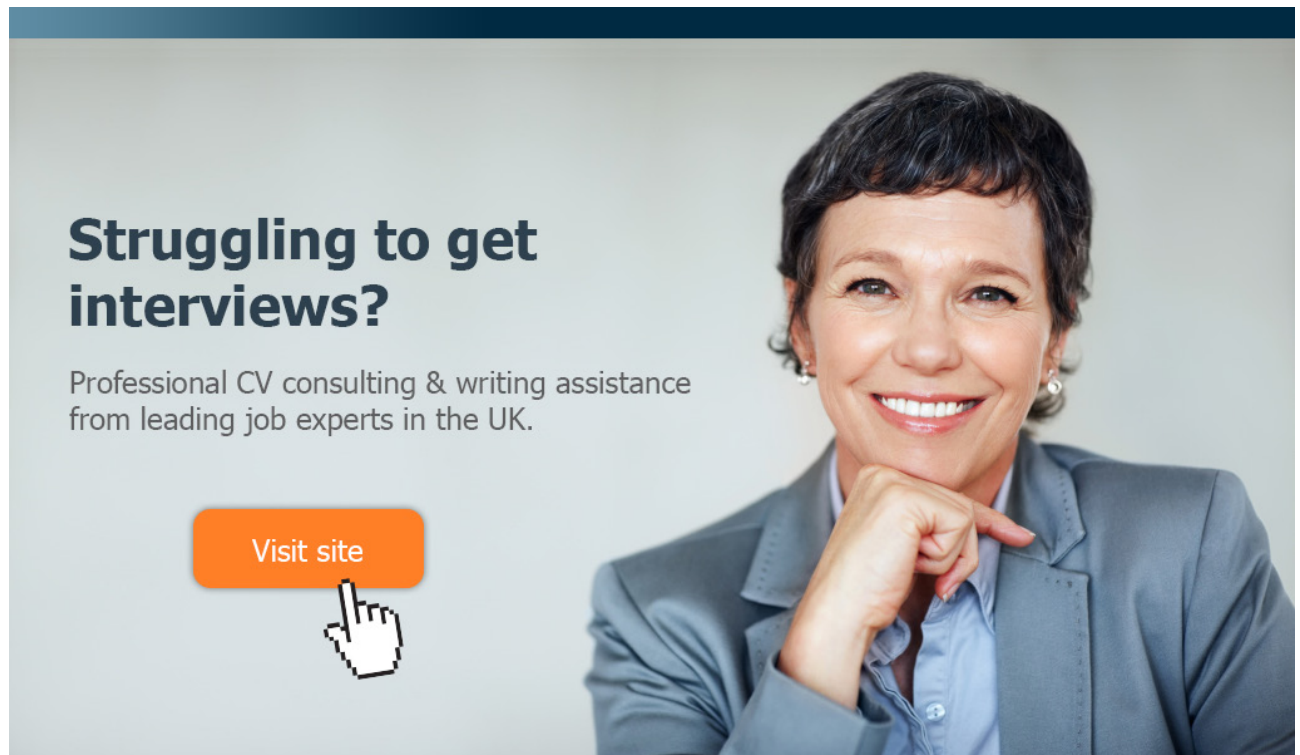
```
=SUMIFS(Table1[Rev_YTD_15],Table1[Market], "="&dash_1!A5)
```

Move down to cell B17 now and the formula finds the total sales for the month by Line, using this formula

```
=SUMIFS(Table1[Rev_Mar_15],Table1[Product Line], "="&dash_1!A17)
```

And Cell C17 contains the equivalent year to date formula

```
=SUMIFS(Table1[Rev_YTD_15],Table1[Product Line], "="&dash_1!A17)
```



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Moving to the other side of the dashboard and column O we find this formula in cell O5 that finds the average sales for Australia for the month

=AVERAGEIFS(Table1[Rev\_Mar\_15],Table1[Market],”=”&dash\_1!N5) and the formula in cell P5 find the average sales for Australia using this formula

=AVERAGEIFS(Table1[Rev\_YTD\_15],Table1[Market],”=”&dash\_1!N5)

These formulas are filled down to row 17, Vietnam, to complete the table.

Finally in this section, look at cells O17 and P17 to find the average month's Line sales and the year to date average Line sales, using these formulas

O17=AVERAGEIFS(Table1[Rev\_Mar\_15],Table1[Product Line],”=”&dash\_1!N17)

P17=AVERAGEIFS(Table1[Rev\_YTD\_15],Table1[Product Line],”=”&dash\_1!N17)

These formulas are filled down to row 21 to complete that table.

### Commentary: using natural language

The commentary uses the most interesting formulas in the dashboard in our opinion. For example, in cell E23 you will see this:

=”The largest single market in this region is “&INDEX(A5:A14,MATCH(MAX(B5:B14),B5:B14,0))&” with sales in the current month of “&TEXT(MAX(B5:B14),”#,##0”)

Let's explain that formula as it does several things all at once: it will take time but it will be well worth your attention!

One of the most important things the formula does is to carry out a lookup operations from **right to left**: VLOOKUP() can only lookup from **left to right**! This formula works by combining the INDEX() and MATCH() functions:

- **MATCH()** asks Excel to find something in a range and tell us its position. In the case of the MATCH() in cell E23 it has been asked to use the MAX() function to find the largest value (MAX) in the range B5:B14 and to tell us where it is (MATCH): when it does it says 10...that's the tenth item down the list of 10 items in this case
- We asked the INDEX() function to look in the range A5:A14 and tell us what it finds in the 10<sup>th</sup> position: that's the position that MATCH() tells it to look for. That's smart and you should consider where else you can use this combination of functions for looking for things.
- We combined the INDEX() and MATCH() combination with CONCATENATE() and the TEXT() function linked again to the MAX() function

- The TEXT() function is used to take the number that MAX() finds and format it as text in the format #,##0, which means make it look like this: 1,000, 15,123, 1,584,236...
- Finally CONCATENATE() joins things together and whilst there are two ways of doing that, we use the "&" method. It works this way, for example:
  - In cell A1 type Duncan
  - In cell A2 type Williamson
  - In cell A3 type Author
  - In cell B1 type =A1&" "&A2&" "&A3...try it and B1 will show
- Duncan Williamson Author
- **Alternatively** Type this in cell B1=CONCATENATE(A1," ",A2," ",A3)
- Now try this:
  - In cell C1 type Excel
  - In cell C2 type Solutions
  - In cell C3 type for Accountants
  - In cell D1 type =C1&" "&C2&" "&C3...try it and B1 will show
- Excel Solutions for Accountants
- **Alternatively** Type this in cell D1=CONCATENATE(C1," ",C2," ",C3)

And in E24:E26 you will find

- E24="The smallest single market in this region is "&INDEX(A5:A14,MATCH(MIN(B5:B14),B5:B14,0))&" with sales in the current month of "&TEXT(MIN(B5:B14),"#,##0")
- E25=INDEX(A5:A14,MATCH(MAX(B5:B14),B5:B14,0))&"s sales for the year to date amount to "&TEXT(MAX(C5:C14),"#,##0")
- E26="Our best Line item in the current month is "&INDEX(A17:A21,MATCH(MAX(B17:B21),B17:B21,0))
- E27=INDEX(A17:A21,MATCH(MAX(B17:B21),B17:B21,0))&" is our best Line item for the year to date "

In the section of the PPP that we labelled Panel Charts we did something a little creative, rather than the kind of panel chart we produced in the Graphs 2 chapter. What we did was this:

- In cell E16 we created a Data Validation List of Companies or Account Holders
- In cell E18 we created a Data Validation List of Product Lines

We use these two Data Validation devices to drive the Panel Graph type output

The range E19:K20 actually feeds of the range T4:Z5 in the **data\_1** tab. Here is what happens there:

In cell data\_1!T5

- =SUMPRODUCT((Table1[Account]=dash\_1!E16)\*(Table1[Product Line]=dash\_1!E18)\*(E11:E704))
- In cell data\_1!U5
- =SUMPRODUCT((Table1[Account]=dash\_1!E16)\*(Table1[Product Line]=dash\_1!E18)\*(F11:F704))
- And so on until the ratio calculation in cell data\_1!Z5
- =IF(OR(V5=0,Y5=0),”NA”,V5/Y5)

Let’s interpret these formulas:

**SUMPRODUCT()** gives us a combination of SUM, total; and PRODUCT, multiplying. What it does is to multiply ranges together and then add the results.

The normal syntax is =SUMPRODUCT(array1,[array2],[array3]...). Such as

10	5
12	8
9	11

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The sum of the products here is  $10 \times 5 + 12 \times 8 + 9 \times 11 = 50 + 96 + 99 = 245$ . Alternatively, you could program this in this way,  $=SUM(A1 \times B1 + A2 \times B2 + A3 \times B3)$  but now you know SUMPRODUCT, why would you do that?

In these examples, though, there is a ‘\*’ between arrays and that’s a bit odd because it means, in this context, AND. So, the formula in **data\_1!T5** of  $=SUMPRODUCT((Table1[Account]=dash_1!E16) \times (Table1[Product Line]=dash_1!E18) \times (E11:E704))$  means

Go to the Account column in Table1 AND looking ONLY for whatever has been chosen in cell dash\_1!E16, go to the **Product Line Column** in Table1 AND looking ONLY for whatever has been chosen in cell dash\_1!E18 and add together all of the values corresponding to these two variables from column E.

**You probably need to study that for a while as it is complex.** You should also say how you would create a different/better dashboard than that!

### 3.3 Dashboard Two

Let’s imagine a completely different kind of dashboard now: a benchmarking dashboard in which you want to review a number of companies in your industry or in the industry of one of your clients. The basis of this dashboard is the Panel Graph: some of the graphs will be controlled by Scroll Bars and others will be static. We don’t show it here but we prepared a PPP sketch before with switched on Excel!

Let’s begin with a very simple dashboard, Figure 5: all we have done here is to construct a table of ratios for eight companies in the Oil and Gas industry and then concentrate on just three of them. Why three? Why these three? No reasons for either choice except for demonstration:

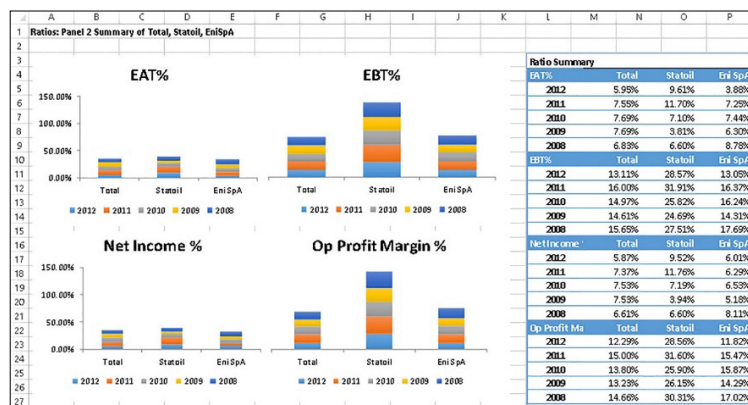


Figure 5 Benchmarking Dashboard: using the Camera Tool

We have used one particular technique for this dashboard that you should consider using too: the **Camera Tool**. All of our work has been done in the file *dash\_panel.xlsx* file **ratios\_panel\_2** tab and we then organised everything in such a way as to make taking a camera tool snapshot so easy. Look at Figure 6 which is a zoomed out view of the **ratios\_panel\_2** tab:

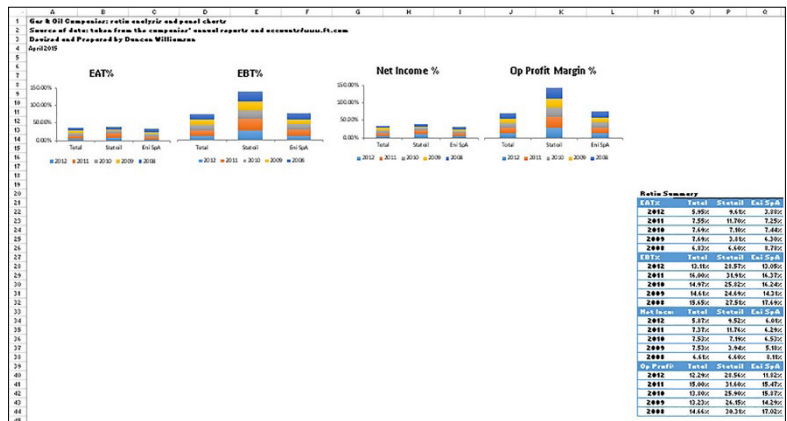


Figure 6 The real view of ratios\_panel\_2b

Here, purely for the camera tool, we have created a table and then **hidden columns** 2, 5–8 of that table. Then we took the camera tool snap and you can see the effect on the dashboard. **Please note**, working with a copy of this tab is the optimal way to work, of course: see the **ratios\_panel\_2b** tab for that.

You need a copy of the tab, by the way, because if you take a snap with the camera tool and paste it somewhere then put your original graph or table back to the way it was, without any hidden columns and so on, the chances are you will make a complete mess of the snap because it's dynamic.

Otherwise, there is nothing complex in this dashboard as all of the data are put into the table via a simple formula and the panel charts are created using **Stacked Column Graphs** as we have seen before.

### 3.4 Hyperlinks

As a matter of interest, we could include some hyperlinks to our dashboard where we want, for example, readers to be able to drill down from a summary to something more detailed. To create a hyperlink:

Select a cell or range or chart for which you want to create a hyperlink  
 Insert...Links...Hyperlink

See Figure 3 and follow it:

1. Click Place in This Document
2. Select the Tab to link to
3. Click the address on the Tab
4. OK

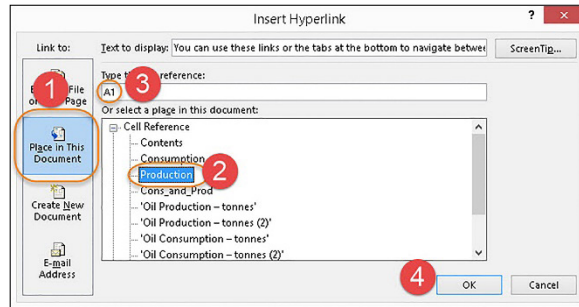


Figure 7 Setting up a Hyperlink from one part of a work book to another

For Example, let's set up a hyperlink to take us from a graph to its source data

Go to the EAT% graph on the ratios\_panel\_2b tab in dash\_panel.xlsx

Click on the graph

Following description that goes with Figure 7 above, with this modification:

The place in the document is the **ratios\_panel\_2b** tab and the cell reference is **M26**

Click OK

Click on the graph now and you will go straight to ratios\_panel\_2b!M26

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### 3.5 Dashboard Three

Dashboard One was not so good in terms of layout and content but we created it to give you some ideas of how to use PPP, several built in functions, how to make Excel talk to you almost in natural language by using the CONCATENATE function and so on. Dashboard Two was designed for you to see the Camera Tool in action so that you could consider using it in a better version of Dashboard One or in your own work. Dashboard Three is a little more complex in the way it reorganises data but having done so, the effect is powerful even though the dashboard is really only a Panel Graph and you need to add Dashboard One style elements to it yourself.

#### 3.5.1 The Data

For this dashboard, we are using the **ratios\_panel\_1b** tab of the *dash\_panel.xlsx* file, which is just a copy of the **ratios\_panel\_1** tab.

First of all, the data: Figure 7 shows you one part of the data which have been hard coded for this exercise: there is a much larger source file for the data but for this demonstration we are working only with four ratios for eight Oil and Gas companies.

	A	B	C	D	E	F	G	H	I
1	Gas & Oil Companies: ratio analysis and panel charts								
2	Source of data: taken from the companies' annual reports and accounts/www.ft.com								
3	Devised and Prepared by Duncan Williamson								
4	April 2015								
5									
6	Ratio Summary								
7	2012								
8		Gazprom	Total	Statoil	Eni SpA	BG Group plc	NK Rosneft' OAO	RN Holding OAO	Novatek OAO
9	Operating Profit Margin	27.04%	12.29%	28.56%	11.82%	32.70%	12.09%	27.56%	40.45%
10	EBT %	31.72%	13.11%	28.57%	13.05%	33.62%	14.20%	27.16%	40.87%
11	EAT %	25.39%	5.95%	9.61%	3.88%	17.48%	11.11%	22.56%	32.91%
12	Net Income %	24.81%	5.87%	9.52%	6.01%	23.87%	11.08%	20.95%	32.92%
13	2011								
14		Gazprom	Total	Statoil	Eni SpA	BG Group plc	NK Rosneft' OAO	RN Holding OAO	Novatek OAO

Figure 7 Ratio Analysis Oil & Gas

#### 3.5.2 The Panel Graphs

The only element of Dashboard Three is a **scroll bar** controlled Panel Graph, which you can see in Figure 8:

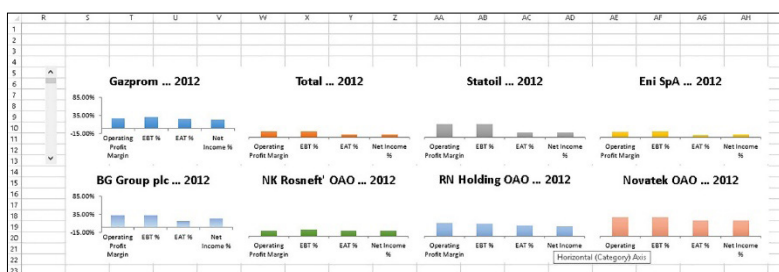


Figure 8 Panel Graphs Controlled by Scroll Bar

In between the contents of Figures 7 and 8 is a section in which we **transpose** the data and create a section on which the Panel Graphs are based. It is right to say that we could have created our final tables from scratch to create the Panel Graphs but we are assuming that, as happens, you are given the raw data by your IT Department or via your Accounting Database or from another source over which you have no control.

### 3.5.3 Transposing Data

**Transposing** in the context of Excel means to switch data from being column based to being row based and we can do that in several ways.

#### Example of Transpose

The three values in the first column are transposed to become the three values in the first row

1	1	2	3
2			
3			

**Figure 9** Transpose from Column to Row

We are going to demonstrate the **TRANSPOSE() Array entered function** here; but you can achieve the same result using **Copy, Paste Special, Transpose**. The TRANSPOSE() function is dynamic so that if you change the source data, the TRANSPOSE() data updates too. With the Paste Special Transposed data, nothing happens when you change the source data.

Why do we need to transpose the data: well, the graphs that we are producing and all of our analysis has to be in columns rather than rows and at the moment they are in rows.

