

Array Formulas and Forms



Array formulas, which work on arrays of data rather than individual cells or ranges, allow users to make calculations that would otherwise be impossible with ordinary formulas. They can perform multiple discrete calculations in a single cell or return results to multiple cells. For example, an array formula can be used to round off totals or subtotals, a feat that is impossible to accomplish with an ordinary formula. Don't miss this opportunity to harness the power of array formulas to improve your analytical abilities in Excel.

Adding controls such as check boxes, list boxes and combo boxes is a great way to make data entry easier.

Introduction

Array formulas, which work on arrays of data rather than individual cells or ranges, allow users to make calculations that would otherwise be impossible with ordinary formulas. They can perform multiple discrete calculations in a single cell or return results to multiple cells. For example, an array formula can be used to round off totals or subtotals, a feat that is impossible to accomplish with an ordinary formula. Don't miss this opportunity to harness the power of array formulas to improve your analytical abilities in Excel.

Forms are an excellent way to simplify data entry in Excel. In this session we will explore the creation of check boxes, list boxes and combo boxes.

Array Formula Basics

An array is a collection or range of two or more items. An array formula is a formula that acts on an array, a range of cells, instead of individual cells, or a formula that delivers results to more than one cell. In a nutshell, array formulas can perform multiple discrete calculations in single cell and return the results to a single cell or return the results to multiple cells. Note that the results of an array formula can be imbedded within other formulas. Since array formulas work on a group of cells in a single operation, array formulas can perform calculations that are not possible with conventional formulas.

Excel has three types of arrays:

- A reference array is an area of a worksheet that contains more than one cell. It can be an ordinary cell range, a worksheet reference, or a defined name.
- A result array is an array of items created by an array operation. For example, the LINEST function can return an array of statistics than defines the results of a linear regression model.
- An array constant is an array of hard-coded values (constants). An array constant can be entered directly into a formula or can be saved and referenced as a defined name.

Array formulas can be created using ordinary functions that take individual cells as their values. This type of array formula must be entered using CTRL + SHIFT + ENTER. Excel also includes functions that operate on arrays natively, such as SUMPRODUCT, AGGREGATE, LOOKUP, INDEX and SUMIF(S), COUNTIF(S), and AVERAGEIF(S). These functions produce array formulas without entering CTRL + SHIFT + ENTER. Another set of functions produce result arrays. Among them are TRANSPOSE, TREND, FREQUENCY, LINEST, AND LOGEST.

Creating Simple Array Formulas

In this first example, three methods – conventional analysis using a helper column, an array formula using the SUM function, and an array formula using SUMPRODUCT – will be used to calculate the total wages paid to a project team for the week, as shown in **Figure 1**.

	A	B	C
1	Team Member	Hourly Rate	Hours
2	Brady	250.00	42.5
3	Wilson	225.00	35.0
4	Luck	175.00	27.0
5	Rogers	200.00	64.0

Figure 1 – Team Timesheet

1. In column D, create individual formulas to calculate the wages for each team member. Copy the formula down and then sum the results in cell **D7**.
2. Build an ordinary array formula. Enter **=SUM(B2:B5*C2:C5)** in cell **D9**. Make sure to press **CTRL + SHIFT + ENTER** to enter the formula. Otherwise, the formula will evaluate to #VALUE!. Note the braces { } surrounding the formula in the formula bar.
3. Use the SUMPRODUCT function to build the formula. Enter **=SUMPRODUCT(B2:B5,C2:C5)** into cell **D10** and press **ENTER**. CTRL + SHIFT + ENTER is not needed to enter the formula, nor do braces { } surround the formula in the formula bar. The SUMPRODUCT function produces an array formula without all of the complexities of an ordinary array formula. It can handle up to 255 arrays of data.

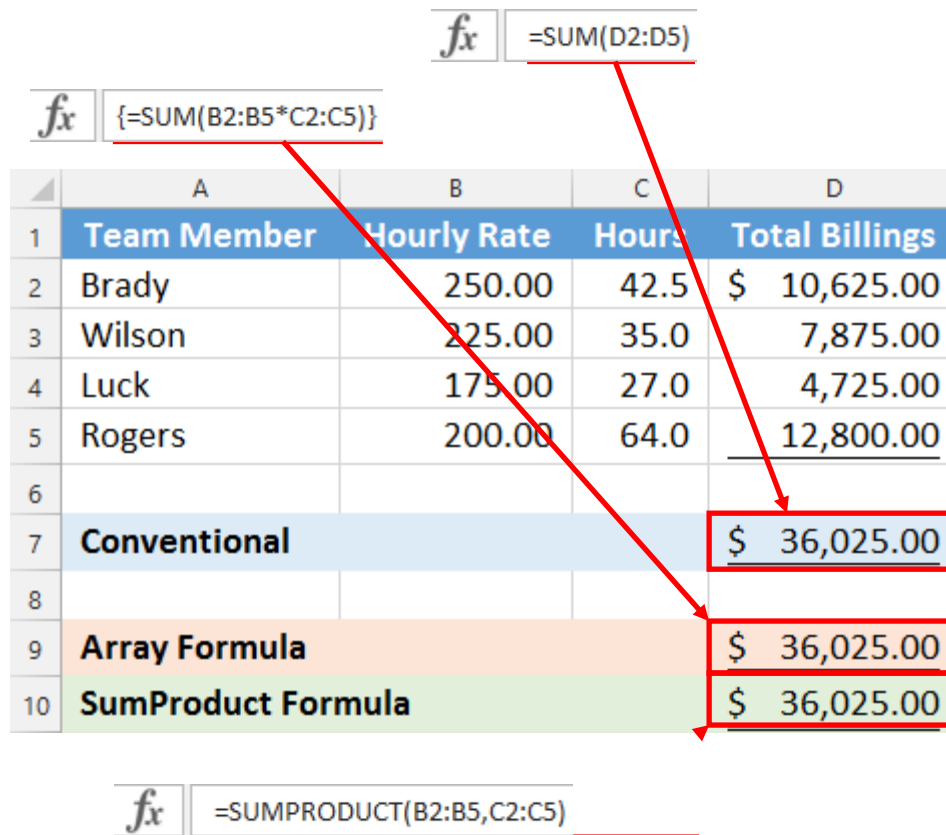


Figure 2 – Conventional vs Array Formulas

Note that each of the three methods returned the same result, but the array formulas used a single cell to make the calculation. In the simple context presented, the most commonly used method with a helper column works as well as the array formulas, but in situations involving thousands of transactions, calculating the extended price or cost of goods just to calculate total revenue or total cost of goods sold would be cumbersome and time consuming. In those situations, a single cell array formula would be a better alternative. Further, using SUMPRODUCT in situations like these is a better solution because it calculates faster and is easier for average Excel users to understand than ordinary array formulas entered using CTRL + SHIFT + ENTER.

Before leaving this example, let's use an advanced technique to examine or troubleshoot array formulas. Position the cursor in cell D9, the cell containing the ordinary array formula. Press F2 to edit the formula and then click **number 1** in the **Screen Tip** that appears to select the array reference. Press F9 to see the underlying array, as shown in **Figure 3**. Do not press Enter without first pressing CTRL + Z to undo the change. Otherwise, the cell references will be replaced with the array constant so that the formula will no longer calculate by reference to the values in the cells, but by reference to the values inside the SUM function, thereby breaking the formula envisaged.

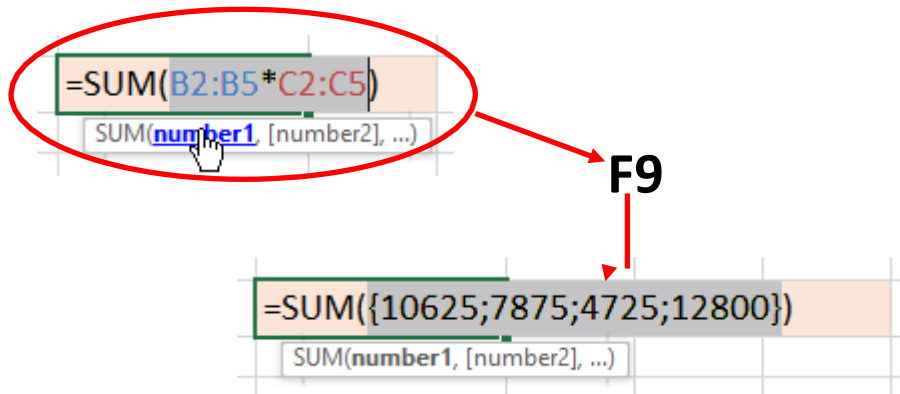


Figure 3 – Troubleshooting an Array Formula

Similarly, the formula built using SUMPRODUCT can be examined. Note that the individual items of the arrays can be examined rather than the results of the array calculations displayed in the ordinary array formula.

Rounding Off in a Total

This example uses an array formula to round off in a total. Many accounting professionals have been faced with the need to sum a large number of amounts that result from floating point calculations. The amounts may be the result of formulas or may be imbedded in data imported from other systems. A problem arises when the amounts are not rounded off because Excel uses the underlying values rather than the displayed values in calculating formulas, including summary totals. Conventional practice requires the use of the ROUND function to round off all of the calculated amounts prior to summing their values, but that solution is cumbersome and time-consuming when a large number of values are present. A better alternative would be to build a formula that can round and sum the amounts in a single calculation. A simple array formula like the one displayed below can perform this task quickly and easily.

`{=SUM(ROUND(E5:E8,2))}`

Note the braces that surround the array formula. The braces are not typed in but are added by Excel when an array formula is entered. To enter an ordinary array formula, type in the formula and then press **CTRL + SHIFT + ENTER**.

