Managing Six Sigma: Understanding the Importance of Self Study

By Dean Christolear

Chapter Two - Measure

Clearly, the Roughing process is responsible for the largest portion of the department scrap. It is almost twice as large as Finishing scrap. This is unusual, since you talked to one of the operators at the roughing operation, and he did not say that scrap seemed to be unusually high.

While you were developing the process flowchart for Part No. 922 you learned that 100% of all parts produced are checked to ensure the diameter is within specification. You decide to visit the roughing operation again to see what information you can gather. One of the operators shows you his Quality Check Sheet for the roughing operation. Once per hour, the operator is required to record the diameter of one shaft. A ring binder at each of the three machines contains the current check sheet for the current week as well as previous weeks. There is data for both first and second shifts. You obtain permission from the supervisor to copy the check sheets for all three lathes.

Your supervisor has volunteered his administrative assistant for any clerical work you may need. She has entered the data into Microsoft Excel® (open the file `Rougher check sheets.xls`) for you to use. Upon opening the file, you find the data arranged in the fashion shown.

Quality Check Sheet
Rougher Number 1

Week 8/7/2006 Shift 1

Monday									
Hour	7:00	8:00	9:00	10:00	11:00	12:00	1:00	2:00	3:00
Diameter	18.883	18.847	18.855	18.844	18.845	18.868	18.863	18.856	18.847

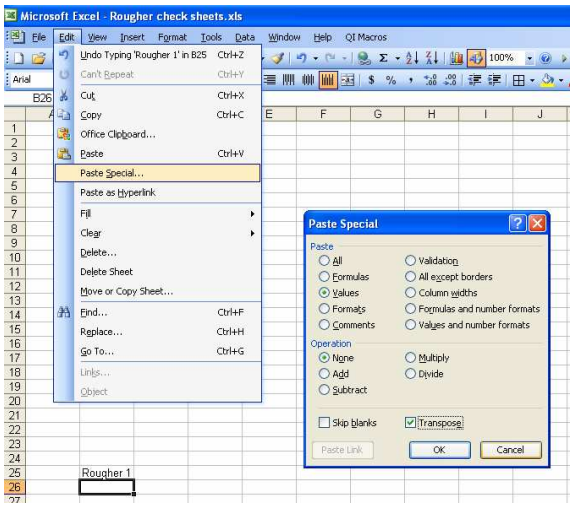
Tuesday									
Hour	7:00	8:00	9:00	10:00	11:00	12:00	1:00	2:00	3:00
Diameter	18.869	18.823	18.849	18.821	18.843	18.875	18.81	18.781	18.867

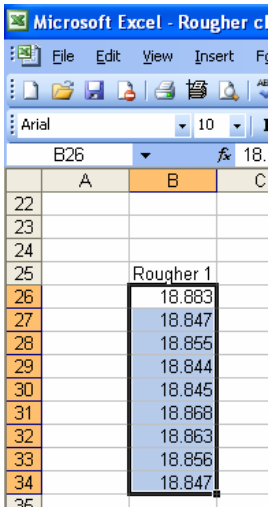
Wednesday									
Hour	7:00	8:00	9:00	10:00	11:00	12:00	1:00	2:00	3:00
Diameter	18.848	18.849	18.876	18.839	18.861	18.859	18.803	18.832	18.847

Thursday									
Hour	7:00	8:00	9:00	10:00	11:00	12:00	1:00	2:00	3:00
Diameter	18.841	18.81	18.854	18.9	18.818	18.871	18.864	18.843	18.816

Friday									
Hour	7:00	8:00	9:00	10:00	11:00	12:00	1:00	2:00	3:00
Diameter	18.878	18.875	18.877	18.794	18.792	18.796	18.909	18.831	18.824