Assuming Figure 9 comprises columns A:D and rows 1, 2 and 3, we would transpose the values in A1:A3 in this way:

- Select cells B1:D1
- Type =TRANSPOSE(A1:A3)
- Then Press Ctrl+Shift+Enter (CSE)
- That will do it

Here is the working section of the worksheet now, part one: starting in K14. This section relates to 2012 and there are separate sections for each of the years 2008–2011, reading down from the section shown in Figure 10. The numbers in the left hand column are for use later. The range L14:P21 contains this Array entered formula:

=TRANSPOSE(B7:I7)

Which turns the hard coded data we saw earlier from being row data to being column data.

We repeat this transposition for all years.

		Operating Profit Margin	EBT %	EAT %	Net Income %	
1	Gazprom	27.04%	31.72%	25.39%	24.81%	2012
2	Total	12.29%	13.11%	5.95%	5.87%	2012
3	Statoil	28.56%	28.57%	9.61%	9.52%	2012
4	Eni SpA	11.82%	13.05%	3.88%	6.01%	2012
5	BG Group plc	32.70%	33.62%	17.48%	23.87%	2012
6	NK Rosneft' OAO	12.09%	14.20%	11.11%	11.08%	2012
7	RN Holding OAO	27.56%	27.16%	22.56%	20.95%	2012
8	Novatek OAO	40.45%	40.87%	32.91%	32.92%	2012

Figure 10 Fully Transposed Table

Before we create the Panel Graphs, we create the Panel Graph input table, as you can see in Figure 11:

**Brain power**

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	J	K	L	M	N	O	P
3	<b>Year</b>	<b>Company</b>	<b>Operating Profit Margin</b>	<b>EBT %</b>	<b>EAT %</b>	<b>Net Income %</b>	
4	2012	1 Gazprom ... 2012	27.04%	31.72%	25.39%	24.81%	
5	2012	2 Total ... 2012	12.29%	13.11%	5.95%	5.87%	
6	2012	3 Statoil ... 2012	28.56%	28.57%	9.61%	9.52%	
7	2012	4 Eni SpA ... 2012	11.82%	13.05%	3.88%	6.01%	
8	2012	5 BG Group plc ... 2012	32.70%	33.62%	17.48%	23.87%	
9	2012	6 NK Rosneft' OAO ... 2012	12.09%	14.20%	11.11%	11.08%	
10	2012	7 RN Holding OAO ... 2012	27.56%	27.16%	22.56%	20.95%	
11	2012	8 Novatek OAO ... 2012	40.45%	40.87%	32.91%	32.92%	

**Figure 11** Ready for the Panel Graphs

You can see the range here and here are the formulas you need to create this list:

J4 =VLOOKUP(\$K4,\$K\$14:\$Q\$53,7,0): this gets the year number from the range starting in Figure 10, above, based on the number you see in K4

K4=1, K5 =K4+1, K6=K5+1...it's a simple serial number but it is vital for this exercise

L4 =L14&"..."&J4...CONCATENATION of name and year

M4 =VLOOKUP(\$K4,\$K\$14:\$P\$53,3,0)...based on the number in K\$, gets the Operating Profit Margin

N4 =VLOOKUP(\$K4,\$K\$14:\$P\$53,4,0)...based on the number in K\$, gets the EBT%

O4 =VLOOKUP(\$K4,\$K\$14:\$P\$53,5,0)...based on the number in K\$, gets the EAT%

P4 =VLOOKUP(\$K4,\$K\$14:\$P\$53,6,0)...based on the number in K\$, gets the Net Income %

We fill those formulas down to row 11 and you should see that the numbers in K4, K5, K6 etc are the lynchpin of this dashboard.

The section we have just created are the foundation of the Panel Graphs.

Panel Graph 1 is based on L4:P4

Panel Graph 1 is based on L5:P5

Panel Graph 1 is based on L6:P6

Panel Graph 1 is based on L7:P7

Panel Graph 1 is based on L8:P8

Panel Graph 1 is based on L9:P9

Panel Graph 1 is based on L10:P10

Panel Graph 1 is based on L11:P11

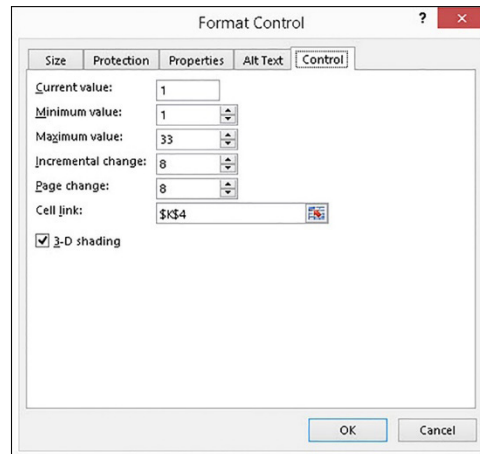
We have used **2D Column Charts** for this Panel but you can use any graph you like, providing it communicates well.

That's it, create those graphs, notice how we have left the vertical axis alone for the left most graph but deleted them elsewhere;

We have made the vertical axis the same size for all charts: same minimum and same maximum

We have used different colours from graph to graph to help you to distinguish between them

And now, to finish everything off, the Scroll Bar, which you can place vertically or horizontally and wherever you like. Just make a note of these parameters, especially the Maximum value of 33...why is it 33 and nothing else? Figure 12 follows:



**Figure 12** Scroll Bar Control

If we have done everything correctly, click away from your Scroll Bar once you have created it and then use it. Every time you click the Scroll Bar your Panel Graph should update automatically and change from company to company!

There is a lot to do to make this Dashboard work but it is well worth the effort: learn it and use it!

## Conclusions

In this chapter we have demonstrated one dashboard in full: beginning with a PPP drawing and ending with a rejection of it! However, it was meant to be a learning exercise so no harm done. The second and third dashboards were meant to comprise one or two main elements and they did so: the aim here is to take you through some relatively complex programming so that you can learn it and apply it.

Dashboards are keystone modules in that to create them you need to think ahead, design, use a variety of Excel techniques and functions and then make them communicate as well as possible. If we have managed to achieve all of that, we have done well. You should consider using as many examples from the rest of the book as possible in your quest for the optimum dashboard so don't just rely on this chapter.

We have concentrated on Panel Charts for no real reason and any chart or combination of different charts can communicate equally well.

## Excel Files Available

All of the Excel files mentioned in this book can be found on this book's page at: <http://bookboon.com/en/excel-solutions-for-accountants-book-3-ebook>

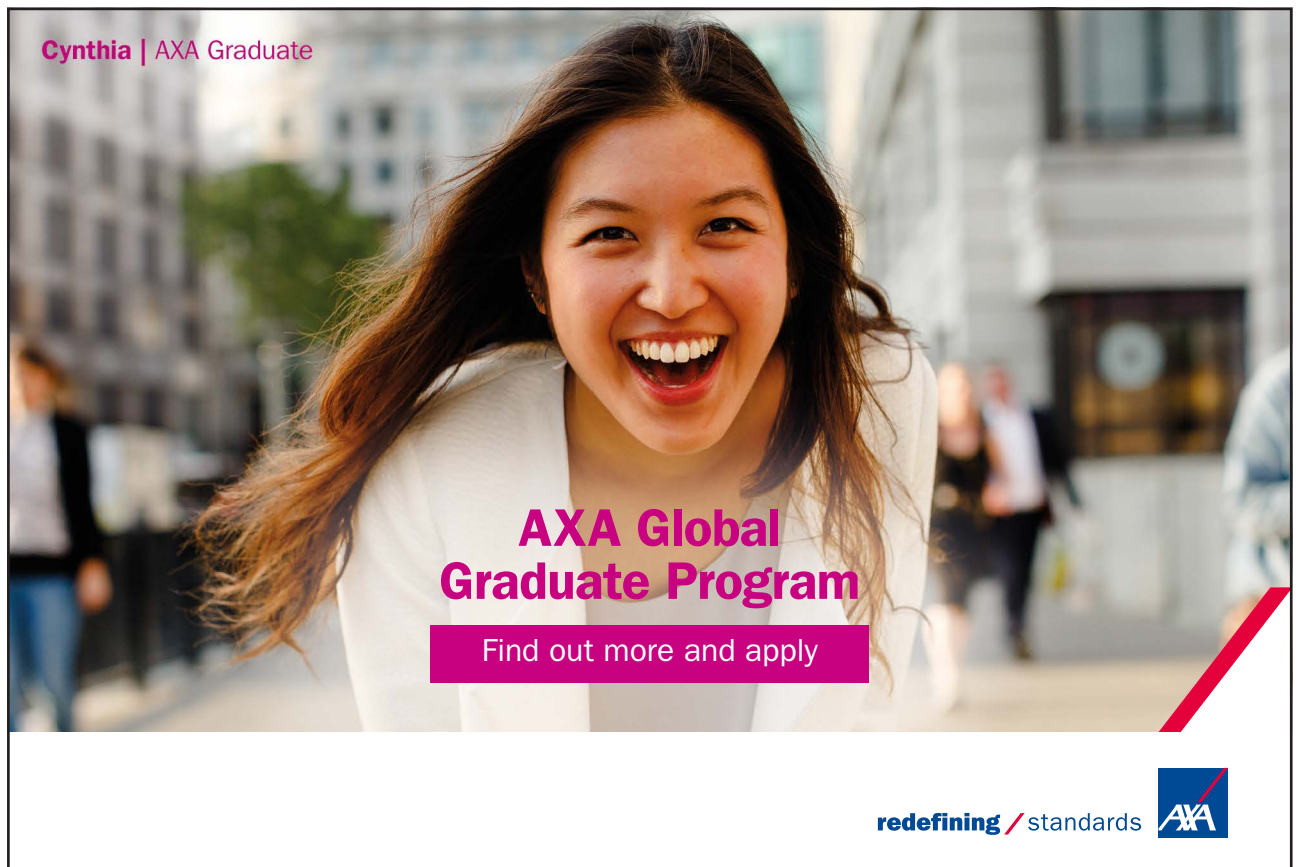
# 4 Pivot Tables 3

## Introduction

Now that your knowledge and skills of Pivot Tables (PTs) are relatively well advanced, this **third of three chapters on Pivot Tables**, take us several steps forward as we work on the communications aspects of PTs: among other things:

- Slicers
- Timelines
- Conditional Formatting
- Pivot Charts

By the end of this chapter you should find Pivot Tables will have become one of your biggest Excel tools for your work as an accountant.



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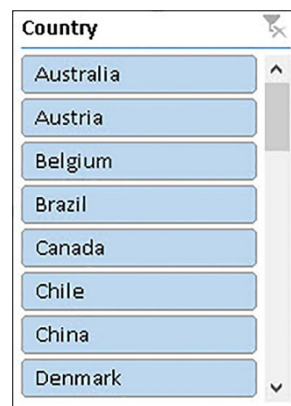
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## Review

In a previous chapter, **Pivot Tables 1**, we started to create and use Pivot Tables from scratch: assuming no knowledge of them at all. However, now you know what they are and some of how to use them. We know that a Pivot Table (PT) summarises data in a flash: it takes a list or, preferably, an Excel Table and organises it and reorganises it in almost any way you care to name. For example, we saw simple lists of sales transactions and records of the results of some of the world's largest companies and we analysed the data in myriad ways using a PT. Look back at **Pivot Tables 1** and **Pivot Tables 2** if you have forgotten anything or want to see again what we did there.

### 4.1 Slicers

A **Slicer** is a **filtering tool** but it's a very attractive filtering tool that looks like Figure 1:



**Figure 1** A Slicer

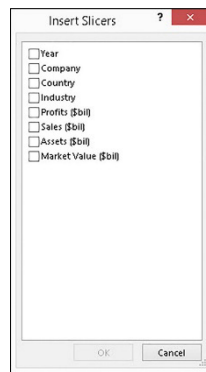
When we click on any of the country names on a slicer, that name is filtered in and unless and until you **Ctrl+Click** another country, it is the only country in the relevant PT. We took this slicer to work with this PT which is on *pivot\_tables.xlsx* **table\_3\_pivot**, part of which is shown below:

Year	(All)	
Country	Tot Sales (\$bil)	Tot Profits (\$bil)
Australia	64.74	8.12
Austria	24.05	1.60
...	...	...
Thailand	0.66	0.12
United Kingdom	242.29	31.81
United States	1,213.50	90.15
Venezuela	1.37	0.26
<b>Grand Total</b>	<b>3,044.86</b>	<b>255.39</b>

**Table 1** Extract of the PT used with the Slicer

We create Slicers like this:

- Click on a PT
- Click Pivot Table Tools...Analyse...Filter...Insert Slicer
- Figure 2, the dialogue box, appears which contains all of the Field Headings associated with that PT. In this case:



**Figure 2** Slicer Dialogue Box

Select one or more of the fields you see here, we will check only Country in this case. Your Country slicer then appears and is ready to use.

Read the note next to the following slicer carefully then try it for yourself:



**Figure 3** Slicer with Instructions!

When you do that, this is the kind of result you will see, where we have Ctrl+Clicked Australia, Austria, Belgium and Brazil only:

1	Year	(All)			
2					
3	Country	Tot Sales (\$bil)	Tot Profits (\$bil)		
4	Australia	64.74	8.12		
5	Austria	24.05	1.60		
6	Belgium	59.69	4.73		
7	Brazil	4.77	0.28		
8	<b>Grand Total</b>	<b>153.25</b>	<b>14.73</b>		
9					
10					
11					
12					
13					
14					
15					
16					

As you filter data with your Slicer, your PT might shrink and grow...it will not conflict with the Slicer though which is why we have been able to put the Slicer next to the PT and make those changes.

Figure 4 Multiple Field Name Selection

Either click on another country...**scroll down** the Slicer to find the country or countries of interest or Ctrl+Click and scroll down to find the country or countries you are interested in.

You can **reset the Slicer** by **clicking on the filter button** in the top right hand corner of the slicer: it's a funnel with a red cross on it when you have something selected rather than all selected.

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Exercise of you to do

- In addition to Country, revise the PT on **table\_3\_pivot** to include Industry and add the Industry Slicer to that tab so that you have TWO Slicers working on the same PT
- Now select, say, 10 countries using the Country Slicer and, say, five Industries using the Industry Slicer
- Figure 5 is what you should see

Year	(All)			
Country	Industry	Tot Sales (\$bil)	Tot Profits (\$bil)	
Australia	Banking	54.56	6.43	
	Building Materials	3.64	0.25	
	Diversified Financials	4.26	0.64	
	Materials	2.29	0.80	
Austria	Insurance	5.63	0.12	
	Oil & Gas Operations	18.42	1.48	
Belgium	Banking	24.48	2.39	
	Food Drink & Tobacco	17.56	1.86	
	Petroleum refining	17.65	0.48	
Brazil	Chemicals	4.77	0.28	
Canada	Chemicals	3.42	0.29	
	Insurance	18.74	1.61	
	Oil & Gas Operations	20.02	2.87	
	Retailing	7.10	0.30	
	Telecommunications	6.23	1.34	

Figure 5 Two Slicers One PT

- We have formatted each Slicer with different colours by selecting a Slicer and choosing **Select Styles in the Slicer Tools Tab Options**
- We changed from **single column to two columns** by using Buttons...Columns...on the same Slicer Tools Tab Options

Make your selections now...10 Countries and five industries

Year	(All)			
Country	Industry	Tot Sales (\$bil)	Tot Profits (\$bil)	
Australia	Banking	54.56	6.43	
Belgium	Banking	24.48	2.39	
	Food Drink & Tobacco	17.56	1.86	
China	Banking	23.18	5.84	
	Consumer Durables	3.95	0.31	
Denmark	Drugs & Biotechnology	5.35	0.93	
France	Banking	15.22	0.82	
	Capital Goods	35.81	0.61	
	Consumer Durables	55.24	4.82	
	Drugs & Biotechnology	32.28	7.49	
Grand Total		267.63	31.50	

Figure 6 When Some Selections are made, other Selections might be Greyed out

What you see here is the selection of ten countries and five industries. However, you can only see that five countries are selected and the rest have been greyed out by Excel. That's because those five industries are not operating in all 10 countries. Well, we didn't know that before.

For now, that is it. However, why not take Slicers one or two steps further by including them in your own Dashboards? Experiment with Slicers now, however: become the **Slicer guru** at work!

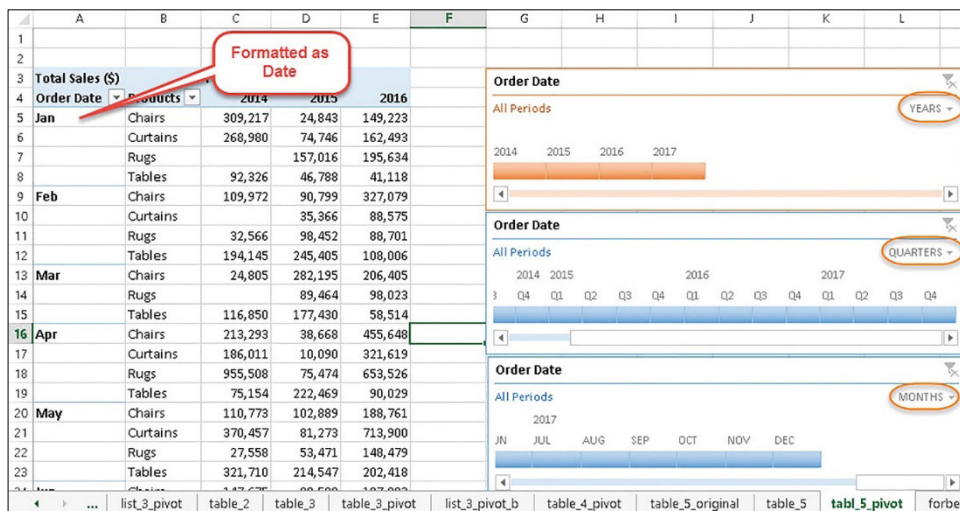
## 4.2 Timelines

**Timelines** are new to Excel 2013 and they are another filtering tool that you might find useful. Please note, if there is no **Date variable** in your data then timelines will not work! Sounds ridiculous but we had to say it just in case!

We can use the PT on the **table\_5\_pivot** tab because the **Order Date Field** is formatted as a date.