		No Rounding	Conventional Rounding	Array Formula
		Average Unit	Average Unit	Average Unit
Total	Units	Cost	Cost	Cost
247.11	4.00	61.78	61.78	61.78
494.22	5.00	98.84	98.84	98.84
741.33	6.00	123.56	123.56	123.56
988.44	7.00	141.21	141.21	141.21
		425.38	425.39	425.39
<div> <div></div> <div>=SUM(ROUND(E5:E8,2))</div> </div>				

Figure 4 - Using an Array Formula to Round and Sum Data in a Total

Again, let's use the technique discussed earlier to examine the array formula. Position the cursor in cell **E10** and press **F2**. Then, click inside the **ROUND** function, click *number* in the **Screen Tip**, and press **F9** to see the unrounded values. Press **CTRL + Z** to undo the changes, and then click inside the **SUM** function but before the **ROUND** function, click *number 1* in the **Screen Tip**, and press **F9** to see the rounded array values. This examination helps us understand just how the array formula is making the calculation. It's not rounding the sum, it's summing the rounds!

Using Array Constants

An array constant is an array of hard-coded values. It can be entered directly into a formula or can be saved and referenced as a defined name. In this example, the US corporate income tax rate table will be stored as a defined name. The defined name will refer to the array constant that makes up the table.

To create the defined name, enter a simple formula that references the tax table. Then press **F9** to convert the cell references into an array. Copy the array to the clipboard with **CTRL + C**. Open the **Name Manager** on the **Formulas** tab and click **New**. Name the defined name **TaxTable** and paste the array into the **Refers to:** box and press **OK**. Note that column items are separated by columns and rows are separated by semi-colons.

Once the defined name is created, the array constant can be used just as any other table array in a **VLOOKUP** function to calculate estimated corporate taxes. Save the constant in your tax worksheet

templates or your default Excel template so that it will always be available. The worksheet used to create the array id shown in **Figure 5**.

$=VLOOKUP(B4,TaxTable,2)+VLOOKUP(B4,TaxTable,3)*(B4-VLOOKUP(B4,TaxTable,1))$					
A	B	C	D	E	F
Corporate Income Tax Estimator					
			Taxable Income	Base Tax	Tax Rate
Taxable Income	\$25,000,000		-	-	15%
			50,000	7,500	25%
Estimated Income Tax	\$8,750,000.45		75,000	13,750	34%
			100,000	22,250	39%
Estimate Using Array Constant	\$8,750,000.45		335,000	113,900	34%
			10,000,000	3,400,000	35%
			15,000,000	5,150,000	38%
			18,333,333	6,416,667	35%

Figure 5 – Storing an Array Constant as a Defined Name

How to Insert a Checkbox in Excel

When you use a spreadsheet to manage information, adding a checkbox seems like overkill. You can just type an “x” or a “1” wherever you might place a checkmark. But if many people will be using your spreadsheet, or you’re concerned about the presentation, inserting a checkbox is a nice touch.

Adding the Developer tab to Excel

In Excel’s default display, the Ribbon doesn’t display the **Developer** tab, which you need for inserting checkboxes. We’re going to change that.

Go to **File > Options**, then click on **Customize Ribbon**. Make sure **Developer** is checked.

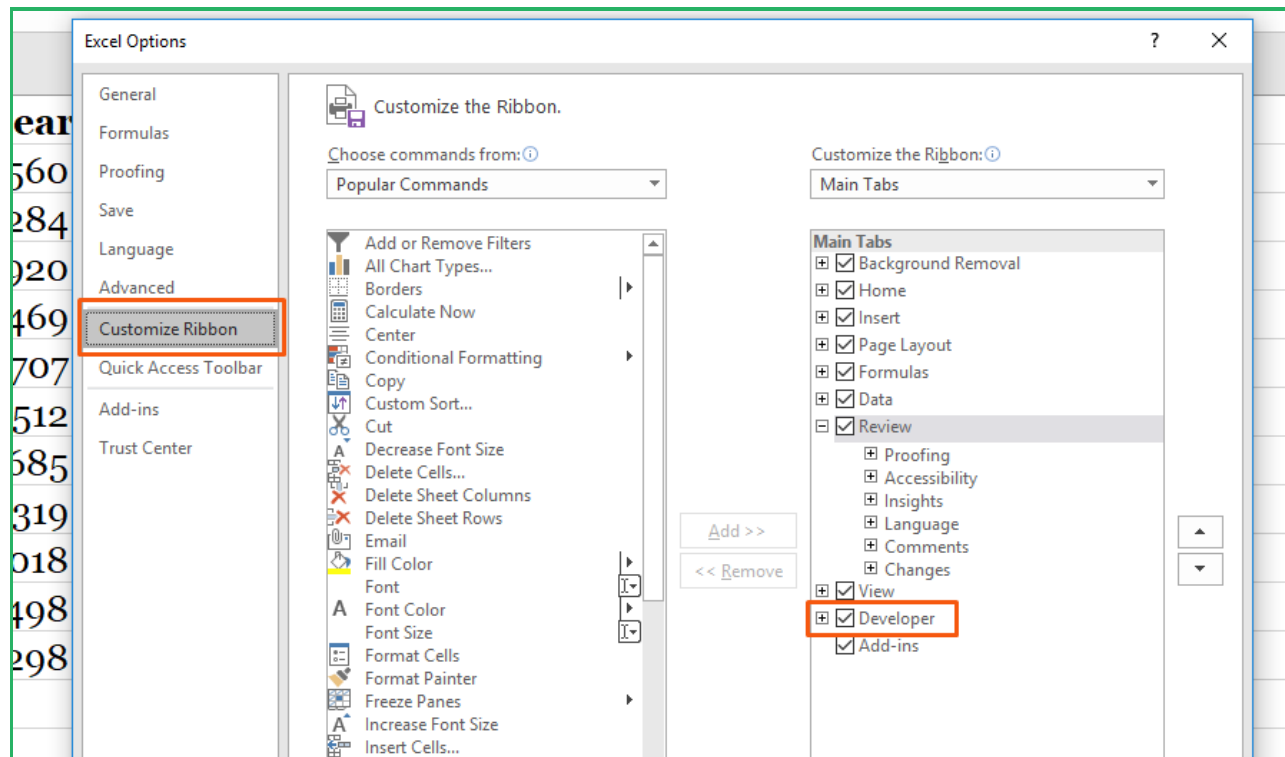


Figure 6 - Turning on the Developer Tab

Now, when you go back to your spreadsheet, you'll see the **Developer** tab displayed.

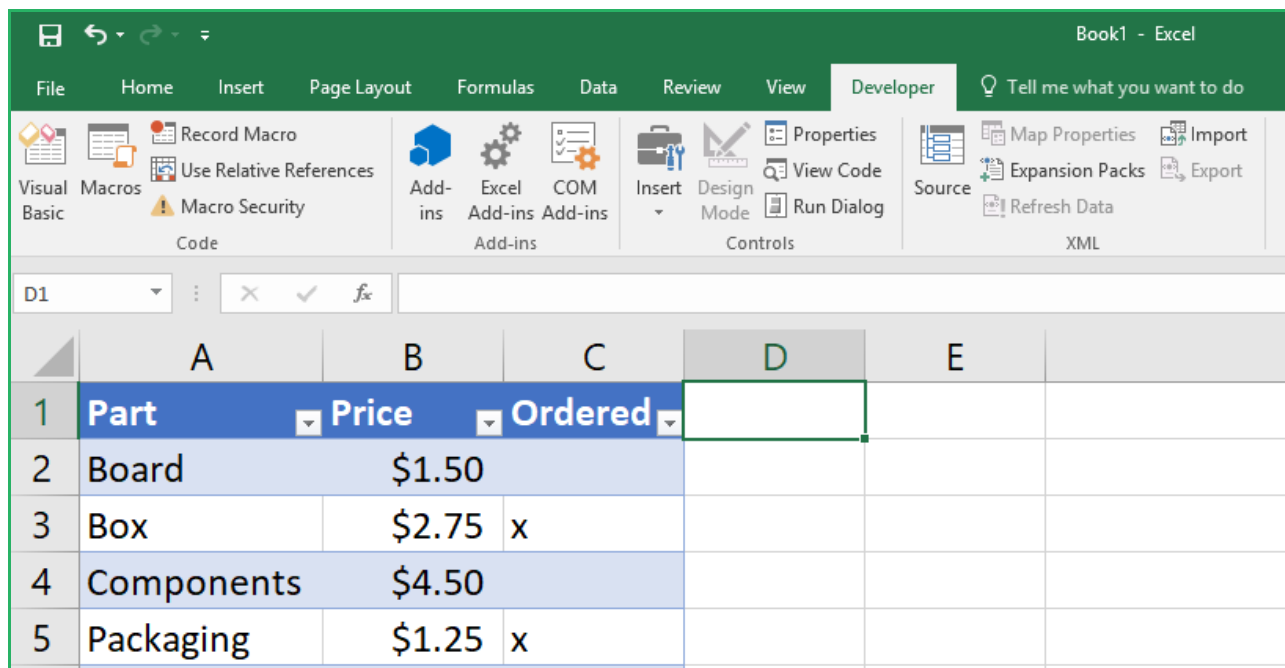


Figure 7 - The Developer Tab

Adding a checkbox

Open up the example workbook, and make sure you're looking at the first worksheet, Parts. You might use something like this for a presentation or a tool to distribute to your co-workers.

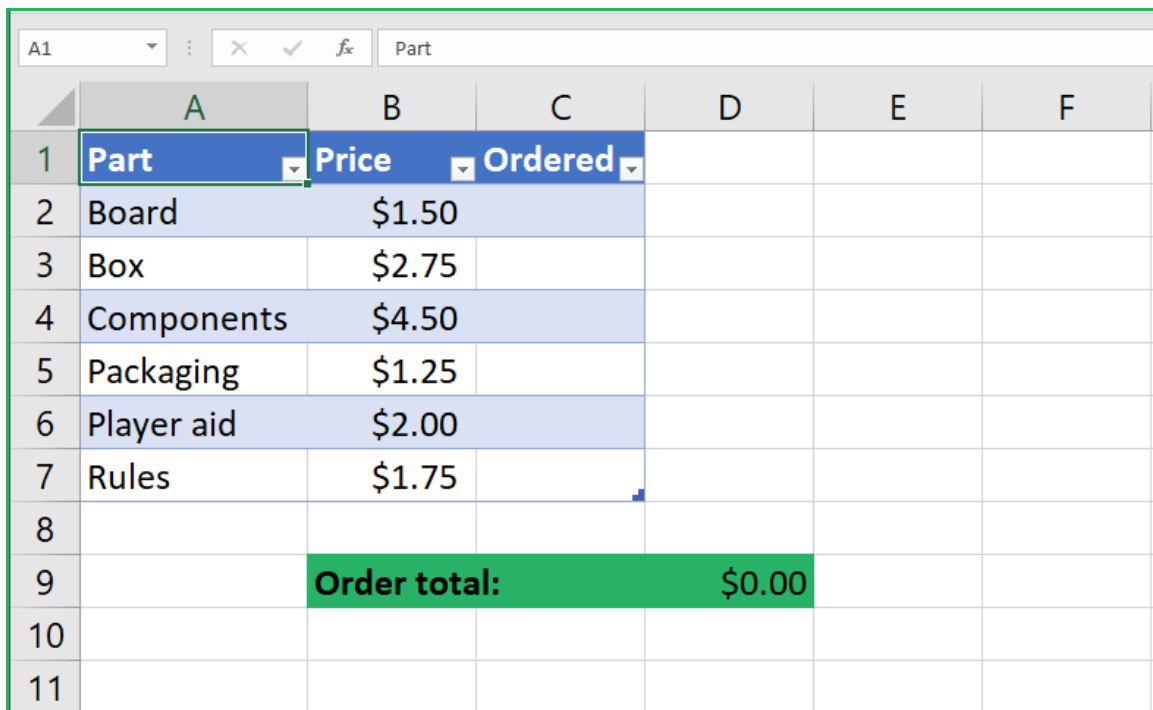
In the spreadsheet's current state, we're using the following formula to calculate the total for a single order:

```
=SUM(IF(ISTEXT(C2),B2),IF(ISTEXT(C3),B3),IF(ISTEXT(C4),B4),IF(ISTEXT(C5),B5),IF(ISTEXT(C6),B6),IF(ISTEXT(C7),B7)))
```

This formula checks to see if any cell in column C has text in it, and if it does, adds the corresponding value from column B to the order.

Let's use checkboxes to make it clearer.

1. First, we'll delete the values from column C.



	A	B	C	D	E	F
1	Part	Price	Ordered			
2	Board	\$1.50				
3	Box	\$2.75				
4	Components	\$4.50				
5	Packaging	\$1.25				
6	Player aid	\$2.00				
7	Rules	\$1.75				
8						
9		Order total:		\$0.00		
10						
11						

Figure 8 - Deleting the Values

2. Then, click on the **Developer** tab in the Ribbon, and click **Insert**. From the resulting drop-down menu, select the checkbox under **Form Controls**:

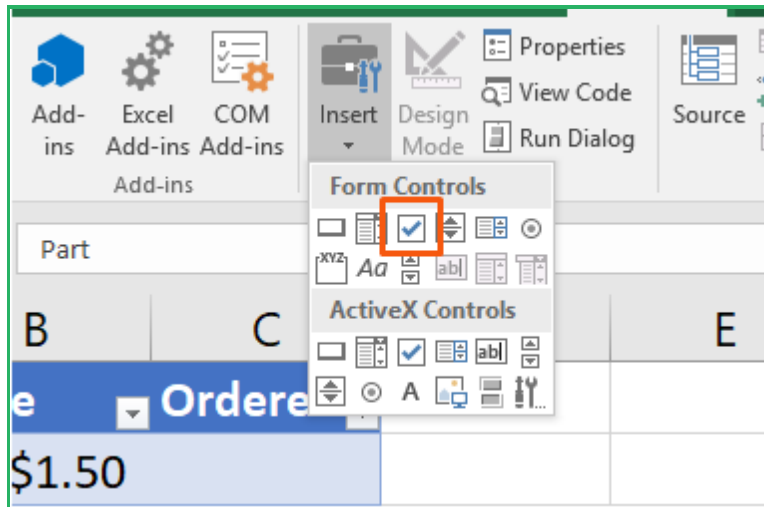


Figure 9 – Selecting the Check Box Form Control

You'll need to click and drag to create a box in which the checkbox will appear. Drag around the cell that you want the checkbox in to get it near where you want it. (In our case, that's cell C2.)

	A	B	C	D	E	F
1	Part	Price	Ordered			
2	Board	\$1.50	<input type="checkbox"/> Check Box 1			
3	Box	\$2.75				
4	Components	\$4.50				
5	Packaging	\$1.25				
6	Player aid	\$2.00				
7	Rules	\$1.75				
8						
9		Order total:		\$0.00		
10						

Figure 10 – Dragging the Check Box Form Control in a Cell

- You'll see that the checkbox comes with some text (this one is labeled "Check Box 1"). You can delete that, so you're left with a simple checkbox:

	A	B	C	D	E	F
1	Part	Price	Ordered			
2	Board	\$1.50	<input type="checkbox"/>			
3	Box	\$2.75				
4	Components	\$4.50				
5	Packaging	\$1.25				
6	Player aid	\$2.00				
7	Rules	\$1.75				
8						
9		Order total:		\$0.00		
10						

Figure 11 – The Finished Check Box

- Now, if you click on that checkbox, a check will appear. Pretty cool, right? But not especially useful, because it doesn't do anything. We need to connect that checkbox to another cell.
- Right-click on the checkbox, and select **Format Control...**

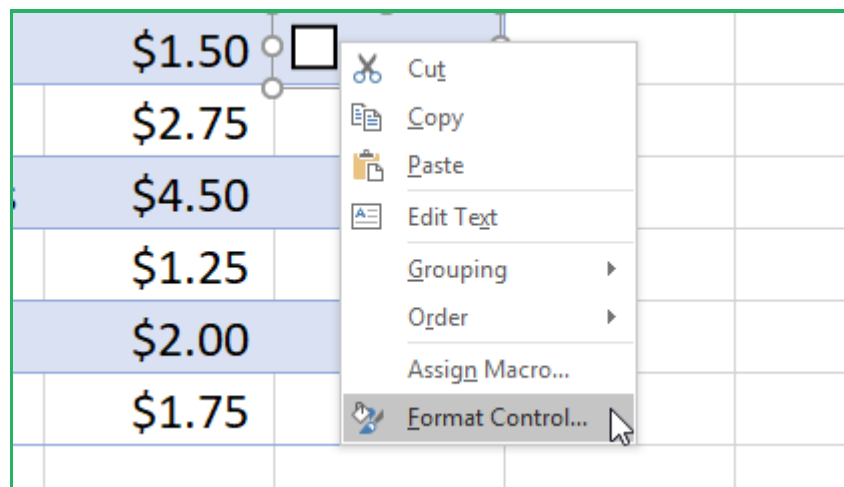


Figure 12 – Using the Format Control

In the resulting window, you'll see that the **Cell link** box is blank. Let's fix that.

- Click into the box, and then click a cell in the spreadsheet. We'll use E2 so you can see what's happening:

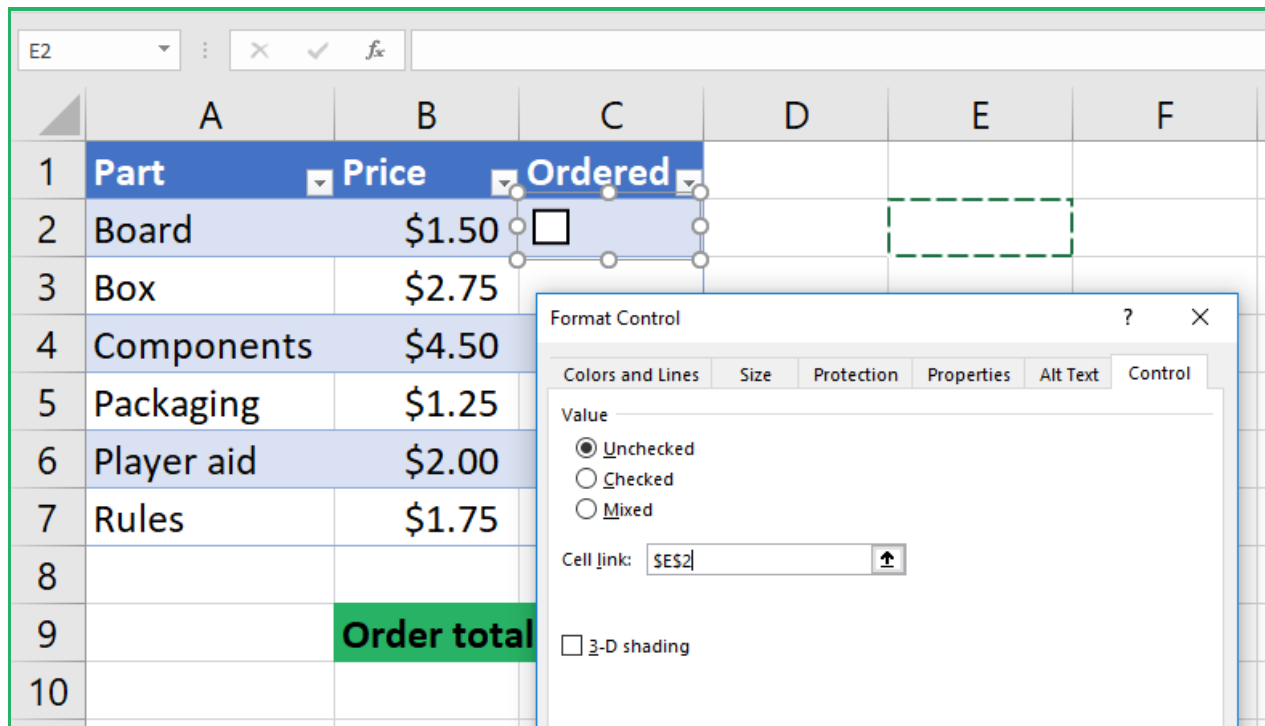


Figure 13 – Using the Format Control

If you're trying to make a professional-looking form, you might want to link the checkbox to a cell in another worksheet. You can also hide the column that contains the TRUE/FALSE values. Now, when you check the box in C2, you'll see a TRUE value appear in F2.