**Purely for demonstration**, the following screenshot shows three timelines on one worksheet:

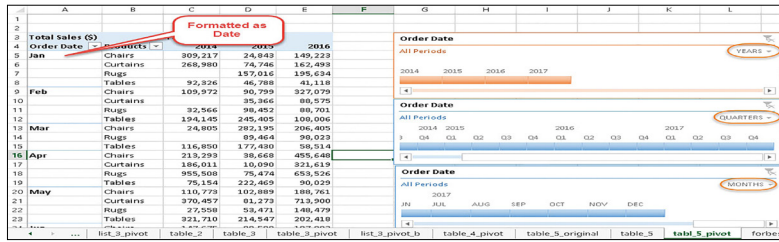
- By years
- By quarters
- By months
- Normally you might have just one of them per sheet/PT



**Figure 7** Three Timelines...Order Date is Formatted as a Date

To keep it very simple, we will demonstrate just the Years timeline.

- To create the timeline, click on the PT
- PivotTable Tools...Analyse ...Filter...Insert Timeline
- You are given a dialogue box which shows the Date Formatted Fields in your PT...Order Date in this case: check it
- OK



- Click on a year on the timeline bar to select any year
- Ctrl+Click on the timeline bar to select two or more years
- Click the Filter icon in the top right hand corner to reset the timeline

Try it!

Where it says Years underneath the filter icon there is a drop down arrow that you can click to change from years to quarters to months...

### 4.3 Combine Slicer and Timeline

In the following screenshot you will see a Year Timeline and a Products Slicer: both have been activated:

- 2016
- Chairs

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Figure 8 shows what it does:

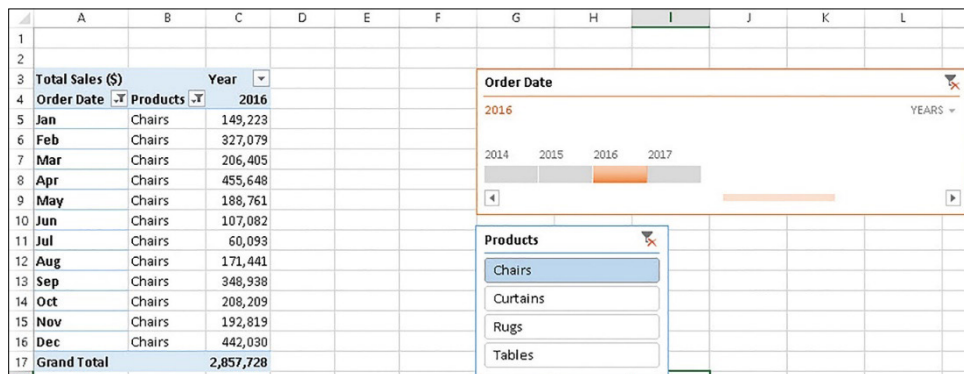


Figure 8 Slicer and Timeline Working Together

### 4.4 Conditional Formatting

Ever Since Excel 2007 and the innovation of the Ribbon, conditional formatting has been fantastic. What follows is just a hint of what conditional formatting can do and in this case we are applying it to PTs only!

Using the **table\_5\_pivot** PT again, use your Timeline to select 2014–2016

And your Slicer to select Chairs.

Select the 2014 column, NOT including the header and not including the Grand Total

Home Tab...Styles...Conditional Formatting

Choose Top/Bottom Rules...Above Average

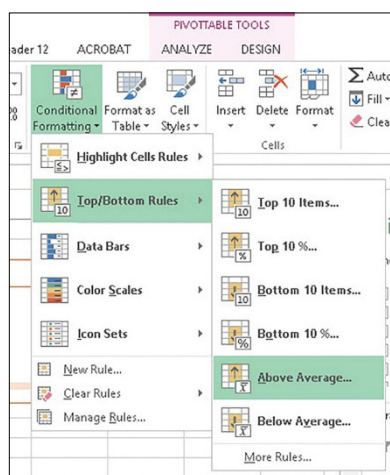


Figure 9 Setting up the Conditional Formatting

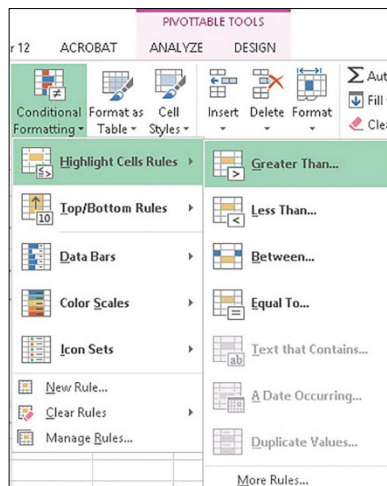
- Choose to format the cells that are above average with green text and green fill...
- Repeat for 2015...alternatively select the 2014 data...Format Painter...apply to 2015
- Repeat for 2016...

You should get this, Table 2:

Total Sales (\$)		Year		
Order Date	Products	2014	2015	2016
Jan	Chairs	309,217	24,843	149,223
Feb	Chairs	109,972	90,799	327,079
Mar	Chairs	24,805	282,195	206,405
Apr	Chairs	213,293	38,668	455,648
May	Chairs	110,773	102,889	188,761
Jun	Chairs	147,675	90,599	107,082
Jul	Chairs	272,911	191,807	60,093
Aug	Chairs	107,844	175,970	171,441
Sep	Chairs	204,446	374,456	348,938
Oct	Chairs	482,876	575,503	208,209
Nov	Chairs	486,938	528,949	192,819
Dec	Chairs	73,862	278,160	442,030
Grand Total		2,544,612	2,754,838	2,857,728

**Table 2** Your Conditionally Formatted PT

- Use your Slicer to select **all other Products** now.
- Notice the conditional formatting disappears
- Select the data in column 2014 again and format...Highlight Cells Rules...Greater Than...200,000
- Format the colour(s) you want to use.



**Figure 10** New Conditional Formatting Rules Applied

Total Sales (\$)		Year		
Order Date	Products	2014	2015	2016
Jan	Curtains	268,980	74,746	162,493
Feb	Curtains		35,366	88,575
Apr	Curtains	186,011	10,090	321,619
May	Curtains	370,457	81,273	713,900
Jun	Curtains	468,255	245,895	276,246
Jul	Curtains	107,933	119,792	74,340
Aug	Curtains		82,446	62,527
Sep	Curtains	198,331	379,245	409,298
Oct	Curtains	73,642	579,221	344,889
Nov	Curtains	434,595	572,367	350,380
Dec	Curtains	649,697	393,617	96,755
Grand Total		2,757,901	2,574,058	2,901,022

Figure 11 Conditionally Formatted PT, Version 2

“I studied English for 16 years but...  
...I finally learned to speak it in just six lessons”  
Jane, Chinese architect

ENGLISH OUT THERE

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Exercise for you to do

Format Paint that formatting to 2015 and 2016...does it work properly?

- Now, select only Tables...does the formatting stay?
- Select only Rugs...does the formatting stay?

Yes and Yes!!

- Choose only 2014 or 2015 or 2016...what happens? Does the formatting stay?
- Deselect Products from the PT entirely and then put it back: does the conditional formatting stay? NO! Be careful!!

There is more to conditional formatting but we have whetted your appetite without a doubt.

Why not go back to the Dashboarding chapter and experiment with conditional formatting there too?

There you can consider working with:

- Data Bars
- Icon Sets
- Colour Scales and
- The many options available.

## 4.5 Pivot Charts

Pivot Charts come from Pivot Tables and we start with a warning: big and complex PTs provide you with awful Pivot Charts (PCs)!

Using the **simple list\_3\_pivot** tab, let's create some PCs

- With Amount as VALUES
- Region and Sales type as ROWS
- County as FILTER
  
- Click on the PT
- Pivot Table Tools...Analyse...Tools ...Pivot Chart
- We have chosen a column chart

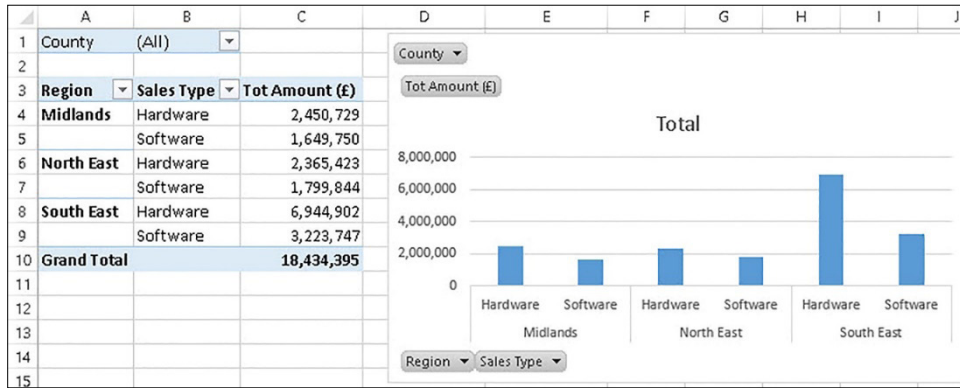


Figure 12 Basic Pivot Chart

Simple PT, simple PC!

Exercise for you to do

Keeping that PC add two more Fields to the PC...Month and Sales Person: see Figure 13, for example:

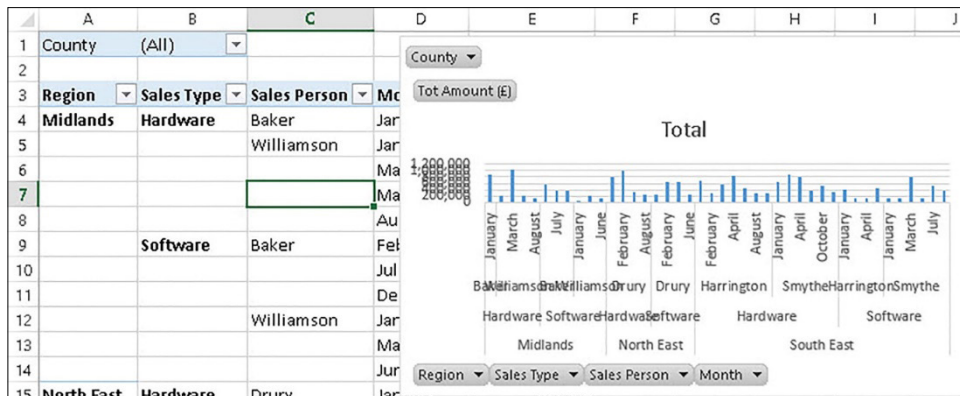
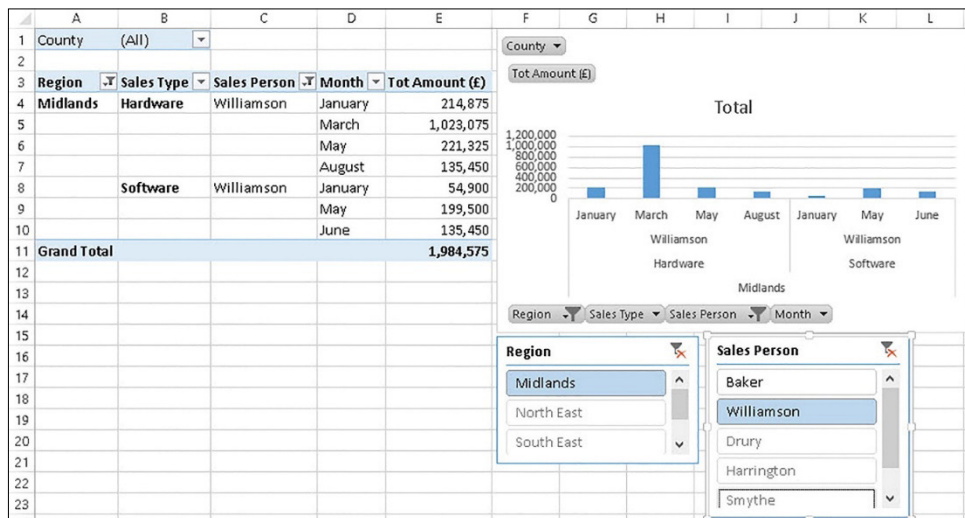


Figure 13 An Over Burdened Pivot Chart

Hmm! Not so smart! This is a relatively small database with relatively few variables in it.

You should consider using Slicers here to help you with this PC...like Figure 14:



**Figure 14** Use one or more Slicers to help to Create Pivot Charts

That's a lot better isn't it!

- Your PC is manageable
- Your PC is not so cluttered
- Your Slicers are clear and small so they fit nicely into the available window space

PCs can be awkward as we have demonstrated so test them carefully and please notice, not all chart types can be used with PTs: Excel tells you what you can and cannot use when you click on the selection of chart.

## Conclusions

Whilst there is still some more work you might do with the dashboarding chapter, we have now completed our three chapter run through of Pivot Tables. We have given you many insights and experiences and if you have done the exercises AND applied the ideas to your own data, you will now be a true and full convert to Pivot Tables if you weren't before.

We are sure you can see PTs can help with data sorting, analysis, management, mathematics and statistics and data communication.

PTs really are the accountant's best spreadsheeting friend!

## Excel Files Available

All of the Excel files mentioned in this book can be found on this book's page at:

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# 5 Forecasting

## Introduction

In this chapter we will work on two distinct aspects of forecasting: on the one hand we will look at how we can create forecast, for example, for receipts from debtors, for electricity costs and other operating costs; we will also discuss how we might create forecasts for revenues. On the other hand we will discuss mathematical/statistical approaches to forecasting, especially time series analysis.

Some of the examples we use in the chapter will follow the pattern of other chapters and be relatively straightforward; but some examples will be a little more complex because the techniques are more complex whether we like it or not!

## 5.1 Forecasting Costs

Here is a very simple question: how can we **forecast**, for example, electricity costs and labour costs for next year? One answer is to draw a graph of the last few years' costs and create a forecast using Excel's **Trendline** function or by using the **Data Analysis ToolPak** utility in some way. We will look at that later but for now let's look at a more realistic and scientific way: in fact, what we are about to do is what accountants all over the world are doing day after day.

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Forecasting electricity costs:

If we are dealing with the electricity costs of running an office, we can probably create a forecast really easily by taking last year’s budget, finding out what next year’s **cost per unit** and **standing charges** will be and making any changes...Like Figure 1:

	A	B	C	D	E	F	G
1	Forecasting						
2							
3	Forecasting Electricity Costs: basic example						
4							
5	Inputs						
6	Monthly Standing Charge	250					
7	Unit Cost	0.125					
8	Calculations						
9		Period	Units Used	Standing Charge	Variable Costs	Forecast Total Cost	
10		Jan	153	250	19.125	269.125	
11		Feb	268	250	33.500	283.500	
12		Mar	240	250	30.000	280.000	
13		Apr	203	250	25.375	275.375	
14		May	381	250	47.625	297.625	
15		Jun	140	250	17.500	267.500	
16		Jul	483	250	60.375	310.375	
17		Aug	190	250	23.750	273.750	
18		Sep	256	250	32.000	282.000	
19		Oct	323	250	40.375	290.375	
20		Nov	352	250	44.000	294.000	
21		Dec	494	250	61.750	311.750	
22			3,483			3,435.375	

Figure 1 Basic Electricity Cost Forecast a

- All we have done here is to set up an input section to house the monthly standing charge, cell B6 and the unit cost in cell B7
- The calculation area shows the **forecast number of units per month**, shows two columns, standing charge and unit cost multiplied by the number of units forecast to be used, to give the total Variable Costs then in column G we add both costs together to find the Forecast total Cost.
- See the file *forecast.xlsx* **basic** tab for this example. Let’s develop that example now, Figure 2 shows us what we might do to make this example a little more realistic

	A	B	C	D	E	F	G
1	Forecasting						
2							
3	Forecasting Electricity Costs: basic example						
4							
5	Inputs						
6	Monthly Standing Charge	250					
7	Unit Cost	0.125					
8							
9		Machine Number and Units		Calculations			
10	Period	1	2	Period	Units Used	Forecast Cost	
11	Jan	242	186	Jan	428	303.500	
12	Feb	148	141	Feb	289	286.125	
13	Mar	119	103	Mar	222	277.750	
14	Apr	134	238	Apr	372	296.500	
15	May	85	191	May	276	284.500	
16	Jun	60	104	Jun	164	270.500	
17	Jul	180	211	Jul	391	298.875	
18	Aug	148	77	Aug	225	278.125	
19	Sep	182	68	Sep	250	281.250	
20	Oct	190	248	Oct	438	304.750	
21	Nov	220	199	Nov	419	302.375	
22	Dec	129	249	Dec	378	297.250	
23				Totals	3852	3,481.500	

Figure 2 Basic Electricity Cost Forecast b

- What we have done here is to separate out the two machines that we now know the company uses and rather than create entire columns for the **Standing Charge** and **Unit Costs**, we have changed the formula in column G to read as follows,
- $G11 = \$B\$6 + F11 * \$B\$7$ ...this links the formula to cells B6 and B7 as you can see, the input cells.
- **Please note:** if you want to draw a graph of the costs, you should consider putting the Standing Charge and Unit cost Columns back
- See the file *forecast.xlsx* **basic (2)** tab for this example. Let's take things one step further to see how else we might develop a model such as this, see Figure 2:

	A	B	C	D	E	F	G	H	I	J
1	Forecasting									
2										
3	Forecasting Electricity Costs: basic example c									
4										
5	Inputs									
6	Monthly Standing Charge		250							
7	Unit Cost		0.125							
8								Calculations		
9										
10	Period							Period	Units Used	Forecast Cost
11	Jan							Jan	379.6	297.450
12	Feb							Feb	290.5	278.813
13	Mar							Mar	501.9	312.738
14	Apr							Apr	454	306.750
15	May							May	309.9	288.738
16	Jun							Jun	200.4	275.050
17	Jul							Jul	210.4	276.300
18	Aug							Aug	342.8	292.850
19	Sep							Sep	177.2	272.150
20	Oct							Oct	809	351.125
21	Nov							Nov	602.3	325.288
22	Dec							Dec	717.3	339.663
23								Totals	4935.3	3,616.913

Figure 3 Basic Electricity Cost Forecast c

- What we have done now, *forecast.xlsx* file **basic (3)** tab is to split out the power input needs of each machine and then find how many units of output there are planned for the coming periods: the calculations table then shows the **kWh inputs** \* the **units of output** to give the Units Used (electricity) and finally the total monthly forecast cost of electricity.
- **Notes:** 1 You could take this example one or two more stages further by further analysing the inputs and outputs in any way you feel is appropriate but for now, that will do for this example.
- 2 The units used and the variable costs have changed from **basic** tab to **basic (2)** tab to **basic (3)** tab: this simulates what might happen as you obtain more and more detailed information about the systems and processes you are modelling.