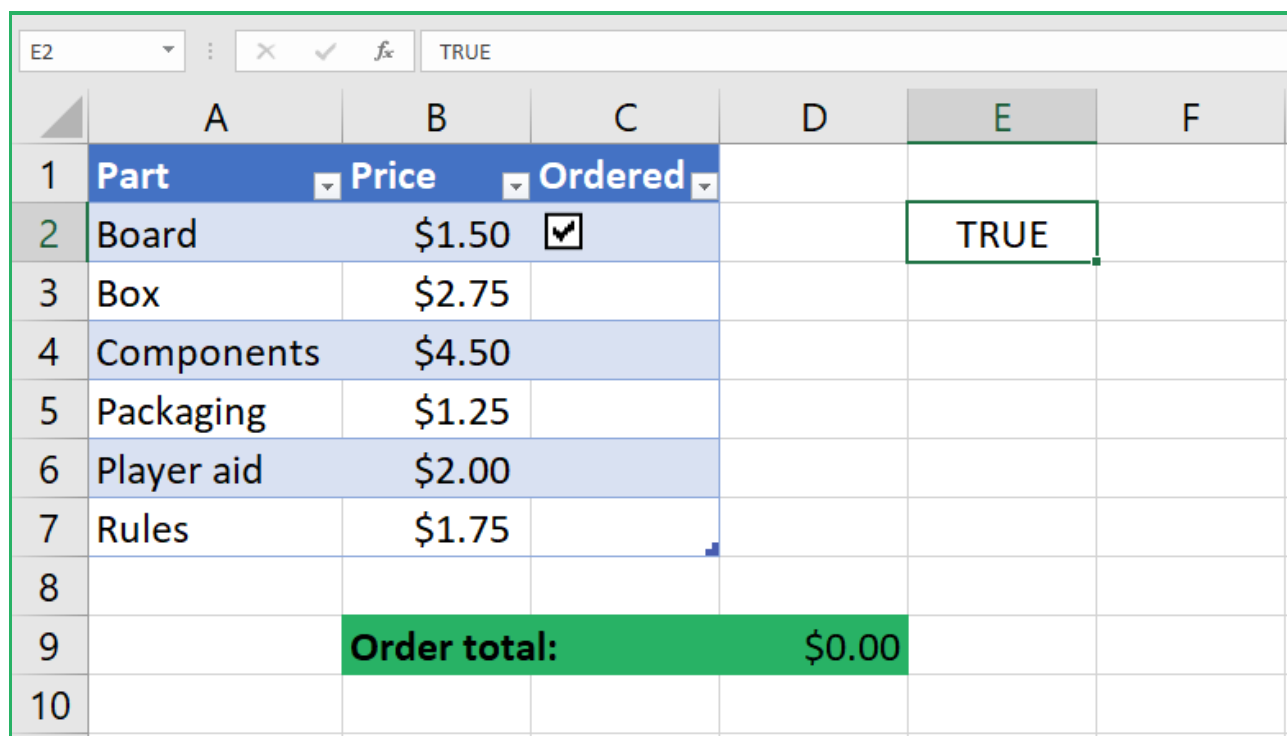


Figure 14 – The Results when you format a Control

Note that after you right-click on a checkbox to change options, you'll need to **click out of that cell** before you can check or uncheck the box again.

If we repeat this process five times, you'll have six checkboxes next to each part, along with six TRUE/FALSE cells.

	A	B	C	D	E	F
1	Part	Price	Ordered			
2	Board	\$1.50	<input checked="" type="checkbox"/>		TRUE	
3	Box	\$2.75	<input type="checkbox"/>		FALSE	
4	Components	\$4.50	<input checked="" type="checkbox"/>		TRUE	
5	Packaging	\$1.25	<input type="checkbox"/>		FALSE	
6	Player aid	\$2.00	<input type="checkbox"/>		FALSE	
7	Rules	\$1.75	<input checked="" type="checkbox"/>		TRUE	
8						
9		Order total:		\$0.00		
10						

Figure 15 – Formatting the Other Check Boxes

Working with linked cells

We've now added some checkboxes to our spreadsheet . . . but what can we do with them? Let's check it out.

1. First, let's rewrite our original totaling formula to work with the checkboxes. Here's how we'll do that:

`=SUM(IF(E2,B2),IF(E3,B3),IF(E4,B4),IF(E5,B5),IF(E6,B6),IF(E7,B7))`

Doesn't that look nicer than the formula we were using before?

2. Try entering this formula into cell D9 and checking a few of the boxes to see what happens.

A1						
	A	B	C	D	E	F
1	Part	Price	Ordered			
2	Board	\$1.50	<input checked="" type="checkbox"/>		TRUE	
3	Box	\$2.75	<input type="checkbox"/>		FALSE	
4	Components	\$4.50	<input checked="" type="checkbox"/>		TRUE	
5	Packaging	\$1.25	<input type="checkbox"/>		FALSE	
6	Player aid	\$2.00	<input type="checkbox"/>		FALSE	
7	Rules	\$1.75	<input checked="" type="checkbox"/>		TRUE	
8						
9		Order total:		\$7.75		
10						

Figure 16 – The Dynamic Total

Just like with any other type of true or false cells, you can count the number of responses. Let's count the number of items we ordered.

- First click into cell B10 and type "Number of items ordered:"

Packaging	\$1.25	<input type="checkbox"/>		FALSE	
Player aid	\$2.00	<input type="checkbox"/>		FALSE	
Rules	\$1.75	<input checked="" type="checkbox"/>		TRUE	
	Order total:		\$7.75		
	Number of items ordered:				

Figure 17 – Setting up for a Count Total

4. Then, in E10, type the following formula:

=COUNTIF(E2:E7, TRUE)

Now, we see a count of how many items we ordered:

	A	B	C	D	E	F
1	Part	Price	Ordered			
2	Board	\$1.50	<input checked="" type="checkbox"/>		TRUE	
3	Box	\$2.75	<input type="checkbox"/>		FALSE	
4	Components	\$4.50	<input checked="" type="checkbox"/>		TRUE	
5	Packaging	\$1.25	<input type="checkbox"/>		FALSE	
6	Player aid	\$2.00	<input type="checkbox"/>		FALSE	
7	Rules	\$1.75	<input checked="" type="checkbox"/>		TRUE	
8						
9		Order total:		\$7.75		
10		Number of items ordered:			3	
11						

Figure 18 – A Dynamic Count Total

The formula counts the number of TRUE entries in column F, which corresponds to the number of checkboxes checked.

Using checkboxes with conditional formatting

You've seen how checkboxes can control other cells—now let's look at improving the presentation a bit. We'll apply conditional formatting so it's easy to see exactly which items on the list have been ordered.