5.1.1 Income Statement Forecasts

In this example we are given some basic inputs for an organisation, see Figure 4. You are shown the completed basic Income Statement Schedule too and you should aim to prepare that statement.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Income Statement Forecast													
2														
3	Inputs													
4	annual demand	4,000												
5	annual capacity level	3,500												
6	initial building cost: per unit of output	10												
7	unit price	12												
8	unit prod cost	2												
9	No of years	10												
10														
11			Income Statement for years 1 to 10	Total	1	2	3	4	5	6	7	8	9	10
12			Revenue	420,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000
13			Fixed Costs	31,000	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100
14			Variable Costs	70,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000
15			profit	319,000	31,900	31,900	31,900	31,900	31,900	31,900	31,900	31,900	31,900	31,900

Figure 4 Basic Income Statement Forecast

This is a forecast: not a budget, which will come later.

Phase One

For phase one of this forecast, you are told the **maximum annual demand** as well as the **annual capacity level**: cells A4:B5 and you must program the Revenue row in the income statement forecast to deal with the difference between them. Your formula here must be able to cope with changes to the demand and capacity as management makes changes or suggests changes to these figures.

You can also see that there is some building work to be done, which is a **capital expenditure item**. However, that building needs to be **depreciated** over the life of the project or department or asset: 10 years. We have programmed the **straight line depreciation calculations** based on a **scrap value** of £4,000 receivable at the end of the project.

That is the end of Phase One and your forecast should look like the one in Figure 4, above. All of this is in the *forecast.xlsx* file, **income (1)** tab.

Phase Two

For phase two there are additional items to take into account: having considered your Phase One forecasts, the directors have asked you to take the following into account.

- There will be additional building work worth £5,000 in Year 3 with a scrap value of £1,000 and further building work worth £7,500 with a scrap value of £2,000 in year 7
- Partly as a result of the building enhancements, the directors believe that the annual capacity will grow at the following rates in the following years shown in Table 1 below:

Year	Growth (%)
3	5
4	5
8	10
9	10
10	5

**Table 1** Capacity Growth Rates

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Prepare your revised Income Statement Forecast in the light of this new information. It might look like this: *forecast.xlsx* file **income (2)** tab, Figure 5 below:

	C	D	E	F	G	H	I	J	K	L	M	N	O
11	<b>Income Statement for years 1 to 10</b>	<b>Total</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	
12	Revenue	456,900	42,000	42,000	44,100	46,200	46,200	46,200	46,200	48,000	48,000	48,000	
13	Fixed Costs	40,500	3,100	3,100	3,600	3,600	3,600	3,600	4,975	4,975	4,975	4,975	
14	Variable Costs	70,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	
15	<b>profit</b>	<b>346,400</b>	<b>31,900</b>	<b>31,900</b>	<b>33,500</b>	<b>35,600</b>	<b>35,600</b>	<b>35,600</b>	<b>34,225</b>	<b>36,025</b>	<b>36,025</b>	<b>36,025</b>	
16													
17	building cost		35000		5,000				7,500				
18	scap value of buildings		4000		1,000				2,000				
19	depreciable value of building		<b>31,000</b>		<b>4,000</b>				<b>5,500</b>				
20													
21	<b>building account</b>		35,000	31,900	33,800	30,200	26,600	23,000	26,900	21,925	16,950	11,975	
22	depreciation		3100	3100	3,600	3,600	3,600	3,600	4,975	4,975	4,975	4,975	
23	balance c/d		<b>31,900</b>	<b>28,800</b>	<b>30,200</b>	<b>26,600</b>	<b>23,000</b>	<b>19,400</b>	<b>21,925</b>	<b>16,950</b>	<b>11,975</b>	<b>7,000</b>	OK
24													
25	annual capacity level		3,500	3,500	3,675	3,850	3,850	3,850	3,850	4,200	4,550	4,725	
26	growth in annual capacity		0	0	0.05	0.05	0	0	0	0.1	0.1	0.05	
27	cumulative growth in annual capacity		0	0	0.05	0.1	0.1	0.1	0.1	0.2	0.3	0.35	

**Figure 5** Revised Income Statement Forecast

At this stage the company has now explored additional options and what it can see is that it has overcome the shortfall in capacity by increasing it from 3,500 units to 4,725 units but that from periods 8 to 10, they are suffering from over capacity. Well, the directors now ask the marketing department to reassess their annual demand constraint or to scale down their investment in year 7.

We could work through many examples such as the ones we have just prepared and create many forecasts for an organisation or activity. However, let's move on to a different type of forecasting now, statistical forecasting. Strictly speaking we will be dealing with time series forecasting.

## 5.2 Statistical Forecasting

Let's start this section by looking at four different graphs so that we can understand the principles behind **statistical forecasting**: Figures 6 to 9, below. We have chosen these four graphs from Professor Wayne Winston's excellent online forecasting course which can be found on [www.lynda.com](http://www.lynda.com). By **time series** we mean data that change over time. Good examples of time series data include populations, sales data are often presented as time series data, growth in such services are air miles travelled and many more.

In this section we will consider four different data series and highlight a few features of time series data. The data and graphs are all found in the *time\_series.xlsx* file **time\_series** tab.

In Figure 6 we see the runs scored by the New York Yankees from 1993 to 2013. In this graph we see the number of runs scored on the vertical axis against the years or seasons on the horizontal axis. This is just about one of the simplest data series we could imagine as it is relatively flat with nothing particularly exceptional to say about it. The line goes up, down and along and on average it's a fairly flat line or curve.

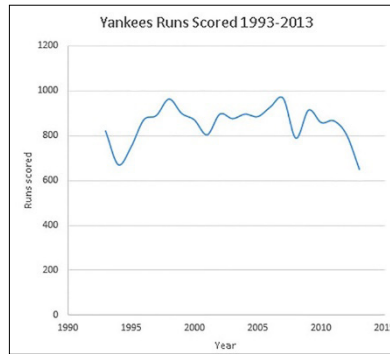


Figure 6 Basic Time Series

As a matter of interest, you will not find the table of data on which Figure 6 is based in the *time\_series.xlsx* file, nor for Figures 7 to 9 either. However, open the file, go to the **time\_series** tab and then click on the curve on the Yankees graph then look in the formula bar where you will see this:

```
=SERIES("Runs",{2013,2012,2011,2010,2009,2008,2007,2006,2005,2004,2003,2002,2001,2000,1999,
1998,1997,1996,1995,1994,1993},{650,804,867,859,915,789,968,930,886,897,877,897,804,871,900,965,
891,871,749,670,821},1)
```

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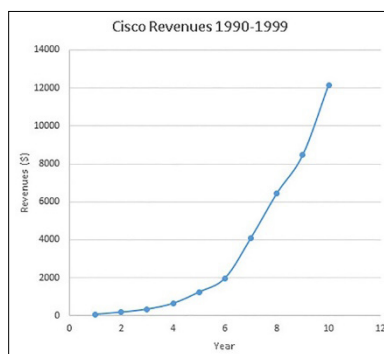
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This means that you can take any data series and enter it directly into your graph without cluttering your work sheet! Take a look at the other data series on the other charts too.

Instead of creating the table of data, Professor Winston has entered the data as you see here: everything is contained in the graph itself

In the following graph, Figure 7, we see the sales revenues of Cisco Systems Inc over a nine year period: what is interesting about this data series is that Cisco's sales are not only growing from year to year but that they are growing **exponentially**. This means that the trend in sales are **growing at a constant percentage** but since such growth is compounded we see the very steep curve rather than the fairly flat curve in Figure 8



**Figure 7** Exponential Growth

Figure 8 shows the quarterly sales data for amazon.com from 1995 to 2012. On the face of it, the amazon data looks to behave in a similar way to that of Cisco Systems. However, the major difference is that we are dealing here with quarterly data, not annual; and we can see that amazon's data are **seasonal data**: that is, sales for quarter one are lower than sales in quarter two which are lower than quarter three and the sales in quarter four are the highest of all. That seasonality pattern is repeated year after year for amazon.com. In 2014, the quarterly sales data for amazon.com were

Q1 = \$19.7 bn

Q2 = \$19.3 bn

Q3 = \$20.6 bn

Q4 = \$29.3 bn

We can conclude by saying that amazon.com's sales are seasonal and their trend is upwards, increasing.

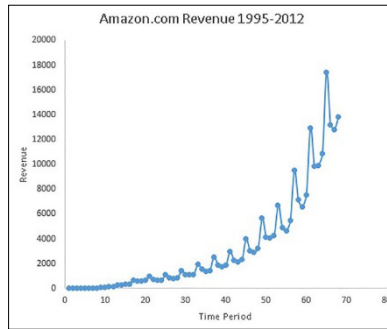


Figure 8 Seasonal Growth

Finally, in this introduction, we see the monthly total airline air miles for the USA over the period 1994 to 2003. Again we see **seasonality** albeit on a monthly rather than a quarterly basis, the trend is not so steep and there is a **discontinuity** in the data towards the end of 2001.

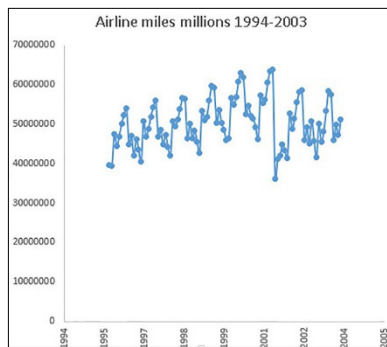


Figure 9 Seasonality with a Discontinuity

5.2.1 amazon.com: seasonality with data

The file *time\_series.xlsx* **amzn** tab contains the data on which Figure 8 is based. Moreover, we have added five more quarters’ worth of data to the data series to enhance the quarterly and trend behaviour of amazon.com’s sales record.

The purpose of sharing this work sheet with you is for you to see the data in a table and then to see the direct link between the data and their seasonality. Otherwise, the graph on that tab is a basic XY Scatter graph.

5.2.2 Noise in Time Series Data

Refer back to the work we have already done on **Trendlines** and **regression analysis** to see how Excel can be used to place a trendline on a graph. When we apply a trendline to a graph we can see the noise inherent in a series of data. Let’s go back to the Figure 6 and see what noise is inherent in the Yankees’ runs data. See Figure 10, below.

**Noise comprises random fluctuations in a time series data set.** We can summarise the noise as the differences between any actual data point and the corresponding value on the trendline at that point. For example, the trendline gives us the linear equation of  $y = 0.3026x + 848.15$  which we apply as shown in the following table, Table 2. In that table we see the first five actual scores, followed by the predictions based on the Trendline equation which in turn is followed by the residuals or noise. Some of the noise is pronounced!

Year	Actual	Prediction	Residual (Noise)
1	821.00	848.45	(27.45)
2	670.00	848.76	(178.76)
3	749.00	849.06	(100.06)
4	871.00	849.36	21.64
5	891.00	849.66	41.34

**Table 2** Yankees Runs Trendline and Noise

These data are shown on the **time\_series\_trendline** tab of the *time\_series.xlsx* file. There is the Cisco Systems example there too but in that case we are using an **exponential trendline** rather than a linear one. In the Cisco case the noise is almost non existent until years 8, 9 and 10 which suggests that the exponential model has been good but that it might be breaking down now. See Table 3 below for the full exploration of noise there:

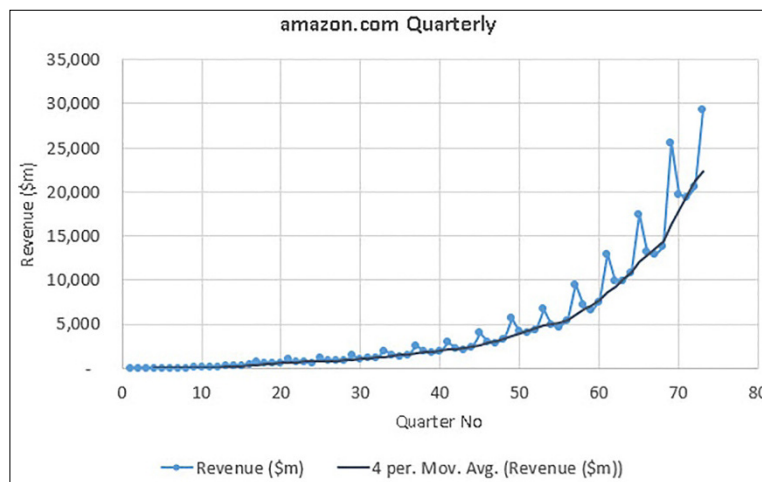


Year	Actual	Prediction	Residual (Noise)
1	70.00	103.48	(33.48)
2	183.00	182.86	0.14
3	340.00	323.16	16.84
4	649.00	571.08	77.92
5	1,243.00	1,009.22	233.78
6	1,979.00	1,783.50	195.50
7	4,096.00	3,151.81	944.19
8	6,440.00	5,569.90	870.10
9	8,459.00	9,843.16	(1,384.16)
10	12,154.00	17,394.90	(5,240.90)

**Table 3** Cisco Exponential Trendline: Noise

### 5.2.3 Moving Averages

We can use Excel’s built in **Moving Average Trendline** now to explore the amazon.com quarterly data that we referred to above. When we create the moving average trendline, what we see is the **deseasonalised** sales line which enables us to appreciate the overall trend in the growth of sales at amazon without the distraction of the **fourth quarter bubble** that amazon experiences. Look at Figure 10 where you can see the four quarter moving average trendline for amazon.com:



**Figure 10** amazon.com 4 Quarter Moving Average

What we see here is the four quarter moving average where the horizontal axis is based on quarter numbers. The moving average curve is relatively smooth as it has effectively taken out the seasonal behaviour of amazon.com’s sales data.

### 5.2.4 Bias in Forecasts

We need to consider the possibility of bias in any forecasts that we do and in terms of the work we are doing here we can assess bias in this way.

**Bias** is not the same as accuracy: bias relates to the systematic over or under stating of forecasts.

In the *time\_series.xlsx* file, **time\_series\_trendline** tab, we have set up the bias test for the sample of just five data points for the Yankees example and all ten data points for Cisco Systems. This test involves finding the value of actual/prediction-1 for each data point and then completing the following, Table 4:

Bias Test Yankees	mean	-0.057
	standard deviation	0.107
	Lower 95% CI	-0.153
	Upper 95% CI	0.038
	Conclusion	There is no bias

**Table 4** Yankees Example Bias Test

We find the average of the actual/prediction-1 values and then their standard deviation.

Using these values we find the lower and upper 95% confidence intervals which are found this way:

$$= \text{mean} \pm 2 * \text{standard deviation} / \text{square root of } n$$

Where n is the number of observations used: five in the case of the Yankees and 10 in the base of Cisco.

The conclusion is then drawn by checking to see if the lower to upper confidence interval range includes zero. In the Yankees example the lower CI boundary is -0.153 and the upper boundary CI is 0.038 so we can see that zero is in that range. Therefore we conclude that these forecasts are not biased.

With Cisco, the equivalent values are: the lower CI boundary is -0.11 and the upper boundary CI is 0.214 so we can see that zero is in that range. Therefore we conclude that these forecasts are not biased.

### 5.2.5 Standard Error of the Regression and Outliers

One crucial aspect of any work in the area of forecasting is to know the consistency of data: we need to check for **outliers**. An outlier is any value more than two standard errors away from the trendline. Again in the *time\_series.xlsx* file, **time\_series\_trendline** tab we have set up the **Standard Error** and Outlier test area for both the Yankees and the Cisco Systems examples.

Standard Error: we use the STEYX() function to find the standard error of the trendline. What this does is to find the standard deviation of all of the residual values that we then use as we are about to see. Look at cell F40 (Yankees) in the file and see this =STEYX(C20:C24,B20:B24) where the result is 84.92 and in cell M40 (Cisco) where the result is 1,778.20. The formulas you now need are shown here, in Table 5, below, including how to program whether the results are biased:

STEYX and Outliers

STEYX		=STEYX(C20:C24,B20:B24)
Outliers	More than 2SE from Trend	
	Residual (Noise)	Outlier?
	(27.45)	=IF(ABS(E45)>2*F\$40,"Outlier","")
	(178.76)	=IF(ABS(E46)>2*F\$40,"Outlier","")
	(100.06)	=IF(ABS(E47)>2*F\$40,"Outlier","")
	21.64	=IF(ABS(E48)>2*F\$40,"Outlier","")
	41.34	=IF(ABS(E49)>2*F\$40,"Outlier","")

Table 5 Yankees STEYX and Outliers

We have found the results for Cisco Systems that are also on this tab.

Finally in this chapter we will look at what is called **autocorrelation**.

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### 5.2.6 Autocorrelation

**Autocorrelation** is the situation in which results of our analysis are not consistent with the results we should expect. What this means is that on average, 50% of our results should be above the trendline and 50% should be below the trendline. If this is not true then the **assumptions** we make about our data or our model might not be valid. Let's evaluate our autocorrelation situation and then interpret it.

For the final time in this chapter, look at the *time\_series.xlsx* file, **time\_series\_trendline** tab again and starting in cell D56 you will see the start of the autocorrelation analysis. Please note for the Yankees and Cisco examples we have hard coded some of the data, purely for demonstration and we do not advocate doing that normally.

**Autocorrelation is concerned with sign changes:** we expect the data to be above the trendline and then below the trendline in equal measure so what we do is to find the total number of possible sign changes in the residuals, which is the total of all estimates minus one: for the Yankees that is 5 – 1.

Using the formula =IF(E58\*E59<0,1,0) in the range F59 and downwards we find the value 1 when there has been a sign change and the value 0 when there hasn't. We then compare the possible sign changes, 4, with the actual number of sign changes, 1 and using this formula decide whether there has been autocorrelation: =IF(G57<=(5-1)/2-SQRT(5-1),"Autocorrelation exists","No autocorrelation"), which is in cell G59.

What that formula is saying is if there are fewer sign changes than expected by the expression  $(5-1)/2 - \text{SQRT}(5-1)$  then the data are not changing signs enough so something is wrong. If there is autocorrelation what we are saying is that in that case the  $r^2$  value, the standard error value and the values of 'a' and 'b' in the regression equation are no longer valid and we cannot use them. The solution to this problem? Redefine your model, gather more data...

We have found the autocorrelation results for Cisco Systems that are also on this tab.

There is a further example of the calculation and interpretation of autocorrelation in the Budgeting Chapter.

### Conclusions

In this chapter we have worked through two distinct ways of preparing forecasts. The first method is called the engineering method and it takes the situation built into a process and models that. The second method was to apply time series analysis to various data sets and set out how we might use and/or rely on forecasts from there.

### Excel Files Available

All of the Excel files mentioned in this book can be found on this book's page at:

<http://bookboon.com/en/excel-solutions-for-accountants-book-3-ebook>

# 6 Budgeting

## Introduction

**Budgeting** is simple, budgeting is a farce, budgeting is so complex it's not worth bothering with. As an accountant you will have heard, or even said, all three! In this chapter, we are going to present a series of examples that will help you to create, prepare and maintain a budget. As we have said several times before in this book, however, we will not present huge, complex examples since we believe you will get lost in the examples and lose sight of the budget.

We believe our examples contain some interesting problems to solve; but whether these examples suit you perfectly or not, they contain techniques that you should find useful.

In this chapter we are going to work through five distinct budgeting exercises: two basic **production** and **purchases budgets** for a manufacturer and then an exercise that includes a **cash budget**. We then prepare a **rightsizing budget** that illustrates how an organisation might have 3,000 employees on the payroll but who are producing only, about 1,300 people's worth of work. Finally, we will look at **forecasting** as it might be linked to budgeting.

## 6.1 Definition

By a **budget** we mean a financial or quantitative **plan** prepared in advance of a **budget period**. Normally, a budget period is a year and a budget can contain values, volumes and qualitative data.

## 6.2 Budget One

### 6.2.1 Ruggy Ltd

This exercise combines a brief review of how to prepare production and purchase budgets and it does so with some **constraints** added. Table 1 is taken from the *budget.xlsx* file, **Ruggy** tab:

opening stocks	
finished goods, square metres	100,000
Raw materials, kilogrammes	400,000
<b>Sales</b> (square metres)	
August	200,000
September	180,000
October	150,000
Closing stock constraints	
Finished goods: proportion of next month's sales in stock at the end of a period	0.4
Raw materials: proportion of next month's stocks in stock at the end of a period	0.5
Raw materials, kilogrammes per unit	5.0
Cost of raw material per kilogramme (£)	1.5

**Table 1** Data for Ruggy Limited



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The closing stock constraints are the only challenging items in this schedule and this is what they mean:

**Finished goods:** the constraint of the proportion of 0.4 means that the closing stock of finished goods in stock at the end of, say, August, should be 40% of the **Sales** of September...

**Raw materials:** the constraint of the proportion of 0.5 means that the closing stock of raw materials in stock at the end of, say, August, should be 50% of the **Production** of September...

Otherwise, the Ruggy Ltd exercise is relatively straightforward and Figure 1 shows the completed budgets:

	C	D	E	F	G
19		<b>Production Budget: August and September</b>			
20		<b>Square metres</b>	<b>August</b>	<b>September</b>	<b>October</b>
21		Opening Stock	100,000	72,000	60,000
22		plus PRODUCTION	172,000	168,000	
23			272,000	240,000	
24		less Closing Stock	72,000	60,000	
25		<b>Sales</b>	<b>200,000</b>	<b>180,000</b>	<b>150,000</b>
26					
27		<b>Purchases Budget: August</b>	<b>August</b>	<b>August</b>	<b>September</b>
28			<b>£</b>	<b>kg</b>	<b>kg</b>
29		Opening Stock	600,000	400,000	420,000
30		plus PURCHASES	1,320,000	880,000	
31			1,920,000	1,280,000	
32		less Closing Stock	630,000	420,000	
33		<b>Production</b>	<b>1,290,000</b>	<b>860,000</b>	<b>840,000</b>

Figure 1 Ruggy Ltd Budgets

Explore the Ruggy Ltd solution and satisfy yourself that you can manage it with no difficulty.

The following exercise is similar to Ruggy Ltd but it contains greater programming opportunities as it is a little more complex.

### 6.3 Budget Two

#### 6.3.1 Morlin Company

The input data for Morlin Company follows, Figure 2:

	A	B	C	D	E	F
1	<b>Basic Budgets for Production and Purchases</b>					
2	<b>Morlin Company</b>					
3						
4	<b>Inputs</b>					
5	Opening stock of finished goods: units	1800				
6	Opening stock of raw materials: kg	2300				
7	Closing stock of finished goods: months sales	2	that is ... closing stock is equal to two months' sales ...			
8	Closing stock of raw materials: months production	1	that is ... closing stock is equal to one month's production ...			
9	Raw material per unit of finished goods	2				
10	Raw materials cost per kg (\$)	3				
11						
12						
13	<b>Sales</b>	<b>Units</b>				
14	January	1,000				
15	February	1,200				
16	March	1,300				
17	April	1,500				
18	May	1,400				
19	June	1,600				

Figure 2 Morlin Company Input Data

This exercise is found in the *budget.xlsx* file, **morlin** tab and it is different from Ruggy Ltd in that it is a six period budget rather than just three periods and the stock constraint is presented a little differently. In addition, there are more unknowns in terms of output cells in the case of Morlin and we have to deal with them.

In this Morlin Company Budgeting exercise you need to be able to program the following:

- =IF() statements
- =IF(OR()) statements
- =IF(AND()) statements

Format Cells to change the way a cell or a range of cells presents the value 0 (zero)

Ordinary formulas such as this one that includes absolute addressing: =D33\*\$B\$10

Figure 3 shows the solution which you should attempt before you go to the file to check our solution:

	C	D	E	F	G	H	I	J
21	<b>Solutions</b>							
22	<b>Production Budget</b>	<b>J</b>	<b>F</b>	<b>M</b>	<b>A</b>	<b>M</b>	<b>J</b>	
23	Opening Stock	1,800	2,500	2,800	2,900	3,000	?	
24	Production*	1,700	1,500	1,400	1,600	?	?	
25		3,500	4,000	4,200	4,500	1,400	1,600	
26	Closing Stock(*)	2,500	2,800	2,900	3,000	?	?	
27	Sales	1,000	1,200	1,300	1,500	1,400	1,600	
28								
29	* = Sales + Closing Stock - Opening Stock							
30	(*) = Sales for the next month plus for the month following that							
31								
32	<b>Purchases Budget Units</b>	<b>J</b>	<b>F</b>	<b>M</b>	<b>A</b>	<b>M</b>	<b>J</b>	
33	Opening Stock	2,300	3,000	2,800	3,200	?	?	
34	Purchases*	4,100	2,800	3,200	?	?	?	
35	Raw materials available for use	6,400	5,800	6,000	3,200	?	?	
36	Closing Stock(*)	3,000	2,800	3,200	?	?	?	
37	Production	3,400	3,000	2,800	3,200	?	?	
38								
39	* = Production + Closing Stock - Opening Stock							
40	(*) = Production units from the production budget * 2 ... 2 kg of raw material per unit of finished goods							
41								
42	<b>Purchase Budget Values</b>	<b>J</b>	<b>F</b>	<b>M</b>	<b>A</b>	<b>M</b>	<b>J</b>	
43	Opening Stock	6,900	9,000	8,400	9,600	?	?	
44	Purchases	12,300	8,400	9,600	?	?	?	
45		19,200	17,400	18,000	9,600	?	?	
46	Closing Stock	9,000	8,400	9,600	?	?	?	
47	Production	10,200	9,000	8,400	9,600	?	?	

Figure 3 Morlin Company Budgets Solution

Let's just highlight the challenging aspects of this exercise:

Firstly, we have set out the logic of the Sales and Production calculations in cells C29:C30 and C39:C40 respectively.

We meet an IF(OR()) statement in cell D24, Production calculation:

$$=IF(OR(D23=0,D25-D23<0),0,D25-D23)$$

You should study this formula and work out what it does before filling it across.

We meet IF(AND()) in cell D26, closing stock of Finished Goods:

```
=IF(AND(E27>0,F27>0),E27+F27,0)
```

You should also study this formula and work out what it does before filling it across.

We first meet an ordinary IF() statement in cell D36, closing Stock of Units to buy:

```
=IF(E37>0,E37,0)
```

The rest of the formulas we used are very basic but check them just in case.

Finally, where you see a “?” in any of the budgets, you will find we have used Right Click...Format Cell in this way: for example, cells I23, H24:I24 and H26:I26:

```
#,##0;[Red]-#,##0;”?”
```

Yet again, work out what we have done and then use it again in the other two budgets. What we did here was to say that wherever there is a zero in a budget we wanted to show ? to highlight the fact that it meant, in this case, we are missing data...this is an optional requirement here but we think you might use it somewhere if not here.

## 6.4 Budget Three

### 6.4.1 Dacre Company

This is essentially a **cash budgeting case study**: read the facts of the case and then consider the requirements and our commentary on them. The focus of this case is manufacturing but that is not entirely relevant: it is the inter relationships and formulations that are important.

Dacre Ltd manufactures a single product. It is preparing monthly budgets for the six months from July to December 2016. The following standard revenue and cost data is available:

- Selling price £12.00 per unit
- Materials 2 kg per unit at £2.40 per kg
- Labour £1.80 per unit
- Direct expenses £1.20 per unit

Sales in June 2016 and July 2016 are forecast to be 10,000 units in each month. As a direct result of marketing expenditure of £95,000 in August 2016, sales are expected to be 11,000 units in August 2016 and to increase by 1,000 units in each month from September to December. Sales after December 2016 are expected to remain at the December 2016 level.

25% of sales are paid for when they are made and 75% of sales are paid for in the month following sale. Stocks of finished goods at the end of each month are required to be 20% of the expected sales for the following month. Stocks of materials at the end of each month are required to be 50% of the materials required for the following month's production.

Materials are paid for in the month following purchase. Labour and direct expenses are paid for in the month in which they occur. Overheads for production, administration and distribution will be £34,000 per month, including depreciation of £12,000 per month. These overheads are payable in the month in which they occur. Dacre Ltd has a £750,000 bank loan at 8% per annum on which it pays interest twice per year, in March and September: it is a **balloon loan** so there is no capital repayment at any time in this budget case.

The cash balance at the end of June 2016 is expected to be £50,000.



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## Required

- a) Prepare the following budgets for Dacre Ltd on a month by month basis for the six month period from July to December 2016:
- production budget (units);
  - cash budget

## Dacre Commentary

Dacre Ltd is a relatively complex exercise in that it combines sales and production, as with Ruggy and Morlin; but it also contains sub calculations of receipts from debtors, payments to creditors, expense creditors, interest calculations, a one off marketing payment and several examples in which one budget inter relates with another one, like sales and production, debtors and cash.

There are no complex formulas in this example and there are no complex functions in use either.

Whilst this is a theoretical case, you should be working through it with an eye to your own cash budget and so on: think PPP too. The key to working with such examples is to be systematic and aim, as always, to prepare a template for your current work and your future work.

To save space in this book, there are no figures or tables to follow that relate to this exercise so go to the *budget.xlsx* file, **dacre** tab and work your way down the Input section and then the output, solutions or budget section.

## 6.5 Budget Four

### 6.5.1 Departmental and Organisational Budget

The purpose of this exercise is for you to consider what to include and how to present a departmental and organisational budget. The data are basically straightforward as we have kept the scenario simple. However, the solutions can be large and complex. We say, can be; but they don't have to be!

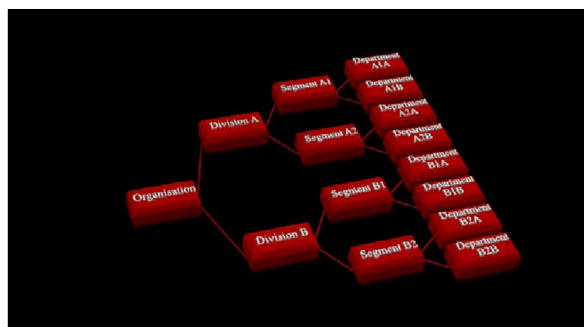


Figure 4 Organigram

Figure 4 gives you an idea of the organisational structure of our organisation and therefore a clue as to the ways in which their budgets might be set up.

The data for this case are as follows, Figure 5:

	A	B	C	D	E
1	<b>Departmental, Segment and Organisational Budgets</b>				
2					
3	<b>Inputs</b>				
4	<b>Price (£ per unit)</b>	<b>Jan</b>	<b>Feb</b>	<b>March</b>	
5	A1A	50	50	53	
6	A1B	47	47	47	
7	A2A	50	50	53	
8	A2B	43	44	44	
9	B1A	150	150	150	
10	B1B	375	350	340	
11	B2A	5	5	4	
12	B2B	7	9	6	
13	<b>Units</b>	<b>Jan</b>	<b>Feb</b>	<b>March</b>	
14	A1A	6,823	7,959	6,058	
15	A1B	735	539	806	
16	A2A	8,325	10,461	8,112	
17	A2B	5,966	3,866	4,973	
18	B1A	625	909	725	
19	B1B	986	615	558	
20	B2A	27,210	21,647	35,175	
21	B2B	34,043	31,154	37,810	
22					
23	<b>Cost of Sales</b>	<b>FC</b>	<b>VC</b>		
24	Segment A	500	0.9500		
25	Segment B	80,000	0.2200		
26	S&GA			100000	

**Figure 5** Input Data

Figure 5 sets out selling prices and sales quantities for three months together with total fixed cost of sales, variable cost of sales for segments A and B. Figure 5 also shows you the S&GA expenses in total. What you are required to do in this case is as follows:

**Prepare** Department Budgets according to the organigram, Figure 4, for  
 each department  
 each segment  
 each division  
 the whole organisation  
 Each department trades in one product only, with no variations

Cost of Sales Illustration

Segment A: January to March  $500 + 0.95 \times \text{Total Sales Value}$

Segment B: January to March  $80,000 + 0.220 \times \text{Total Sales Value}$

S&GA of \$100,000 per month are shared according to sales units

**Illustrate** the gross and net profit margins for each month for each department, segment, division and for the organisation as a whole

## Commentary on the case

In this case you could use the following functions

- VLOOKUP()
- IF()
- RIGHT()
- SUM()
- Some of these functions could be nested one within an other.

In addition there are arithmetic calculations to do, percentages to format.

Equally importantly, the solution you will find in the *budget.xlsx* file **dept\_org** tab reflects and follows the organigram in Figure 4 above. As before, since the solution is large, we have condensed its layout somewhat but it does follow the layout of figure 4.

The layout of the work sheet is in our usual cascade style:



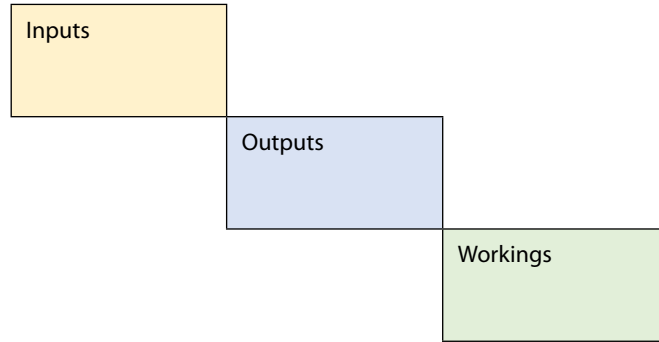
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**Table 2** Overall Worksheet Cascade Style Layout

The emphasis of the exercise is that it is a cash budgeting question: it is a short but excellent exercise in following a pattern whilst at the same time adding value to the budgeting process.

You could extend the **dept\_org** tab, of course, by adding graphs and Sparklines and so on if you think it's appropriate: we did not do that, however.

Here are three screenshots of our final solution, figures 6, 7 and 8: these screenshots will give you an impression of the work to be done but for greater clarity, open the *budget.xlsx* file!

	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
27	Budgets													
28			2	3	4									
29			Department A1 A			Department A1 B			Department A2 A			Department A2 B		
30			January	February	March	January	February	March	January	February	March	January	February	March
31	Sales	Units	6,823	7,959	6,058	735	539	806	8,325	10,461	8,112	5,966	3,866	4,373
32		£ per Unit	50	58	59	47	47	47	58	58	53	63	46	44
33		Total Sales	341,150.00	397,950.00	321,074.00	34,545.00	25,333.00	37,882.00	416,250.00	523,050.00	429,936.00	256,538.00	170,104.00	218,812.00
34		Cost of Sales	324,592.50	378,552.50	305,520.30	33,317.75	24,588.35	36,487.90	395,937.50	497,397.50	408,933.20	244,211.10	162,098.80	208,371.40
35		Gross Profit	16,557.50	19,397.50	15,553.70	1,227.25	766.65	1,394.10	20,312.50	25,652.50	20,998.80	12,326.90	8,005.20	10,440.60
36		S&GA	2,664.40	3,108.01	2,385.67	287.02	210.48	314.75	3,250.94	4,085.05	3,167.76	2,329.74	1,503.68	1,941.97
37		Net Profit	13,893.10	16,289.49	13,168.03	940.23	556.17	1,079.35	17,061.56	21,567.45	17,823.04	9,997.16	6,495.52	8,498.63
38		Gross Profit Margin	4.85%	4.87%	4.84%	3.55%	3.03%	3.68%	4.88%	4.90%	4.88%	4.81%	4.71%	4.77%
39		Net Profit Margin	4.07%	4.05%	4.16%	2.72%	2.20%	2.65%	4.10%	4.12%	4.15%	3.90%	3.62%	3.88%
40														
41			Department B1 A			Department B1 B			Department B2 A			Department B2 B		
42			January	February	March	January	February	March	January	February	March	January	February	March
43	Sales	Units	625	909	725	988	615	558	27,210	21,847	35,175	34,043	31,154	37,810
44		£ per Unit	350	358	350	375	358	340	£	£	4	7	8	6
45		Total Sales	93,750.00	136,350.00	108,750.00	369,750.00	215,250.00	189,720.00	136,050.00	108,235.00	140,700.00	238,301.00	280,386.00	226,860.00
46		Cost of Sales	100,625.00	109,937.00	103,325.00	161,345.00	127,355.00	121,738.40	109,931.00	103,811.70	110,954.00	132,426.22	141,884.32	129,303.20
47		Gross Profit	(6,875.00)	26,353.00	4,825.00	208,405.00	87,895.00	67,981.60	26,119.00	4,423.30	29,746.00	105,874.78	138,701.08	96,556.80
48		S&GA	244.06	354.97	283.11	385.04	240.16	217.90	10,625.59	8,453.22	13,735.94	13,293.89	12,165.73	14,764.92
49		Net Profit	(7,119.06)	25,998.03	4,541.89	208,019.96	87,654.84	67,763.70	15,493.41	(4,029.92)	16,010.06	92,580.89	126,535.35	82,186.88
50		Gross Profit Margin	-7.33%	19.33%	4.46%	56.36%	40.63%	35.83%	19.20%	4.09%	21.14%	44.43%	49.47%	42.74%
51		Net Profit Margin	-7.53%	19.07%	4.16%	56.26%	40.72%	35.72%	11.93%	-3.72%	11.98%	38.65%	45.12%	36.23%
52														

**Figure 6** Departmental Budgets

Strictly speaking all of these departmental budgets should be on the same level rather than Department A above Department B but this layout makes it easier to follow here.