1. First, select cell A2, go to the **Home** tab on the Ribbon, and click **Conditional Formatting**:

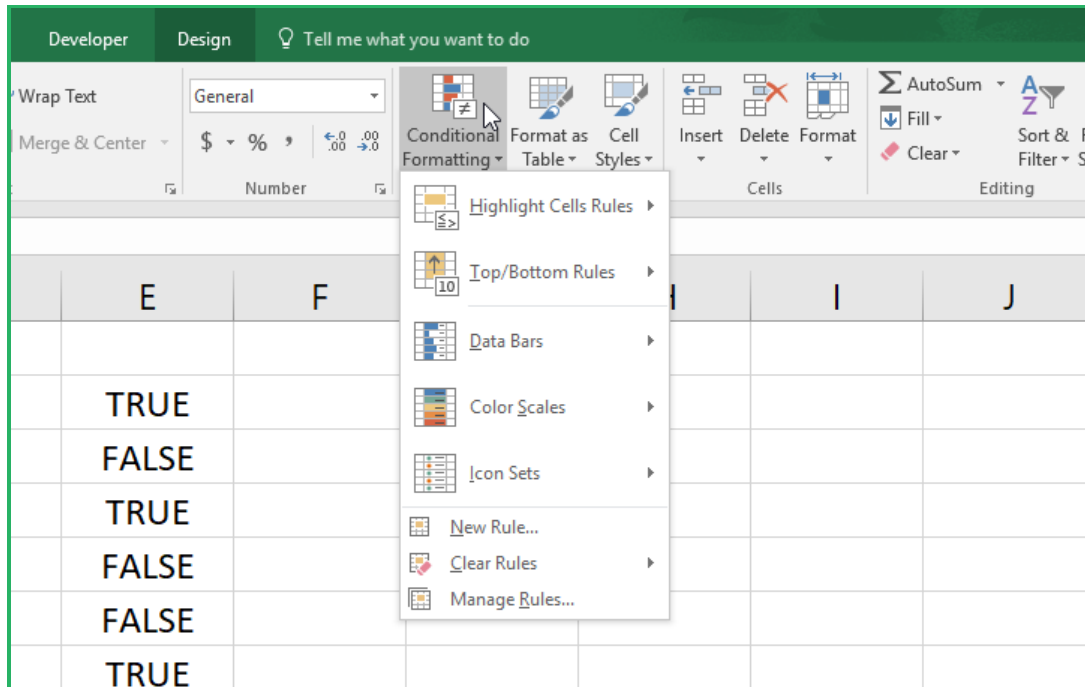


Figure19 – Setting Up a Conditional Format on Check Boxes

2. Hover over **Highlight Cells Rules**, and select **More Rules...**

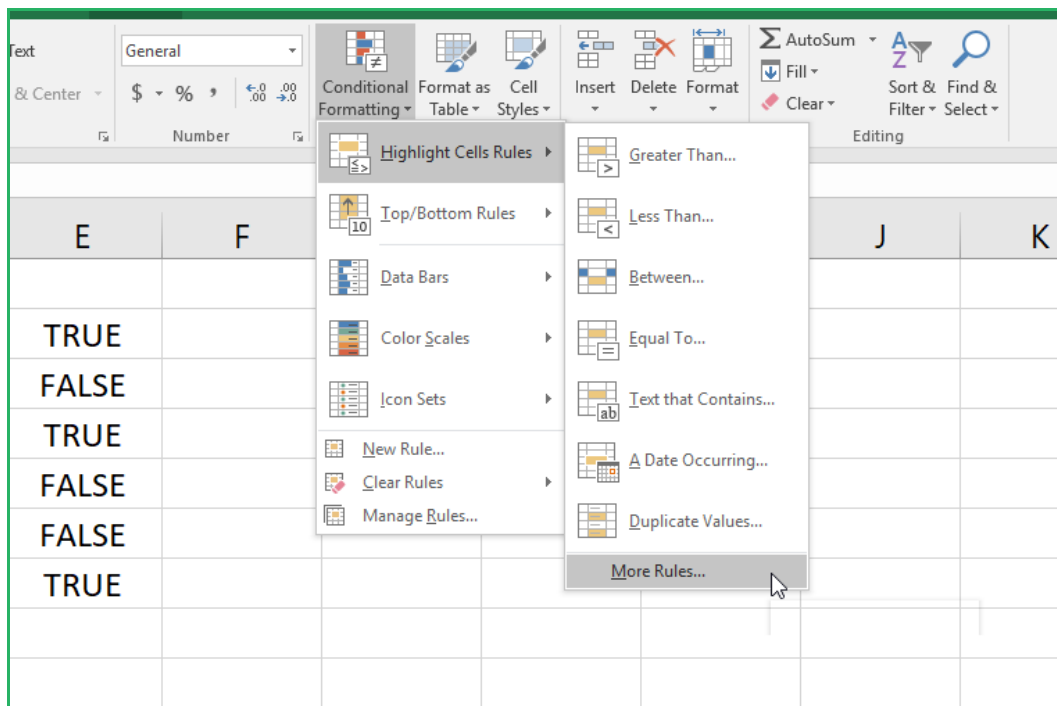


Figure 20 – Setting Up a Rules

3. Among the available options you'll find **Use a formula to determine which cells to format**. Select that one:

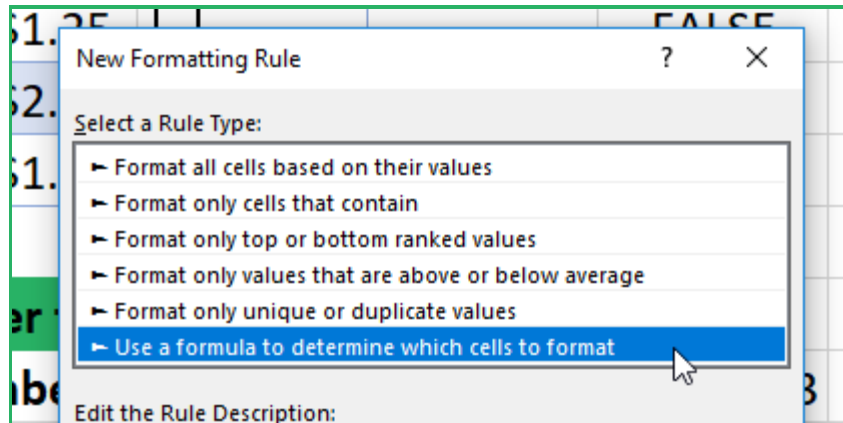


Figure 21 – Selecting the Rule Type

4. In the **Format values where this formula is true** box, click the upward-facing arrow and select cell E2:

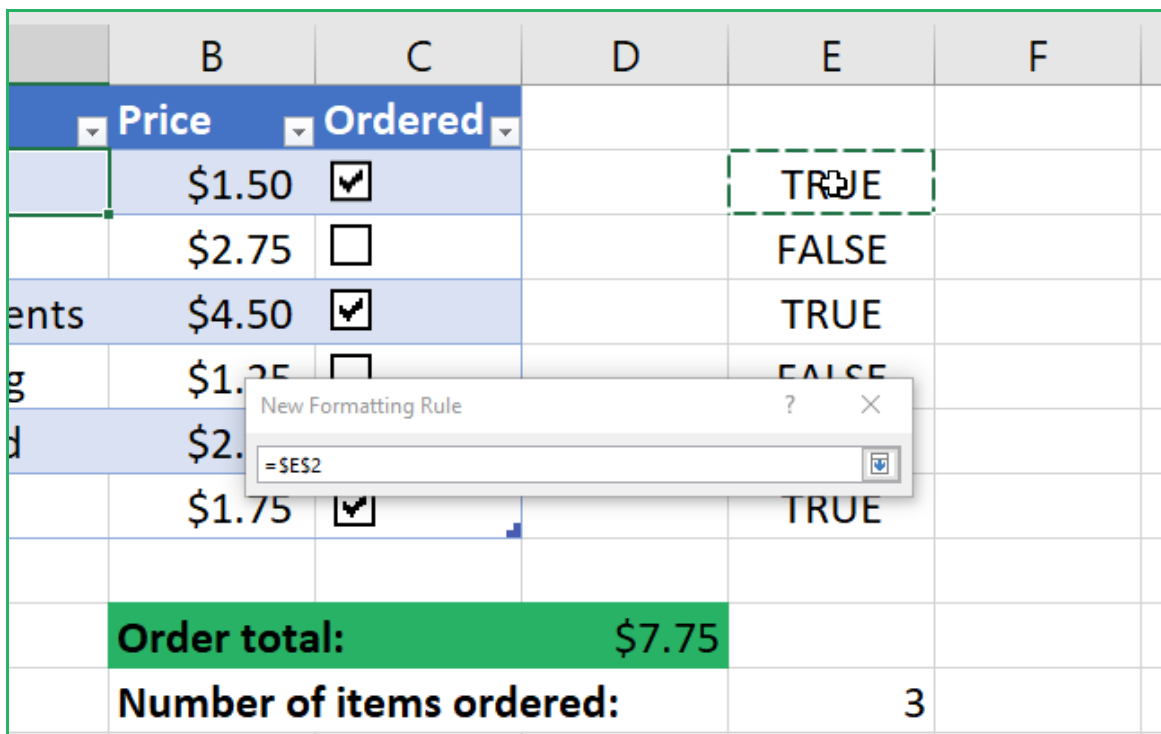


Figure 22 – Creating the Rule

5. For this particular example, make sure to remove the dollar signs from the Format values where this formula is true: box.
6. Alternatively, you can save a bit of time by simply typing =E2 in the box.
7. Now, we'll choose a format. Click the **Format...** button, and change the highlighting to a light green color, the text color to dark green, and the text style to bold:

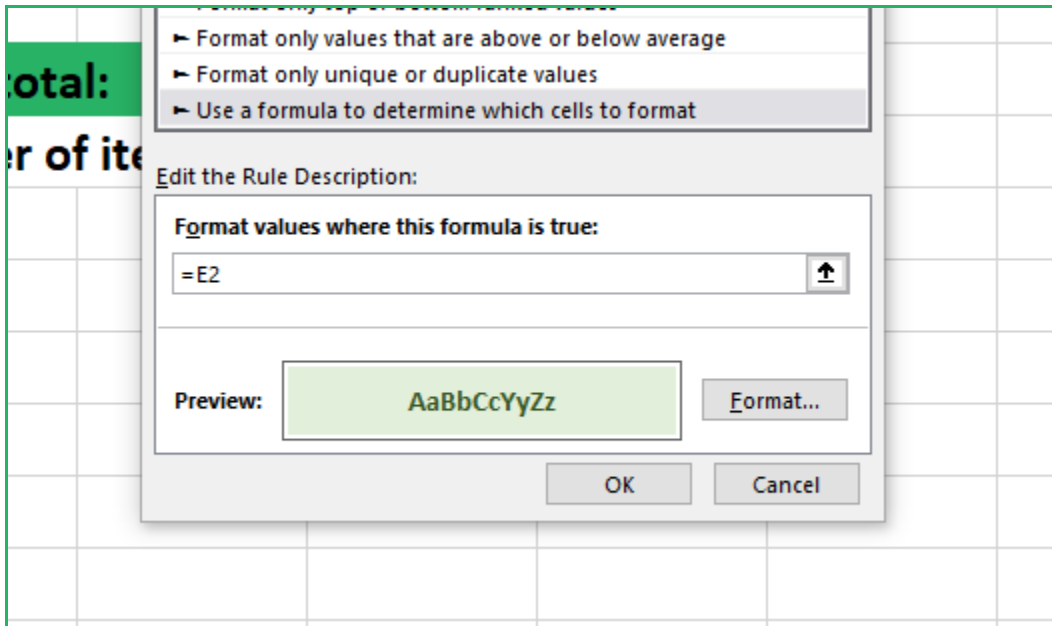


Figure 23 – Formatting the Conditional Format

8. Finally, click **OK**.
9. Now, use the fill handle to drag cell A2 down through A7:

	A	B	C	D
1	Part	Price	Ordered	
2	Board	\$1.50	<input checked="" type="checkbox"/>	
3	Box	\$2.75	<input type="checkbox"/>	
4	Components	\$4.50	<input checked="" type="checkbox"/>	
5	Packaging	\$1.25	<input type="checkbox"/>	
6	Player aid	Board \$2.00	<input type="checkbox"/>	
7	Rules	\$1.75	<input checked="" type="checkbox"/>	
8				