		Segment A1				Segment A2				
		January	February	March	Quarter	January	February	March	Quarter	
54										
55	Sales	Units	7,558	8,498	8,864	22,920	14,291	14,327	13,085	41,703
56		£ per Unit								
57	Total Sales		375,695.00	423,283.00	359,356.00	1,157,334.00	672,788.00	693,154.00	648,748.00	2,014,690.00
58	Cost of Sales		357,910.25	403,118.85	342,008.20	1,103,037.30	640,148.60	659,436.30	617,310.60	1,916,955.50
59	Gross Profit		17,784.75	20,164.15	16,947.80	54,896.70	32,639.40	33,657.70	31,437.40	97,734.50
60	S&GA		2,951.42	3,318.49	2,680.41	8,950.33	5,580.68	5,594.74	5,109.73	16,285.15
61	Net Profit		14,833.33	16,845.66	14,267.39	45,946.37	27,058.72	28,062.96	26,327.67	81,443.35
62	Gross Profit Margin		4.73%	4.76%	4.72%	4.74%	4.85%	4.86%	4.85%	4.85%
63	Net Profit Margin		3.95%	3.98%	3.97%	3.97%	4.02%	4.05%	4.08%	4.04%
64										
65										
66										
67										
68	Sales	Units	1,611	1,524	1,283	4,418	61,253	52,801	72,985	187,039
69		£ per Unit								
70	Total Sales		463,500.00	351,600.00	298,470.00	1,113,570.00	374,351.00	388,621.00	367,560.00	1,130,532.00
71	Cost of Sales		261,970.00	237,352.00	225,863.40	724,985.40	242,357.22	245,436.62	240,863.20	728,717.04
72	Gross Profit		201,530.00	114,248.00	72,606.60	388,584.60	131,993.78	143,124.38	126,696.80	401,814.96
73	S&GA		623.10	595.13	501.02	1,725.24	23,919.48	20,616.95	28,500.86	73,033.28
74	Net Profit		200,906.90	113,652.87	72,105.58	386,859.36	108,074.30	122,507.43	98,195.94	326,775.68
75	Gross Profit Margin		43.48%	32.43%	24.33%	34.36%	35.28%	36.83%	34.47%	35.94%
76	Net Profit Margin		43.34%	32.32%	24.23%	34.74%	28.87%	31.52%	26.72%	29.08%
77										
78										
79										
80	Sales	Units	21,849	22,825	19,949	64,623	62,864	54,325	74,268	191,457
81		£ per Unit								
82	Total Sales		1,048,483.00	1,116,437.00	1,007,704.00	3,172,624.00	837,851.00	740,221.00	668,030.00	2,244,102.00
83	Cost of Sales		990,058.85	1,062,815.15	959,318.80	3,019,992.80	504,327.22	482,848.62	466,526.60	1,453,702.44
84	Gross Profit		50,424.15	53,621.85	48,385.20	152,631.20	333,523.78	257,372.38	199,503.40	790,399.56
85	S&GA		8,532.10	8,913.23	7,790.14	25,235.47	24,548.58	21,214.07	23,001.87	74,764.53
86	Net Profit		41,892.05	44,708.62	40,595.06	127,395.73	308,975.20	236,158.31	170,501.53	715,635.03
87	Gross Profit Margin		4.81%	4.82%	4.80%	4.81%	38.61%	34.77%	29.55%	35.22%
88	Net Profit Margin		4.00%	4.02%	4.03%	4.02%	36.88%	31.90%	25.60%	31.89%

Figure 7 Segmental Budgets

The same comment applies here as it does to the departmental budgets: they should really all be on the same level rather than Segment A above Segment B. Divisions A and B are in the right place, however.

		Organisation				
		January	February	March	Quarter	
90						
91	Sales	Units	84,713	77,150	94,217	256,080
92		£ per Unit				
93	Total Sales		1,886,334.00	1,856,658.00	1,673,734.00	5,416,726.00
94	Cost of Sales		1,502,386.07	1,545,463.77	1,425,845.40	4,473,695.24
95	Gross Profit		383,947.93	311,194.23	247,888.60	943,030.76
96	S&GA		33,080.68	30,127.30	36,732.02	100,000.00
97	Net Profit		350,867.25	281,066.93	211,096.58	843,030.76
98	Gross Profit Margin		20.35%	16.76%	14.81%	17.41%
99	Net Profit Margin		18.60%	15.14%	12.61%	15.56%
100						

Figure 8 Organisation Budget

Overall, we have shown the greater detail at the top of the worksheet and the summary, organisation budget, at the bottom of the worksheet, you might want to reverse that and have this organisation budget at the top, the division budgets next and so on.

## 6.6 Budget Five

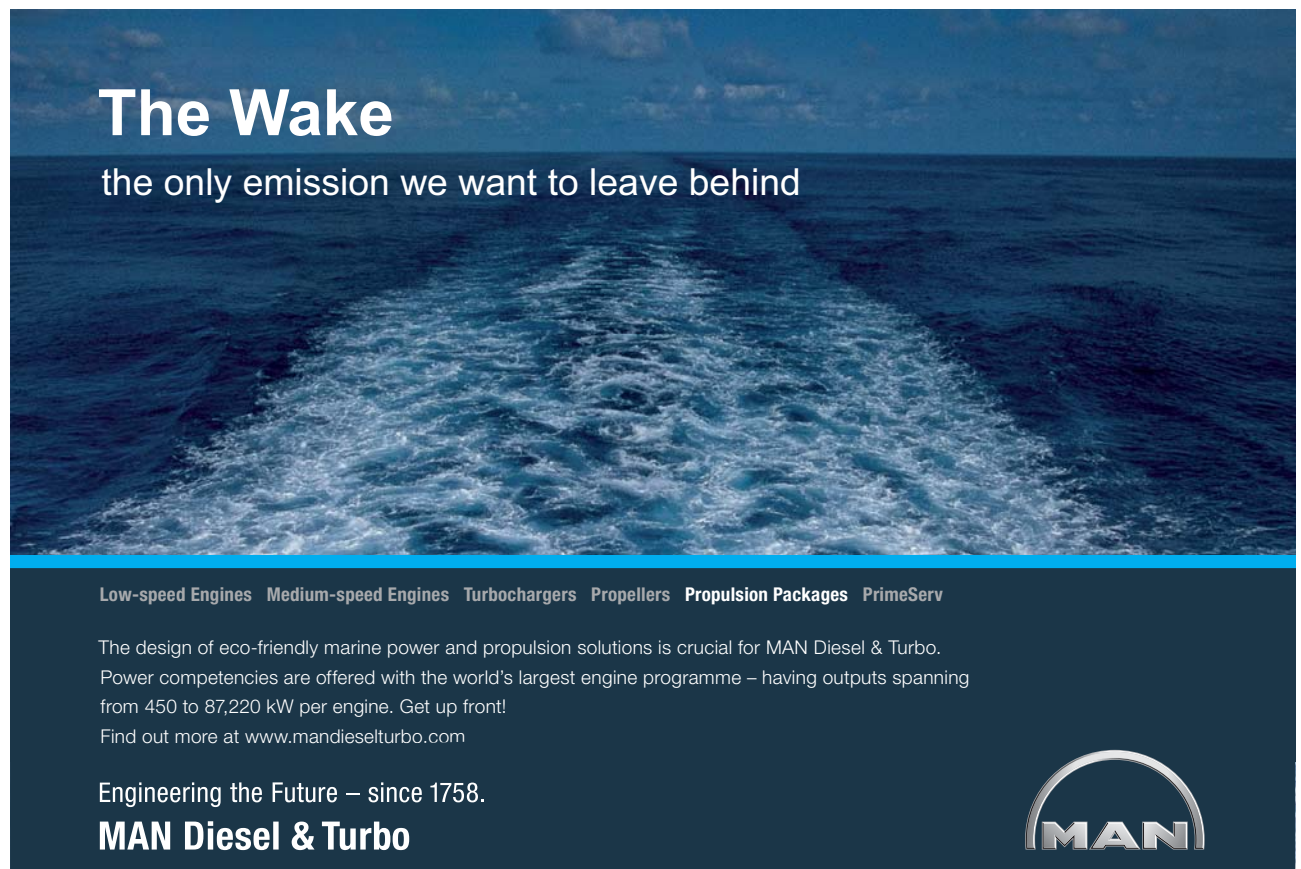
### 6.6.1 Rightsizing Manpower

**Manpower planning** or **rightsizing** as it is now called can be more complex and scientific than it used to be. On the one hand there is the very simple manpower planning model that says we find the number of people we need by analysing jobs and tasks, evaluating times taken, down time, waiting for materials and so on. We also need to know qualifications and skill levels and so on.

In this case we are taking a more advanced view of rightsizing in that we are presenting a model that might take what we have just said for granted or already included but then it takes into account such things as

- Additional absences
  - Sickness
  - Unauthorised
  - Training
- Performance levels
  - Poor
  - Average
  - Talented

The model we are concerned with here is in the *rightsize.xlsx* file and whilst the concept is simple, the calculations and interpretations take time to get to grips with.




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The following table, Table 3, highlights the findings of a survey of 1,000 employees across a region covering many organisations and many industries:

Category	Mix	Productive Hours/Week
Poor Performers	22%	5
Average Performers	61%	20
Talented Performers	17%	32
	100%	

**Table 3** Category of Workers and their Productivity

What Table 3 is telling us is that, for example, 22% of all employees are classified as being poor performers and on average their productive work amounts to just 5 hours of effort per week: meaning that for the other 30 or 35 hours or whatever it is, they are essentially being paid but are doing nothing worthwhile.

The **example\_1** tab in the *rightsize.xlsx* file shows two things:

1. At the levels of productivity shown in Table 3, how many workers are needed carry out the tasks assigned? The bottom line of that section of the table, row 111 on that tab, shows that if 100 people are employed, they would need 20 employees working at 5 hours per week but only 5 employees who can work for 20 hours a week and just 3.13 employees if they all work 32 productive hours a week.
2. The second part of the major table on the **example\_1** tab shows the number of employees required at the mix of employees shown in the first two columns in Table 3, irrespective of their productivity.

In other words, **example\_1** shows how many people you **need** versus how many you actually **employ**: the differences are large! By the way, the survey on which this analysis is based is real and its results are real!

Now look at **example\_2** which is the same model but set out in a different way. What this tab shows is the total number of hours potentially available, if everyone does everything they are paid to do. Then by means of the calculations found in the range A25:H31, we see what percentage of total hours are found to be productive: 41.25% in this example. That means that 58.75% of all hours paid for are adding no value to the company.

Put that another way: if we assume that total labour costs are £100,000,000 per year, then the average hourly wage calculations are, Table 4:

Annual Payroll	£100,000,000		£100,000,000
Total Hours Available: <b>annual paid hours</b>	5,424,000	Actual Annual Productive Hours	2,237,556
Average Payroll cost per hour	£100,000,000/5,424,000 = £18.00	Average Payroll cost per hour	£100,000,000/2,237,556 =£44.69

**Table 4** Average Hourly Payroll Costs

Your company can now answer the question: should we really be subsidising so many employees that drives our hourly labour costs to almost £45 when we pay everyone an average of just £18 per hour?

## 6.7 Budget Six

### 6.7.1 Forecasting and Budgeting

The distinction between a forecast and a budget has become blurred these days. This case gives some insights into the differences between them. The exercise takes some real data and initially you are asked to work on a forecast and then provide a budget from those data. The difference between forecast and budget, then, is strategy, objectives and targets.

The data for this exercise are found in the file *2012\_BP-Energy-Outlook-2030\_dw.xlsx*, starting on the **contents** tab. What follows is a summary of how we set about creating forecasts in the first instance.

#### Oil production...UK

Created a working copy by creating the new tab Oil Production – tonnes (2)

Deleted all sub totals

n/a becomes 0...or delete that row: we are aware that might not be the perfect thing to do but we don't have any choice in an exercise such as this!

transposed the entire table so that names are now in a header row

calculated correlation statistics using =CORREL() and found that the UK matched Mexico, Egypt and Other Africa in terms of their production history then deleted all other data apart from these four: we did this to see the patterns in highly correlated data...does this help us in any way?

Changed Year to year number

Graphs of all four countries

Deleted years 1965 to 1981 as we felt they added no useful information and were very old anyway

UK Trendline = -1.3618x + 150.17

Where x = year number

#### Oil Consumption...UK

Created a working copy by creating the new tab Oil Consumption – tonnes (2)

Deleted all sub totals

n/a becomes 0...or delete that row

transposed the entire table so that names in header row

calculated correlation statistics using =CORREL() and found that the UK matched Denmark, Other Europe & Eurasia in terms of their consumption history then deleted all other data apart from these three

Changed Year to year number

Graphs of all three countries

Deleted years 1965 to 1981 as we felt they added no useful information and were very old anyway

Trendline =  $-0.0465x + 81.443$

Where  $x$  = year number

Production v Consumption...UK

We created a new tab Production\_Consumption

For years 1982–2010

Converted year to year number

The advertisement features a central graphic on the left with three stylized human figures inside a circular arrangement of four arrows, surrounded by several gears. To the right of this graphic, the text 'UNLEASHING CHANGE MANAGEMENT' is written in large, bold, blue capital letters. Below this, the dates 'OCTOBER 18 & 19, 2018' and the location 'DE RODE HOED AMSTERDAM' are listed in smaller blue text. The bottom of the ad shows a silhouette of an Amsterdam skyline with a windmill, a bridge, and various buildings. In the bottom left corner, the text 'Global Executive Events' is visible. A hand cursor icon is positioned over a green oval at the bottom right of the ad, which contains the text 'Click on the ad to read more'.

**Columns E:F** contain predictions of production based on the Trendline =  $-1.3618X + 150.17$  as discussed above where X = year number

Calculated the Residuals: Actual Production – Predicted Production

Plotted the graph of Year No (X) and Production Residuals (Y)

**Columns H:I** contain predictions of production based on the Trendline =  $-0.0465x + 81.443$  discussed above where X = year number

Calculated the Residuals: Actual Production – Predicted Consumption

Plotted the graph of Year No (X) and Consumption Residuals (Y)

### 6.8 Autocorrelation, Bias and Outliers

In the forecast chapter we discussed three major problems with time series data: **autocorrelation**, **bias** and **outliers**. In the *2012\_BP-Energy-Outlook-2030\_dw.xlsx*, starting on the **production\_consumption** tab we have prepared all three analyses for you, see Figure 9 below:

	G	H	I	J	K	L	M	N	O	P
36	<b>Autocorrelation</b>		28 possible sign changes			28 possible sign changes				
37			4 total sign changes			6 total sign changes				
38			14% % Sign Changes			21% % Sign Changes				
39			12 Cutoff sign changes			12 Cutoff sign changes				
40			<b>Actual sign changes less than cutoff = autocorrelation</b>			<b>Actual sign changes less than cutoff = autocorrelation</b>				
41										
42	<b>Bias Test</b>			<b>Bias Test</b>						
43	mean	-0.001324		mean	0.000889					
44	standard deviation	16.79971		standard deviation	3.666638					
45										
46	Lower 95% CI	-16.8163		Lower 95% CI	-3.29851					
47	Upper 95% CI	16.81365		Upper 95% CI	3.300266					
48	<b>Conclusion</b>	There is no bias		<b>Conclusion</b>	There is no bias					
49										
50	<b>STEYX and Outliers</b>			<b>STEYX and Outliers</b>						
51	STEYX	7.380065		STEYX	8.621456					
52										
53	<b>Residuals</b>		<b>Outlier</b>	<b>Residuals</b>		<b>Outlier</b>				
54		(22.44)	Outlier		(5.05)					
55		(9.34)			(8.13)					
56		3.13			9.10					
57		6.04			(3.04)					
58		6.86			(3.04)					
59		4.50			(5.21)					
60		(3.03)			(0.36)					
61		(24.42)	Outlier		1.45					

**Figure 9** Autocorrelation, Bias, Outliers

The conclusions here are summarised in Table 5, below:

	Production	Consumption
Autocorrelation	It is present: model needs revision	It is present: model needs revision
Bias	No bias	No bias
Outliers	20 outliers	One outlier

**Table 5** Summary Autocorrelation, Bias, Outliers

Now What?

We have **trendline equations** and the  $r^2$  values: we have made predictions and tested them for autocorrelation, bias and outliers and both production and consumption data contain problems that mean we should revise these data sets in some way before we incorporate them in any firm forecast or in our budgets. Meaning? Meaning that we might need more detailed estimates, maybe country by country, region by region; and/or monthly rather than annual data. It might also mean that we should incorporate other macro economic variables in our forecasts to make them more reliable: such as GDP data, sales of vehicles and anything else that suggests why we produce and consume oil and gas or whatever it is we are doing.

## 6.9 The Budget

Let's assume that the above problems are not present in our data set, how do we go from forecast to budget? The answer is that we now have to take into account such aspects as:

- Profit targets
- ROCE targets
- Availability of cash for investment if we need to invest
- Availability of manpower to increase output, say; or potential redundancy payments if we have to reduce our production capacity

### 6.9.1 Hyperlinks

As a matter of interest, we have included a hyperlinked contents section on the contents tab of the *2012\_BP-Energy-Outlook-2030\_dw.xlsx* file. To create a hyperlink:

Enter some text in a cell, such as the name of another work sheet or tab

Select that cell

Insert...Links...Hyperlink

See Figure 10 and follow it:

5. Click Place in This Document
6. Select the Tab to link to
7. Click the address on the Tab
8. OK

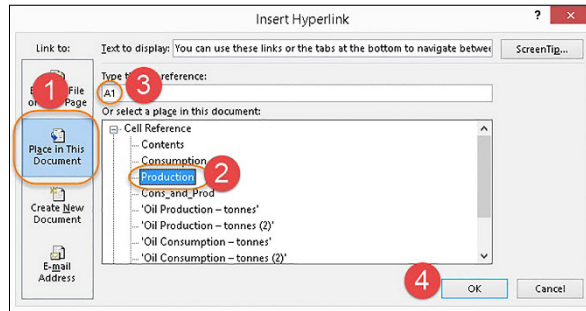


Figure 10 Setting up a Hyperlink from one part of a work book to another

**Conclusions**

In this chapter we have worked through five distinct budgeting exercises and a forecasting into budgeting exercise: we began with two basic production and purchase budgets for a manufacturer. We then added the dimension of a cash budget since they are often the most important budgets that organisations must prepare. We then prepared a rightsizing budget that illustrated how an organisation might have 3,000 employees on the payroll who are producing only, about 1,300 people’s worth of work. Finally, we looked at forecasting as it might be linked to budgeting.

**Excel Files Available**

All of the Excel files mentioned in this book can be found on this book’s page at:

<http://bookboon.com/en/excel-solutions-for-accountants-book-3-ebook>

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# 7 Aggregate, Offset, Solver

## Introduction

This chapter is concerned with three powerful functions, the AGGREGATE() function, the OFFSET() function and the SOLVER Add-In.

The AGGREGATE() Function tidies up a series of things that previous versions of Excel could not allow us to do. All in one function, then, are 19 things that we can now do and the first section of this chapter sets out what these things are and how to do them.

The OFFSET() function is not so powerful on its own but when linked with or tied to one or more other functions, you will appreciate its power!

SOLVER is an Add-In that we have already used in this book but this part of the chapter sets out a series of things that it can do that are often of great use to an accountant: from resource allocation to the solution of simultaneous equations with many variables, SOLVER can help us out!

## 7.1 Aggregate Function Templates

The aggregate function was newly created for Excel 2010 and it provides us with some interesting functionality: overcoming shortfalls in the performance of such functions as AVERAGE, MIN, MAX, LARGE, SMALL and a few more...19 of them altogether. The trouble is, good as it is, it is not that simple to apply. What we have done is to create templates that will help you to use the aggregate function in one or both of the formats in which it might be used.

Open the file *aggregate.xlsx* and on the **intro** tab you will see a summary of this function, taken from the Excel help file for it.

On the examples tab there are just a few examples of where the AGGREGATE() function is needed, see Figure 1 for that, which shows the results of using functions both with and without the help of the AGGREGATE() function.

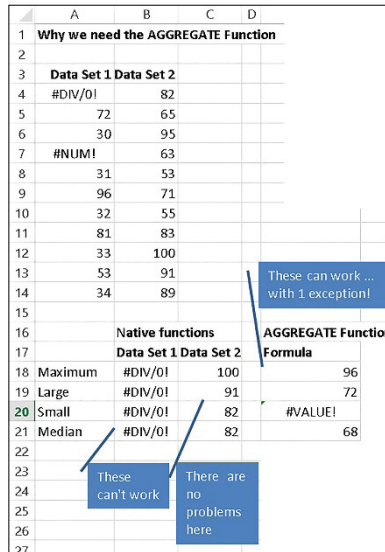


Figure 1 Why AGGREGATE is Needed

We can split the list of functions that AGGREGATE() supports in this way:

Reference Format: AGGREGATE(function\_num, options, ref1, [ref2], ...)

Array Format: AGGREGATE(function\_num, options, array, [k])

Function Number	Reference Format Function	Function Number	Array Format Function
1	AVERAGE	14	LARGE
2	COUNT	15	SMALL
3	COUNTA	16	PERCENTILE.INC
4	MAX	17	QUARTILE.INC
5	MIN	18	PERCENTILE.EXC
6	PRODUCT	19	QUARTILE.EXC
7	STDEV.S		
8	STDEV.P		
9	SUM		
10	VAR.S		
11	VAR.P		
12	MEDIAN		
13	MODE.SNGL		

Table 1 Classification of AGGREGATE Function by Type

Go to the *aggregate.xlsx* file and work your way through the 13 reference format functions (**template\_aggregate\_reference** tab) and the six array format functions (**template\_aggregate\_array** tab) and see which of these 19 you need.

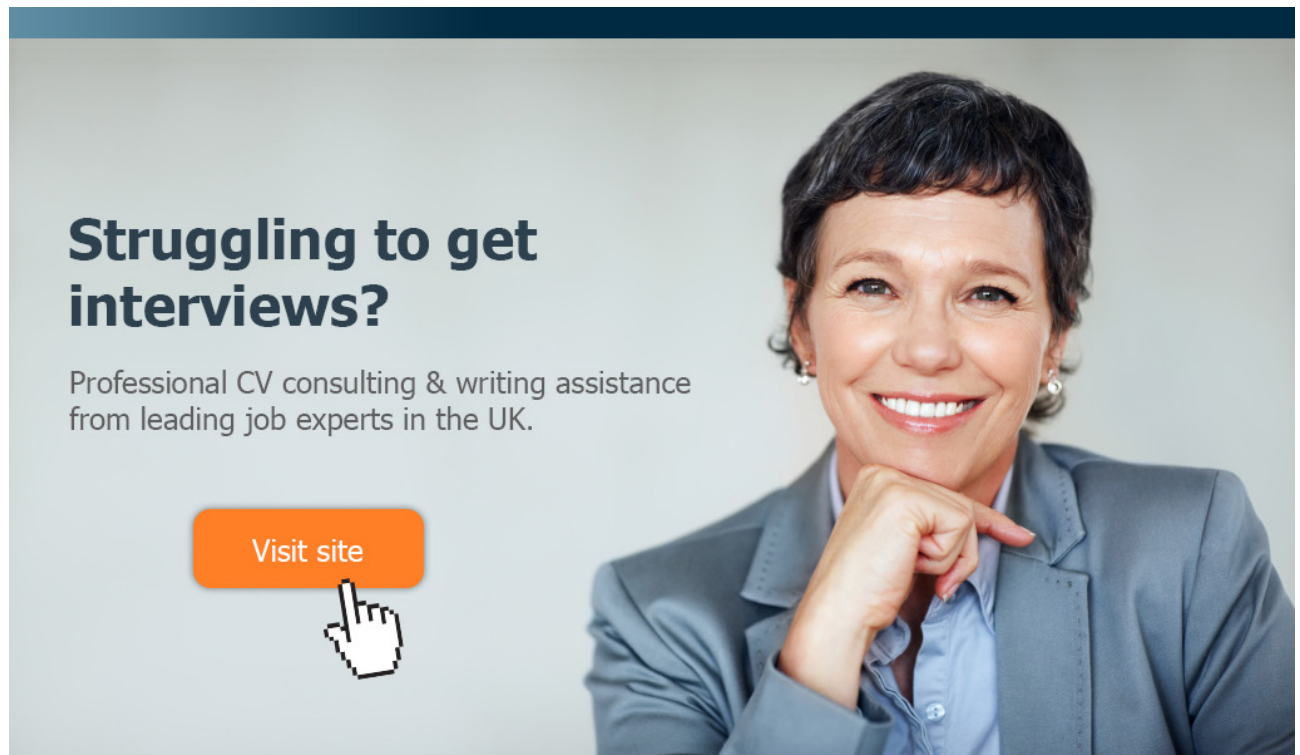
By the way, we believe that our aggregate template file is the best we have seen anywhere in a book or on the internet!

## 7.2 The Offset function

In terms of looking for information in Excel:

- VLOOKUP() is good but it is designed to look for information by going down and looking to the right.
- OFFSET() is designed so that it can go from looking down, looking right, as well as looking up and to the left

That's not to say that we can't do more with VLOOKUP(), we can; but on average with VLOOKUP() we go from one green to one blue to one orange.



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In this section we will work through a series of examples that you will be able to follow. However, for anyone who has never thought about using relative references or ideas before, you will find a detailed explanation of the OFFSET function from a Microsoft web page at the end of this article, including examples of where you can use negative numbers/references in it. Negative numbers as references mean that you can look left and upwards rather than just right and downwards.

We have also included further OFFSET() examples for anyone to practise with, also at the end of the section too.

Although it's not important for the examples you are about to see, one important feature of the OFFSET function is that it can read left and right (using positive and negative references) whereas functions such as VLOOKUP can only read from left to right: this can be a massive bonus.

Imagine you are following a company using a database such as the one found on [www.ft.com](http://www.ft.com). In this database you can find the:

- Income statement
- Balance sheet
- Statement of cash flows

for five continuous years for any listed company and can copy and paste these statements into an Excel worksheet, as we have done in the Ratio Analysis chapters. Now, though, imagine that the new year comes along and you want to update your worksheet just for the new year. You can keep the old data, of course, so that you then have six years' worth of data then seven years and so on. Take a look at the screenshot below for a potential problem, Figure 2, which comes from the *ratio\_analysis.xlsx* file that we used when we discussed ratio analysis!:

	A	B	C	D	E	F
1	amazon.com					
2	http://markets.ft.com/research/Markets/Tearsheets/Financials?s=AMZN:NSQ&subview=IncomeStatement					
3	In millions of USD (except for per share items)					
4						
5	<b>Income Statements</b>					
6	Fiscal data as of Dec 31 2014	<b>2014</b>	<b>2013</b>	<b>2012</b>	<b>2011</b>	<b>2010</b>
7	REVENUE AND GROSS PROFIT					
8	Total revenue	88,988	74,452	61,093	48,077	34,204
9	OPERATING EXPENSES					
10	Cost of revenue total	62,752	54,181	45,971	37,288	26,561
11	Selling, general and admin. expenses, total	16,650	12,847	9,723	6,864	4,397
12	Depreciation/amortization	0	0	0	0	0
13	Unusual expense(income)	0	0	0	0	0
14	Other operating expenses, total	133	114	159	154	106
15	Total operating expense	88,810	73,707	60,417	47,215	32,798
16	Operating income	178	745	676	862	1,406

**Figure 2** Inserting Data Presents a Potential Lookup Problem

Typically, financial reports read from right to left, as in the case above: the earliest year on the right and the latest year on the left. That means that we have to insert 2015 in between the current columns A and B. Well, that part's easy, of course and can be achieved in a few ways.

One problem might face then is that, having got the data, we want to analyse them. Any formulas, such as financial ratios, will be reading from columns B to F and we want to keep it that way because for example, we just want to analyse the last five years even when we have six, seven or more years' worth of data. When we add our columns, our current ratio formulas might adjust themselves as we do so. We need to take control of that situation and using the OFFSET function is one way of doing that.

### 7.2.1 Looking up Without the OFFSET function

Before we use the OFFSET function let's see what happens when we use traditional ratio calculations

Let's say that you want to analyse some of amazon.com's recent financial results, Figure 3 and **please note**, none of the changes we are discussing here are in the file we created for this section; so please work through everything here by yourself!

	A	B	C	D	E	F	G	H	I	J	K	L	
1	amazon.com												
2	http://markets.ft.com/research/Markets/Tearsheets/Financials?s=AMZN:NYSE												
3	In millions of USD (except for per share items)												
4													
5	<b>Income Statements</b>								1	2	3	4	5
6	Fiscal data as of Dec 31 2014	2014	2013	2012	2011	2010		2014	2013	2012	2011	2010	
7	REVENUE AND GROSS PROFIT							Gross Profit Margin (%)	29.48	27.23	24.75	22.44	22.35
8	Total revenue	88,988	77,000	67,000	58,000	51,000		Operating Income Margin (%)	0.20	1.00	1.11	1.79	4.11
9	OPERATING EXPENSES							2010 - 2014					
10	Cost of revenue total	62,752	54,000	47,000	41,000	36,000		Average Revenues					
11	Selling, general and admin. expenses, total	16,650	12,000	10,000	9,000	8,000		Standard Deviation Revenues	21,498				
12	Depreciation/amortization	0	0	0	0	0							
13	Unusual expense(income)	0	0	0	0	0							
14	Other operating expenses, total	133	106	90	78	68							

Figure 3 amazon.com Results

In addition to the profit margin calculations that we will discuss below, we have added average revenue and standard deviation of revenue calculations:

- G9=Average Revenues
- G10=Standard Deviation Revenues
- H9=AVERAGE(A8:F8)
- H10=STDEV(A8:F8)

Now, when you update your worksheet next year to include 2015 in a new column B, you should see revised formulas like this:

		2014	20
		Formulas updated automatically	
10	Gross Profit Margin (%)	=C8-C10)/C8*100	27.
04	Operating Income Margin (%)	=C16/C8*100	1.
		2010 - 2014	
61	Average Revenues	=AVERAGE(C8:G8)	
97	Stadard Deviation Revenues	=STDEV(C8:G8)	

Figure 4 Formulas Updated Automatically

Can you see: in column I, all of the formulas were updated by shifting them right, from B to C: what was, for example,

$$(B8-B10)/B10*100$$

is now  $(C8-C10)/C10*100$

So, you say, add some **absolute addressing** and change them to, for example,

$$(\$B8-\$B10)/\$B10*100$$

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but all you get is  $=(\$C8-\$C10)/\$C10*100$

Let's see how the OFFSET function might help us here.

### 7.3 The OFFSET Function in Action

The OFFSET function can do all of the work for you and let's start with the easier of the two sets of calculations first: **average** and **standard deviation** of the five years' revenues.

The syntax for the OFFSET function is  $=\text{OFFSET}(\text{reference},\text{rows},\text{cols},[\text{height}],[\text{width}])$ , We can work out how to understand this function by looking at the following examples:

#### Average Revenues

Instead of this formula  $=\text{AVERAGE}(B8:F8)$

Let's use this formula  $=\text{AVERAGE}(\text{OFFSET}(A8,0,1,1,5))$

What we are saying here with OFFSET is start with the **reference**, cell A8, stay in that row (value=0), move one column right (1), the height of the range you are selecting is one row (1) and you have chosen a width of five columns (5). Like the first example in the graphic below:

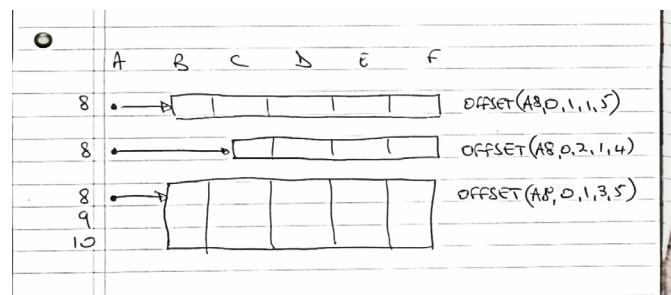


Figure 5 PPP of the OFFSET() Function

In the second example above we have changed the columns to two so that OFFSET now stays in the target row, row 8 and then moves to column two of the range which is C8 and we have left the height alone at [1] and changed the [width] to 4 columns so now OFFSET is setting up the range C8:F8 for the average or standard deviation functions to use and not B8:F8.

#### Standard Deviation Revenues

Instead of this formula  $=\text{STDEV}(B8:F8)$

Let's use this formula  $=\text{STDEV}(\text{OFFSET}(A8,0,1,1,5))$

### 7.3.1 Understanding OFFSET can be Tricky but N can help you!

There is no doubt that it could be a challenge to understand the difference between the AVERAGE and STDEV formulas that include the OFFSET function so here is something to help you...N! By adding +N() to the end of the OFFSET functions we have added a comment INSIDE the formula to explain what it does so that it can help the user to see what's going on if it's not immediately obvious.

=AVERAGE(OFFSET(A8,0,1,1,5))+N("That is, Average Revenues for the years 2010 to 2014")

=STDEV(OFFSET(A8,0,1,1,5))+N("That is, Standard Deviation of Revenues...")

If you have never used +N() before, try it and see how much you like it! Don't like it, don't use it!

### 7.3.2 OFFSET Copied Across Two or More Columns

In the case of the profit margin calculations, we have set them up to find the margin year by year and not just for one period or a range of periods. That means filling right, as we saw above:

	A	B	C	D	E	F	G	H	I	J	K	L			
1	amazon.com														
2	http://markets.ft.com/research/Markets/Tearsheets/Financials?s=AMZN:N														
3	In millions of USD (except for per share items)														
4															
5	Income Statements								1	2	3	4	5		
6	Fiscal data as of Dec 31 2014	2014	2013	2012	2011	2010			2014	2013	2012	2011	2010		
7	REVENUE AND GROSS PROFIT								29.48	27.23	24.75	22.44	22.35		
8	Total revenue	88,988							* 204	Operating Income Margin (%)	0.20	1.00	1.11	1.79	4.11
9	OPERATING EXPENSES														
10	Cost of revenue total	62,752	59,561												
11	Selling, general and admin. expenses, total	16,650	15,377												
12	Depreciation/amortization	0	0												
13	Unusual expense(income)	0	0												
14	Other operating expenses, total	133	106												

Figure 6 Filling Right...

So the OFFSET functions tells Excel where to begin, the **reference cell**. Then Excel starts its calculations without directly naming any range or setting out cell addresses and in that way, when a new column is inserted, there are no references to get updated or overwritten.

Play with the OFFSET function now and don't forget, as with any function, the options in square brackets [...] are optional. **Reminder:** there are more examples to work on at the end of this article.

### 7.3.3 Gross and Operating Income Margins

Let's work on the gross and operating income margins of the last five years for amazon.com. We start in cell H7, with the ratio titles being in cells G7:G8

- G7=Gross Income Margin
- G8=Operating Income Margin (%)

- $H7 = (B8-B10)/B8*100$ ...note, they don't show the gross income which is Sales – Cost of Revenue total. Hence (B8-B10)
- Fill Right to columns I:L and there you are, the profit margins for each of the five years
- When you update your worksheet next year to include 2016, the OFFSET functions does all of the work for you!

	G	H	I
4			
5		1	2
6		=B6	=C6
7	Gross Profit Margin (%)	=((OFFSET(\$A8,0,H5,1,1)-OFFSET(\$A10,0,H5,1,1))/OFFSET(\$A8,0,H5,1,1))*100	=(OFFSET(\$A8,0,I5,1,1)-OFFSET(\$A10,0,I5,1,1))/OFFSET(\$A8,0,I5,1,1)*100
8	Operating Income Margin (%)	=OFFSET(\$A16,0,H5,1,1)/OFFSET(\$A8,0,H5,1,1)*100	=OFFSET(\$A16,0,I5,1,1)/OFFSET(\$A8,0,I5,1,1)*100
9		=F6&" - "&B6	
10	Average Revenues	=AVERAGE(OFFSET(A8,0,1,1,5))+N("That is, Average Revenues")	+N() used here
11	Standard Deviation Revenues	=STDEV(OFFSET(A8,0,1,1,5))+N("That is, Standard Deviation of Revenues")	
12			

Figure 7 The OFFSET() Function you need

Here is the OFFSET function you need, Figure 7:

In this case OFFSET starts in \$A8, stays in the same row (0), moves 1 column to the right into B8 (we have used a cell reference to make that happen, not just by typing 1, then it chooses one row and one column to work with. Fill that formula right and you see this in the next column:



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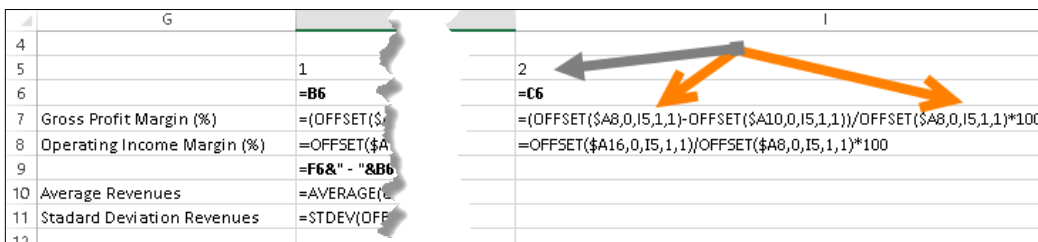


Figure 8 See how OFFSET() Keeps Working

OFFSET starts in cell \$A8, stays in that row, moves 15, ie 2, columns to the right, which is two columns to get to cell C8 and then picks up the value in that cell...