Figure 24 – Selecting the Rest of the Cells

10. In the pop-up menu, select **Fill formatting only**.

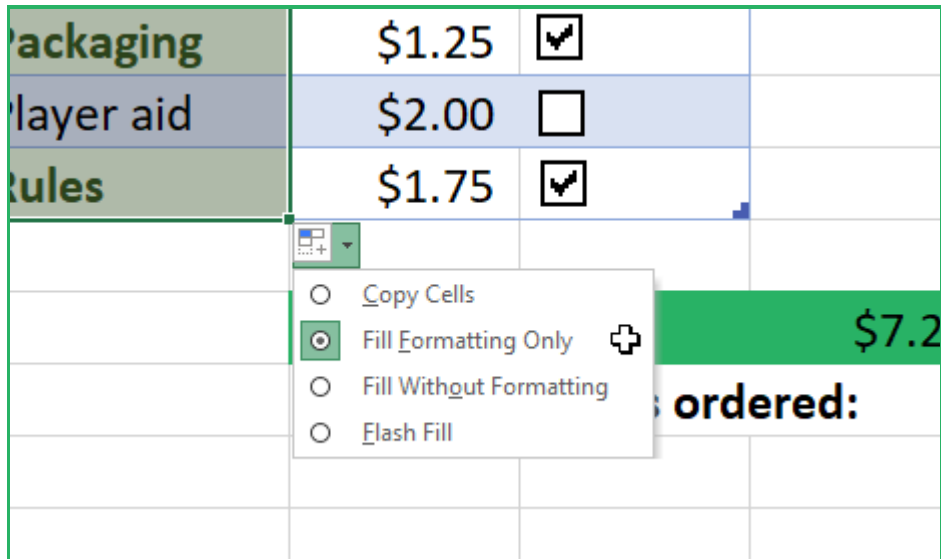


Figure 25 - Turning on the Developer Tab

Now, any cell in column A that corresponds to a checked box in column C will receive the green highlight:

	A	B	C	D	E	F
1	Part	Price	Ordered			
2	Board	\$1.50	<input checked="" type="checkbox"/>		TRUE	
3	Box	\$2.75	<input checked="" type="checkbox"/>		TRUE	
4	Components	\$4.50	<input type="checkbox"/>		FALSE	
5	Packaging	\$1.25	<input checked="" type="checkbox"/>		TRUE	
6	Player aid	\$2.00	<input type="checkbox"/>		FALSE	
7	Rules	\$1.75	<input checked="" type="checkbox"/>		TRUE	
8						
9		Order total:		\$7.25		
10		Number of items ordered:			4	

Figure 26 – The Finished Workbook

How To Easily Create A Drop-Down List

The drop-down list is a *great* way to seem like a superuser. At the same time, it's a very user-friendly asset in almost all custom-made Excel sheets.

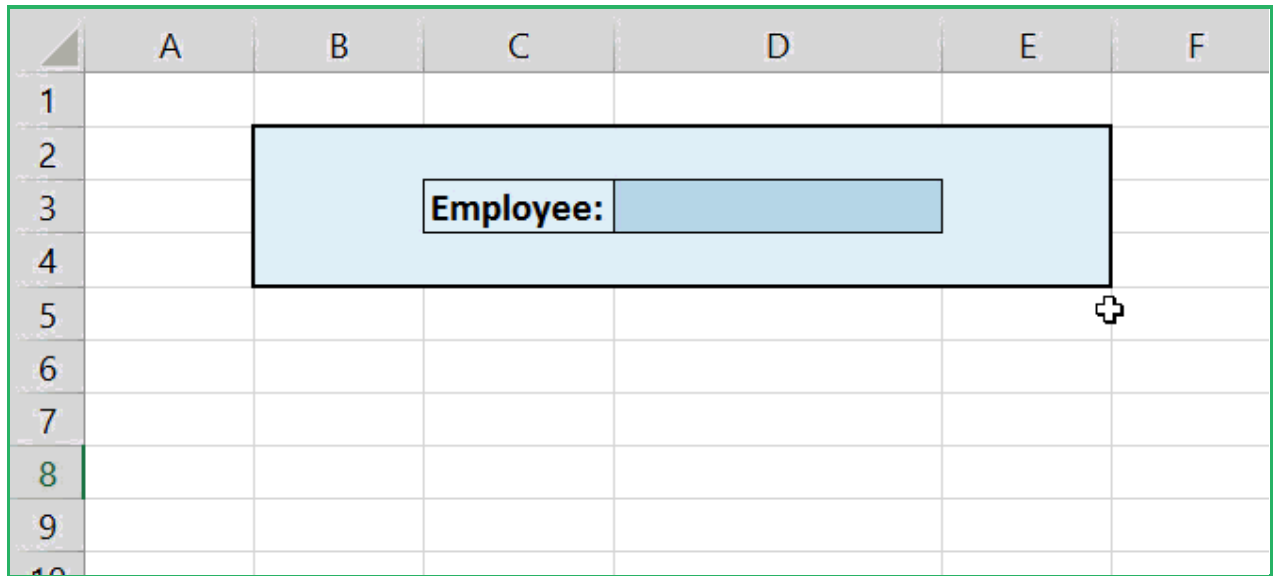


Figure 27 – Creating a Dropdown List

A drop-down list is actually a tiny window from where you can peek into some other data you have constructed. This also gives you the possibility of controlling *exactly* what can be entered into a cell. This makes the drop-down menu a very common and powerful data validation tool.

1. First, we have a sheet with all the names of our employees.

This is the data we would like to see when opening our drop-down menu.

	A	
1	Employees	
2	Abigail Aalderink	
3	Andrew Gupta	
4	Annie Hunter	
5	Apple Lyn	
6	Bobbi Simon	

Figure 28 – The List

Then we have the “gateway” where we want to be able to scroll through all the names on the other sheet. This “gateway” is placed in the “Dropdown” sheet of the Excel sample file.

2. We'll put our drop-down menu in cell B1.

	A	B	C
1	Employee:		
2			

Figure 28 – Selecting the Dropdown Cell

3. Go to the “Data” tab

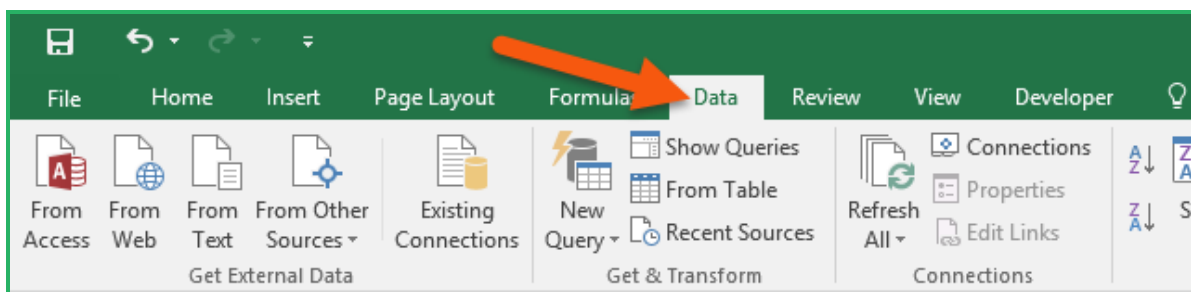


Figure 29 – Opening the Data Tab

4. Click “Data Validation”

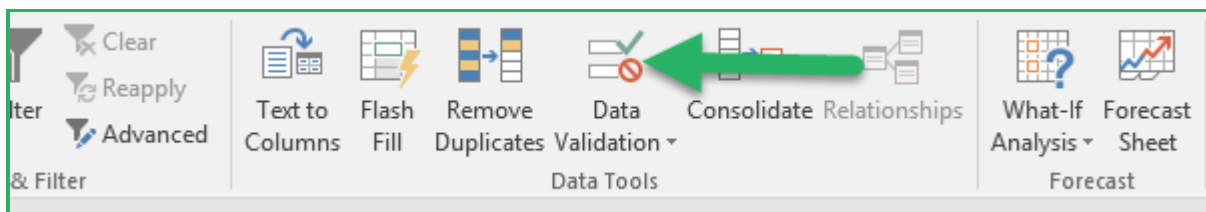


Figure 30 – Selecting Data Validation

5. Choose the “List”

In the pop-up box, you need to click the drop-down menu to pick what kind of data validation method you want.

6. Click the arrow next to the field and click “List”

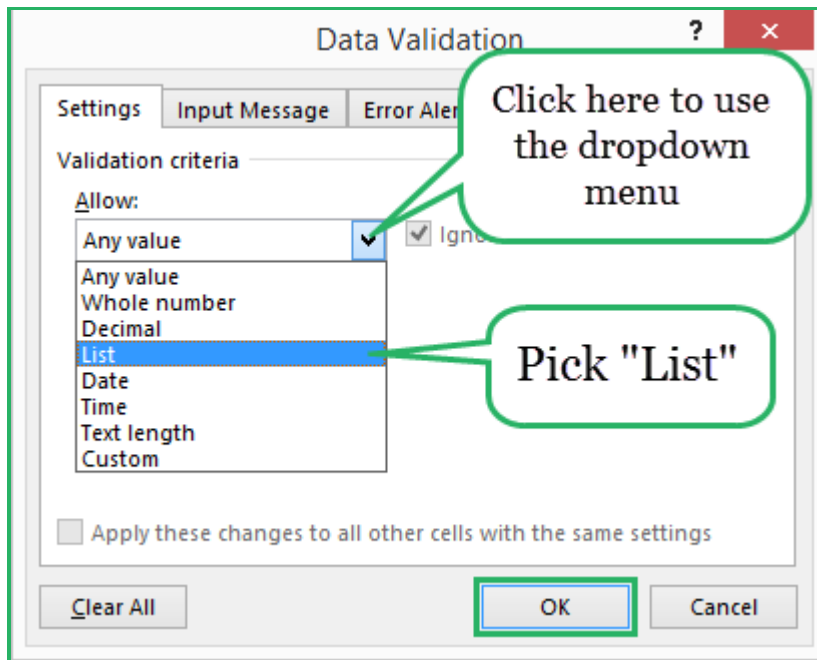


Figure 31 – Selecting List

7. Click “OK” to move on to the next step.
8. Select the source which is the data sheet.
9. Click once in the “Source:” field.
10. Then click the “Data” sheet and select all the employees.
11. Click “OK”.

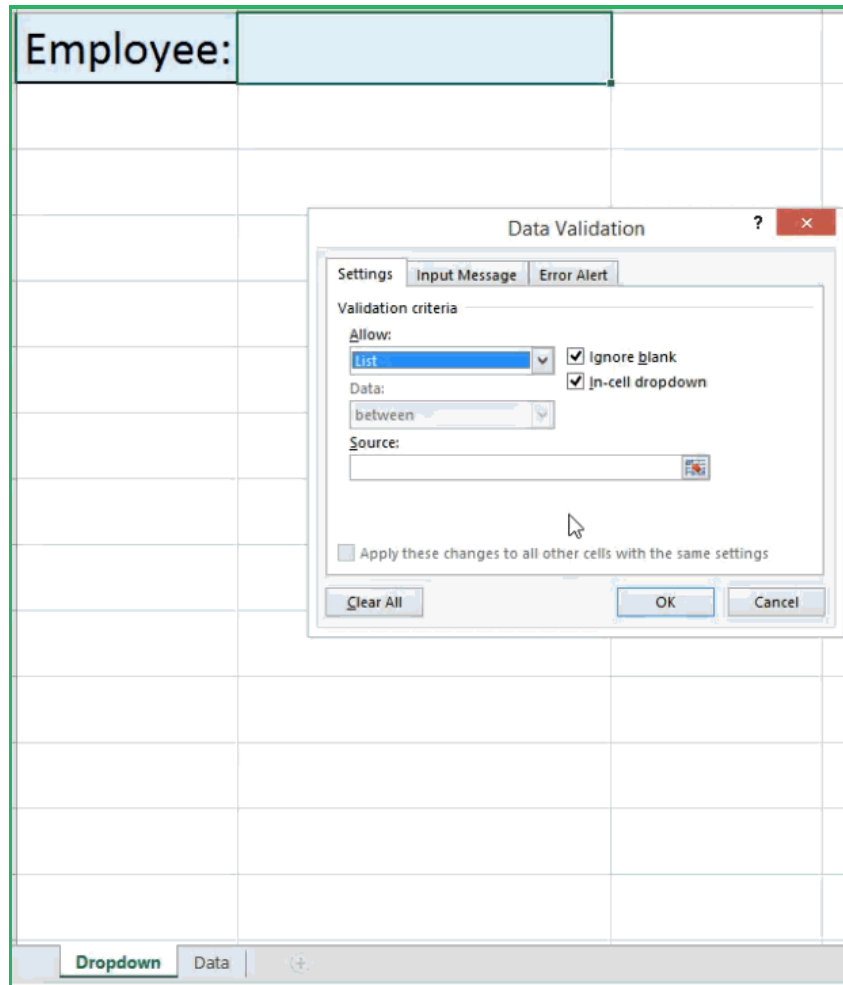


Figure 32 – Setting the Source

There's a neat shortcut you can use to select all the employee names in (almost) an instant. When selecting the cells for the source, select the first name you encounter (in cell A2) – then hold down Ctrl + Shift and click the down arrow on your keyboard. You've now selected *all the names* in the sheet in just a few seconds.

Here's the end result!

	A	B	C
1	Employee:		
2		Abigail Aalderink	
3		Andrew Gupta	
4		Annie Hunter	
5		Apple Lyn	
6		Bobbi Simon	
7		Bradley Sack	
		Bryan Sloane	
		Caylie Price	

Figure 33 – The Finished Dropdown List

How To Add A Combo Box In Excel.

Combo Boxes are a great tool for **enhancing user interaction** with your spreadsheets. They are drop down list type elements that enable the user to choose among selections in a list

What Is a Combo Box?

We already stated that a ComboBox is a drop down list element. We also said that they enhance the user experience with spreadsheets. On the administrative side, creating a ComboBox allows for **more control over user input**. This can be practical in cases where text input is not optimal.

In Excel, we find two options for creating a ComboBox. There is one option called **Form Control** while the other is **ActiveX Control**. We will use the Form Control approach and use the list that is shown in the Figure below.

	A	B	C
1			
2		Eye Color	
3		Black	
4		Brown	
5		Blue	
6		Green	
7		Hazel	
8		Grey	
9			
10			

Figure 34 – The Combo Box Data

1. Go to the Controls group of the Developer tab and click on the arrow under Insert. You should see both Form Control and ActiveX Control elements.