We have used +N() in all cells.

### 7.3.4 OFFSET Working for you

Now that you have come this far, go back and insert a new column for another year and enter or create some new data for the cells we are using here and see if the OFFSET function has done what we want... working on the last five years' worth of data only!

We have to say that if you have a lot of OFFSET functions your worksheet might slow down. This is because the OFFSET function is volatile: so every formula containing OFFSET will be recalculated after each worksheet change. But using OFFSET could well be significantly easier than manually adjusting each formula.

## 7.4 Further OFFSET() Examples

More examples if you think you need the practise: we have colour coded the cells in the range A3 to C7 and your task is to derive the OFFSET function to do the following:

1 In cell A3 Find what is in the anchor cell of E10	
2 In cell A5 find the contents of I11	
3 In cell A7 find the contents of F13	
4 In cell C5 sum the range K14:K15	
5 In cell C7 sum the range D9KF11	
Why not be creative and think about using OFFSET to help with other calculations, finding averages and so on? You will see some suggestions for these in my suggested solutions.	

Figure 9 Using the OFFSET() Function

Whilst we have not provided an Excel file here for you, the solutions to these examples are:

1 =OFFSET(H12,0,0)

2 =OFFSET(H12,-1,1)...or =OFFSET(H12,0,0)/10..... or =OFFSET(H12,0,0)/(10+5)

3 =OFFSET(H12,1,-2)

4 =SUM(OFFSET(H12,2,3,2))...or AVERAGE((OFFSET(H12,2,3,2))...or something else!

5 =SUM(OFFSET(H12,-3,-4,3,3))...or AVERAGE(OFFSET(H12,-3,-4,3,3))...or something else

## 7.5 Solver

The first thing to appreciate is that SOLVER is an Add-In. SOLVER should appear as a button in the top right hand corner of the Data Tab and if it does not appear there:

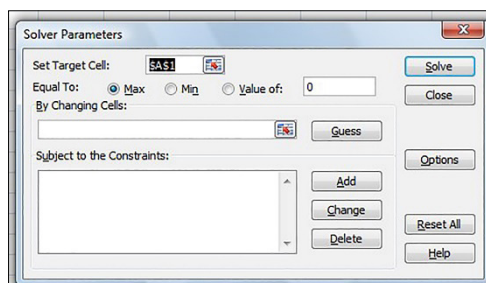
- Click the Microsoft Office Button
- Excel Options
- Add-Ins
- Go
- Select the **Solver Add-In** check box
- OK

Click yes to confirm and this should install the SOLVER add in now

Start SOLVER as follows:

- Data
- Analysis
- Solver

And you will be presented with this dialogue box:



**Figure 10** SOLVER Parameters Dialogue Box

The Target Cell is the cell in the worksheet you are working on for which you want to find:

- The maximum possible value such as maximum profit
- The minimum possible value such as minimum cost
- An exact value such as the break even point

There is then a choice to be made as to which cell[s] in the worksheet are to be changed in order ensure that our optimum solution is found.

Probably the trickiest part of SOLVER is to set the constraints: that is, appreciating that raw materials or labour hours or even cash are in short or finite supply and how the SOLVER is to work with that information.

Let's work through a basic resource allocation problem to explore these elements of SOLVER.

### 7.5.1 Resource Allocation Problem

FurnCo manufactures desks and chairs. Each desk uses 4 units of wood and each chair 3 units of wood. A desk contributes £40 to profit and a chair contributes £25. Marketing restrictions require that the number of chairs produced to be at least twice the number of desk produced. There are 20 units of wood available.



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Required

Use Excel's SOLVER to maximise FurnCo's profit.

Solution

In formal terms, we can set out this problem as follows:

Maximise  $40d + 25c$

Subject to:  $c \geq 2d$

$w \leq 20$

Where:

Maximise  $40d + 25c$  means maximise the profit when desks earn £40 each and chairs earn £25 each

$c \geq 2d$  means that the number of chairs needs to be at least twice that of the number of desks

$w \leq 20$  means that there is no more than 20 units of wood available

It is possible to solve this problem without using SOLVER and many people reading this may well have solved it already! However, I have used this deliberately simple problem so that we can concentrate on SOLVER rather than the problem.

Firstly, we need to set out our worksheet to cope with this problem: what follows is just one possible layout. I have included in this table all of the information and formulas needed for SOLVER to do its job too:

	A	B	C	D	E
1	product	units to produce	units of wood per unit	contribution per unit	wood used
2	desk		4	40	=B2*C2
3	chair (where $c \geq 2d$ )		3	25	=B3*C3
4	$w \leq 20$				=E2+E3
5	Profit = $40d + 25c$	=SUMPRODUCT(B2:B3,D2:D3)			

Here is the SOLVER dialogue box with all of the above set out in it:

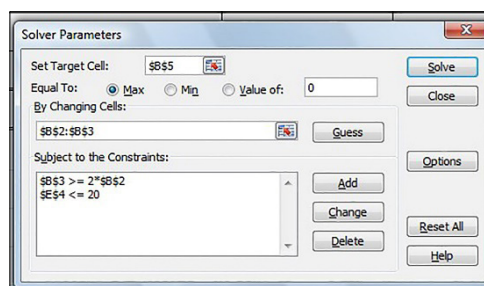


Figure 11 SOLVER Dialogue Box: problem established

The **target cell** is B5 which SOLVER will enter as \$B\$5 is the profit calculation cell and we have set it so that SOLVER will find the Max[imum] value possible. The target cell MUST contain a formula, by the way, or SOLVER cannot solve the problem.

The **changing cells** are B2:B3 which, again, SOLVER enters as \$B\$2:\$B\$3

The constraints are

$B3 \geq 2 * B2$  which is that the number of chairs to be made is to be put into cell B3 and SOLVER needs to ensure that the number of chairs is to be at least twice that of the number of desks

$E4 \leq 20$  which says that the total amount of wood that is used, to be found in cell E4, must be no more than 20 units...again note the absolute addressing \$ in the constraints

Once we are happy that we have completed everything correctly we just need to click the Solve button. SOLVER will now present you with this:

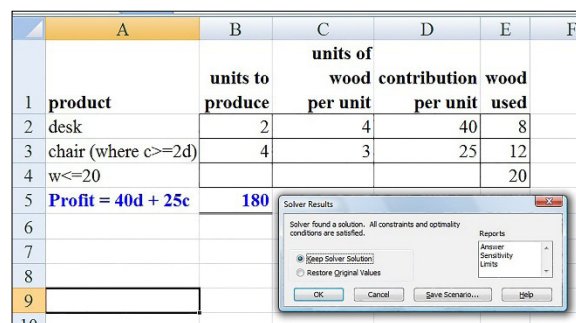


Figure 12 Found it! SOLVER Solves

You can see the solution now: profit is maximised when we produce 2 desks and 4 chairs, using 20 units of wood giving a profit of £180.

You are given the option of keeping the solution or restoring your sheet to its original values: the choice is entirely yours. If you are working on a more complex problem you might want to take a look at the reports that SOLVER can prepare for you:

- Answer
- Sensitivity
- Limits

Here is the Answer report that SOLVER prepared for this exercise:

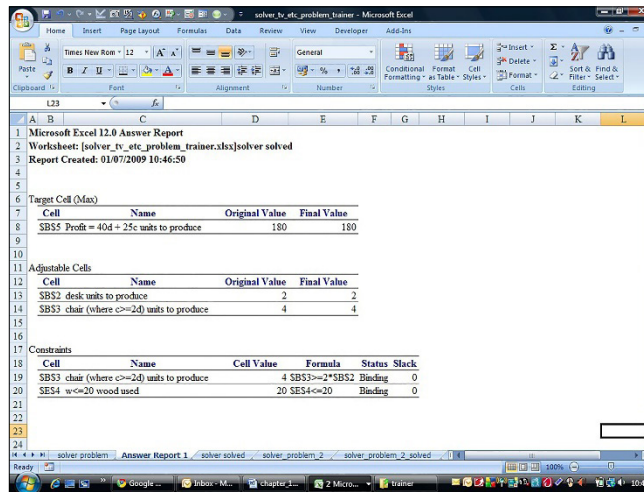


Figure 13 SOLVER Explains the Answer

Just in case you are wondering, you can make changes to the number of chairs and desks to make and see if you can improve the amount of profit *providing you stay within the limits imposed by the constraints.*

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In the book Duncan Williamson (2012) *The Excel Project: Excel for Accountants, Business People...from the Beginning: a Comprehensive Guide to Excel* you will find several more SOLVER based problems that you can work through. Take a look at just one more problem here, completely different from FurnCo, just to see what else SOLVER might do for you.

### 7.5.2 Office Assignment Problem 1: introducing the BINARY option

This problem comes from [www.solver.com](http://www.solver.com) and whilst the problem is not ours, the way we have set out and are demonstrating the method of using SOLVER most definitely is. That's not to say that the [www.solver.com](http://www.solver.com) method is wrong or worse, but it is not, in our opinion, as user friendly as ours.

Office assignment problems can also be solved by SOLVER and they do so by using the **binary option**. We have had variables being set as greater than...less than...integers; but now we are going to ask SOLVER to provide us with a binary solution. That is, where the answer is given as 0 or 1...yes or no...binary... assigned the room/not assigned the room!

In this problem a company wants to assign 14 employees to 10 offices. Each employee has a preference for a certain office and the question is, how should the company assign employees to the offices to maximize the preference of all employees? In the table that follows, 1 means first choice, 2 means second choice...10 means do I really have to? How should the company assign the people to the offices to optimise the preferences of the employees? The screenshot that follows reveals the preferences of the employees:

	A	B	C	D	E	F	G	H	I	J	K
1	Office Assignment										
2	Source: www.solver.com										
3											
4	Inputs										
5	Preferences (1=first, 10=last choice)										
6		Office 1	Office 2	Office 3	Office 4	Office 5	Office 6	Office 7	Office 8	Office 9	Office 10
7	Employee 1	3	2	1	4	6	5	8	9	10	7
8	Employee 2	5	3	2	6	1	7	9	8	4	10
9	Employee 3	10	8	1	9	7	4	3	6	2	5
10	Employee 4	7	3	2	9	5	4	8	6	1	10
11	Employee 5	1	3	6	8	5	2	9	10	7	4
12	Employee 6	4	9	1	5	6	8	2	7	10	3
13	Employee 7	2	1	10	9	5	3	6	8	4	7
14	Employee 8	6	5	1	3	2	4	7	8	9	10
15	Employee 9	8	9	10	5	4	3	2	1	6	7
16	Employee 10	9	10	3	2	5	4	1	7	8	6
17	Employee 11	7	3	5	2	9	8	1	10	4	6
18	Employee 12	6	5	1	9	10	2	3	4	7	8
19	Employee 13	6	8	10	9	1	2	3	4	5	7
20	Employee 14	6	3	5	9	1	2	10	4	8	7

Figure 14 Office Allocation Problem for SOLVER

Since you have already been told that the solution revolves around a binary solution, can you solve it **before** looking at the solution? You need to think carefully about the target cell and the changing cells!

## Solution

- 1) The variables are the assignments of the people to different offices.
- 2) There are the following logical constraints

M24:V37 = binary

and the other constraints

W24:W37 = 1

M38:V38 = M40:V40

- 3) The Objective or Target Cell is X38 and this means optimise the preference of the employees by **minimising** the sum of the total preferences given to the assigned offices.

We have not shown all of the formulas in all of the cells of the final table, so here is what you need to see to work out the rest of them.

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	S	T	U	V	W	X
19						
20						
22						
23	Office 7	Office 8	Office 9	Office 10	Total	Preference
24	0	0	0	0	=SUM(M24:V24)	=SUMPRODUCT(B7:K7,M24:V24)
25	0	0	0	0	=SUM(M25:V25)	=SUMPRODUCT(B8:K8,M25:V25)
26	0	0	1	0	=SUM(M26:V26)	=SUMPRODUCT(B9:K9,M26:V26)
27	0	0	1	0	=SUM(M27:V27)	=SUMPRODUCT(B10:K10,M27:V27)
28	0	0	0	0	=SUM(M28:V28)	=SUMPRODUCT(B11:K11,M28:V28)
29	0	0	0	1	=SUM(M29:V29)	=SUMPRODUCT(B12:K12,M29:V29)
30	0	0	0	0	=SUM(M30:V30)	=SUMPRODUCT(B13:K13,M30:V30)
31	0	0	0	0	=SUM(M31:V31)	=SUMPRODUCT(B14:K14,M31:V31)
32	0	1	0	0	=SUM(M32:V32)	=SUMPRODUCT(B15:K15,M32:V32)
33	1	0	0	0	=SUM(M33:V33)	=SUMPRODUCT(B16:K16,M33:V33)
34	1	0	0	0	=SUM(M34:V34)	=SUMPRODUCT(B17:K17,M34:V34)
35	0	1	0	0	=SUM(M35:V35)	=SUMPRODUCT(B18:K18,M35:V35)
36	0	0	0	0	=SUM(M36:V36)	=SUMPRODUCT(B19:K19,M36:V36)
37	0	0	0	0	=SUM(M37:V37)	=SUMPRODUCT(B20:K20,M37:V37)
38	=SUM(S24:S37)	=SUM(T24:T37)	=SUM(U24:U37)	=SUM(V24:V37)		=SUM(X24:X37)
39						
40	2	2	2	1		

Figure 15 Some of the Formulas we used to set up the Problem

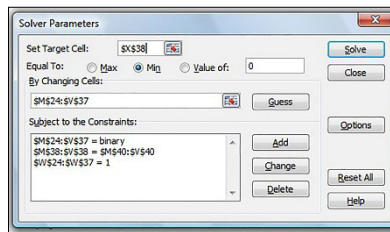


Figure 16 SOLVER Parameters Dialogue Box

Solutions												
	Office 1	Office 2	Office 3	Office 4	Office 5	Office 6	Office 7	Office 8	Office 9	Office 10	Total	Preference
Assignments												
Employee 1	0	0	1	0	0	0	0	0	0	0	1	1
Employee 2	0	0	0	0	1	0	0	0	0	0	1	1
Employee 3	0	0	0	0	0	0	0	0	0	1	0	2
Employee 4	0	0	0	0	0	0	0	0	1	0	1	1
Employee 5	1	0	0	0	0	0	0	0	0	0	1	1
Employee 6	0	0	0	0	0	0	0	0	0	0	1	3
Employee 7	0	1	0	0	0	0	0	0	0	0	1	1
Employee 8	0	0	0	1	0	0	0	0	0	0	1	3
Employee 9	0	0	0	0	0	0	0	1	0	0	1	1
Employee 10	0	0	0	0	0	0	1	0	0	0	1	1
Employee 11	0	0	0	0	0	0	1	0	0	0	1	1
Employee 12	0	0	0	0	0	0	1	0	0	1	4	
Employee 13	0	0	0	0	1	0	0	0	0	0	1	2
Employee 14	0	0	0	0	1	0	0	0	0	0	1	1
Total	1	1	1	1	2	1	2	2	2	1	23	
Required	1	1	1	1	2	1	2	2	2	1		

Figure 17 SOLVER Solved it!

The solutions to all SOLVER problems are found in the file *solver.xlsx* that accompany this chapter: in addition there are several more SOLVER style problems, with solutions, in that file.

### 7.5.3 Comments

We can see from the results that not everyone got their preferred office: employee 3 was assigned to his 2<sup>nd</sup> choice office as was employee 13, employees 6 and 8 were assigned to their 3<sup>rd</sup> choice office while employee 12 was assigned her 4<sup>th</sup> choice office. We can see that from the values in the Preferences column and those values come from the use of the SUMPRODUCT(...) function.

Offices 5, 7, 8 and 9 have been assigned two employees each as per the requirements of the question.

When everybody wants a different office, there will be no problems. If all employees prefer the same office (more likely!), the problem gets more difficult and it might be necessary to give an employee 7th or 8th choice. It might be wise, in that case, to add a constraint to say that no assignment worse than 5th choice is given, for instance. This may cause the problem to be infeasible, ie there is no possible solution. If this happens, you will have to relax the constraint on the assignments, eg no worse than 6th or even 7th choice.

### Conclusions

This chapter has brought to you three very important elements of Excel: the AGGREGATE function, the OFFSET function and the SOLVER Add-In. Each does something different from the rest and we recommend that you study the accompanying Excel files in detail to enhance your understanding of these elements since we really cannot do them just in just 11 or 12 pages or so.

The AGGREGATE function allows us to use 19 functions more directly than before when, for example, your database or list contains dirty data: words instead of numbers, printing characters rather than numbers and so on. There are two forms of this function, reference and array and the spreadsheet we have developed and presented here is probably the best basic resource for AGGREGATE that you will find anywhere. Big claim!

The OFFSET function helps you to find buried treasure: it allows you to go to a desert island and find where X marks the spot! Seriously, starting in one cell, the reference cell, you tell excel to turn left, turn right, go forward, go backwards. The purpose of all of this is a lookup function that beats VLOOKUP and HLOOKUP for directionality.

SOLVER is a bundle of operations research routines all in one place and we have seen here and in other chapters that SOLVER for help us to allocate resources, find minimum costs, solve multiple variable simultaneous equations and a lot more. It's powerful and relatively user friendly!

### Excel Files Available

All of the Excel files mentioned in this book can be found on this book's page at:

<http://bookboon.com/en/excel-solutions-for-accountants-book-3-ebook>