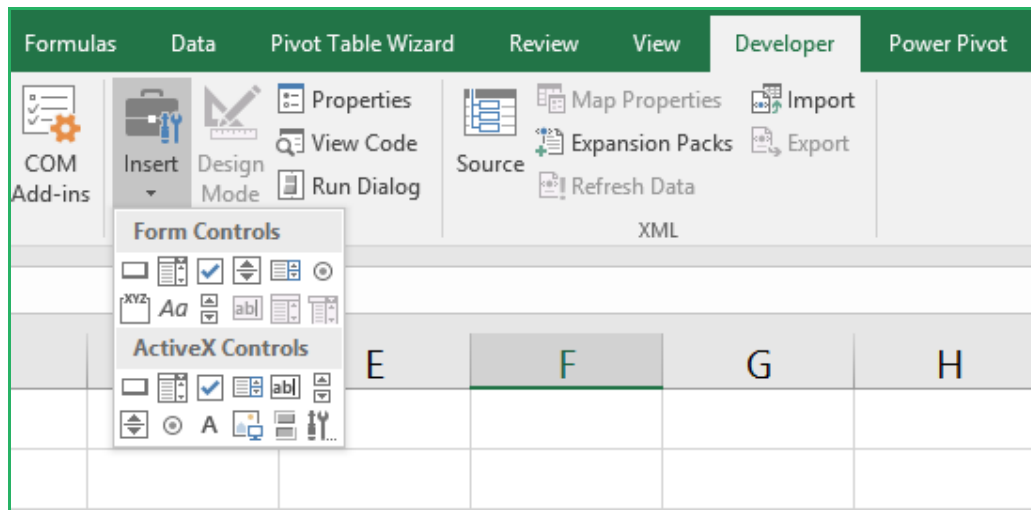


Figure 35 – Viewing the Controls

2. Select the Combo Box icon from **Form Controls**.

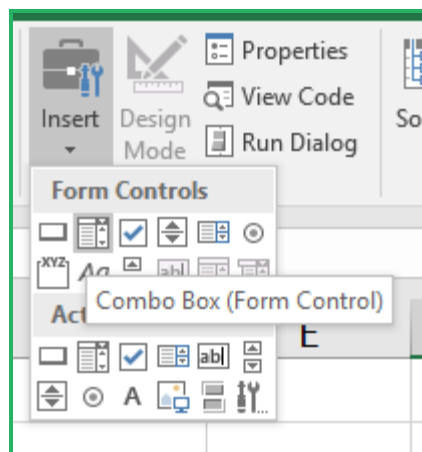


Figure 36 – The Combo Box Control

3. Once you click on ComboBox, you can now drag your mouse and draw the ComboBox into your worksheet.

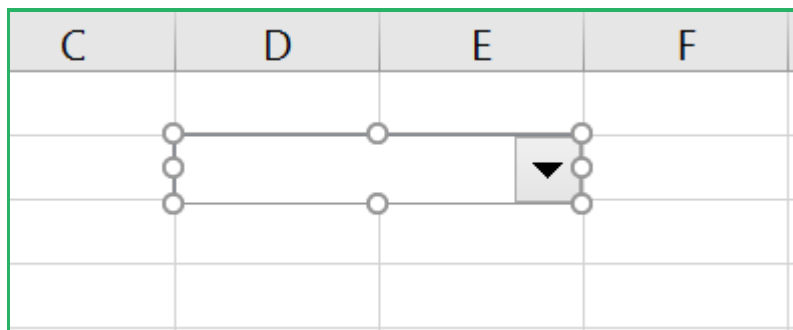


Figure 37 – Dragging the Combo Box Control to a Cell

4. Right click on our new ComboBox element and select Format Control.

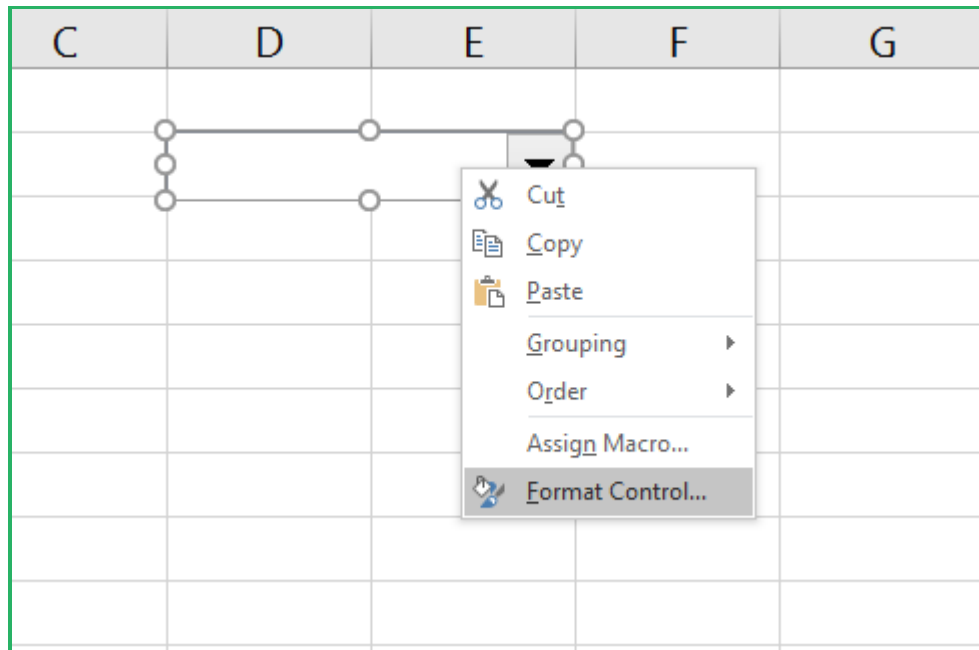


Figure 38 – Opening Up the Format Control

5. Once the Format Object dialog box opens, go to the **Control** tab.
6. Click on the button to the right of the Input range text box to select the range of values for our list.

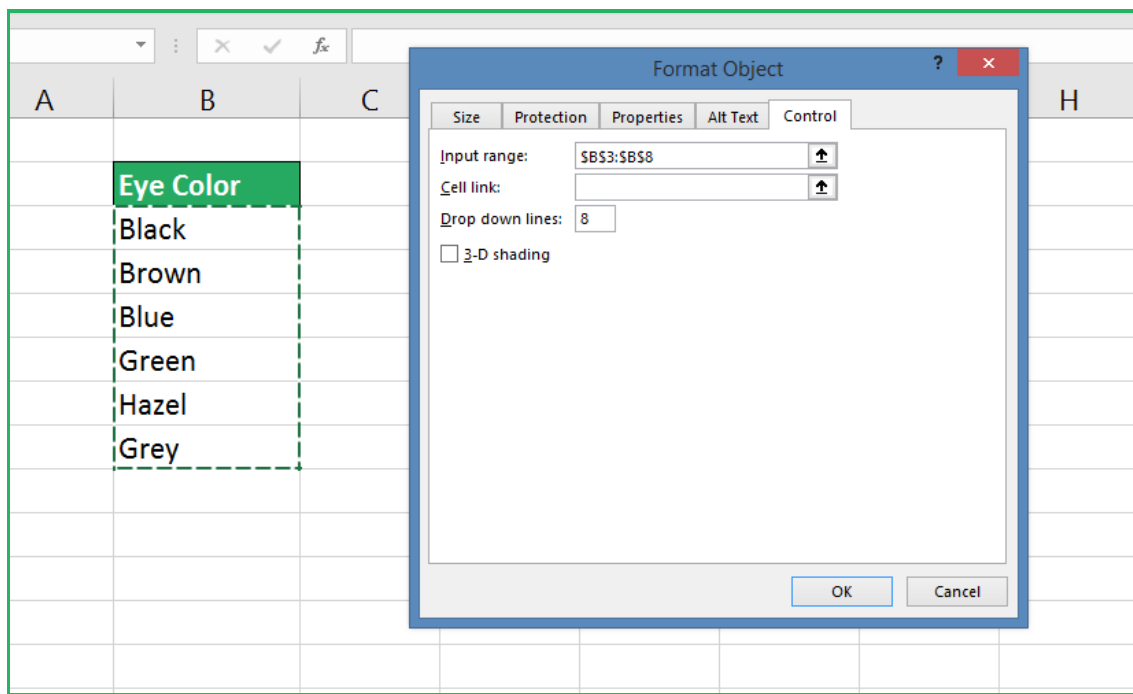


Figure39 – Setting the Range

We can also change the number of drop down lines to 6.

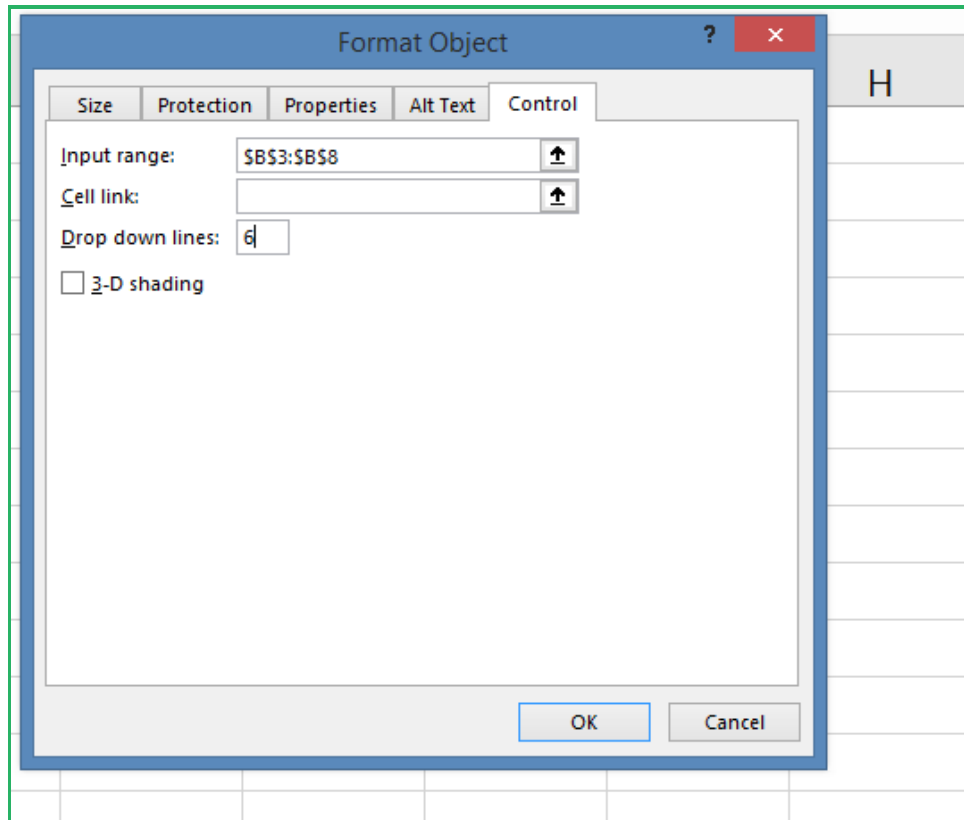


Figure 40 – Setting the Number of Dropdown Lines

7. Click OK.
8. Now you should be able to click on the down arrow in your ComboBox to see your list.

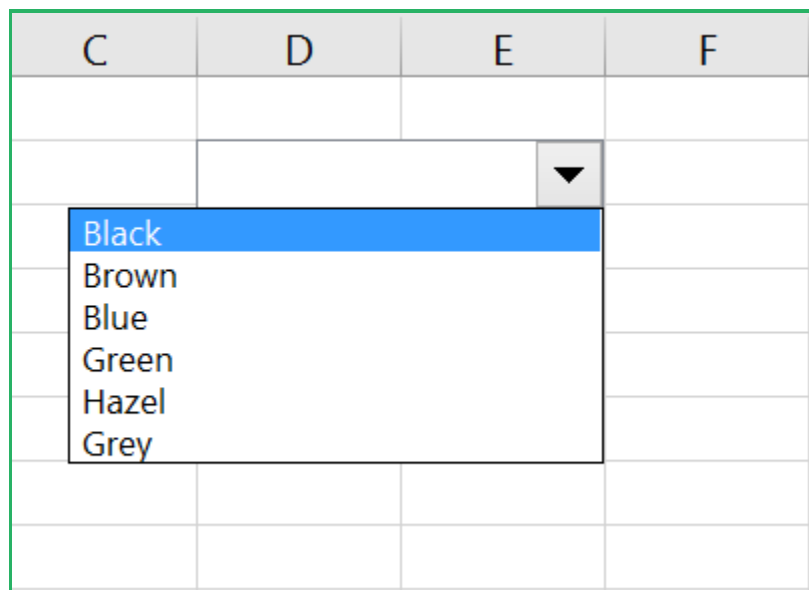


Figure 41 – The Finished Combo Box