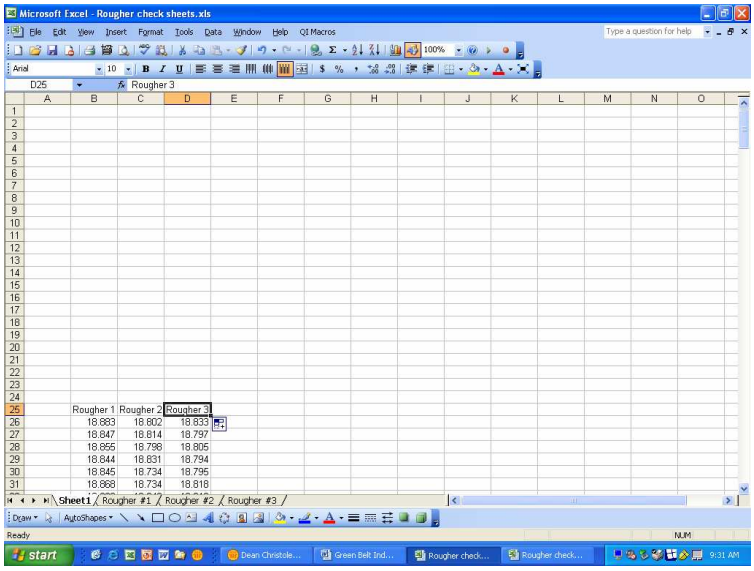
In order to analyze the data you will need to put it in column form. Insert a new worksheet by selecting Insert, Worksheet. A new worksheet ply will be added to the file (most likely labeled Sheet 1). Click on Cell B25 and type “Rougher 1.” Click on the tab labeled Rougher #1 and paint the first row of data for Monday, August 7. There are nine data points representing the first part of the run, the hourly samples and the last part of the run. Copy the cells and then select the tab for the new worksheet. Click Cell B26 and select Edit, Paste Special. When the Paste Special dialog box appears, click Values and Transpose, then click OK.



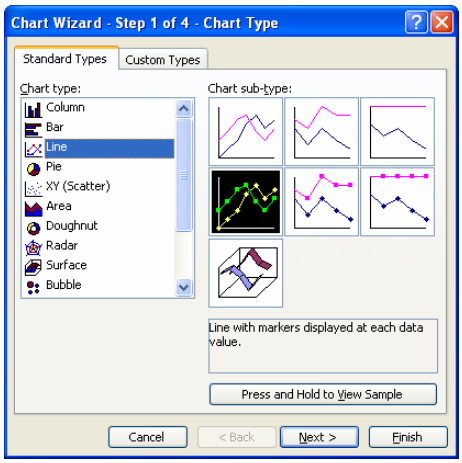


The data for the first day will appear in Column B without formatting as shown.

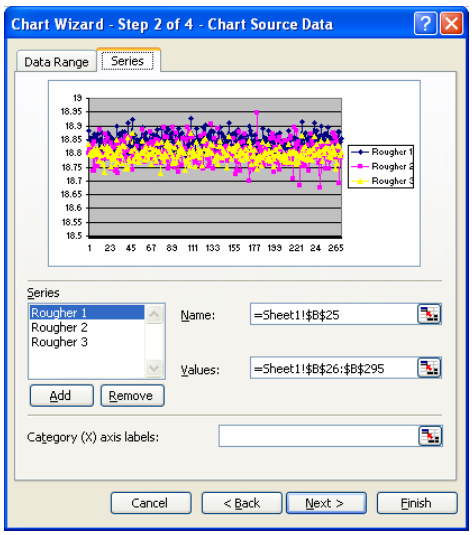
Continue this process for each day. There are three days of data for First and Second Shift. When you finish copying the data, there should be 270 data points for Rougher 1. Repeat the process for Rougher 2 and Rougher 3. When you are finished, your spreadsheet should look as shown.



The first step to understanding the variation in the three roughers is to make a line plot, commonly called a Run chart. Paint all three columns of data including the header. Select Insert, Chart and select the Line option.



If the Chart Wizard's Step 2 of 4 does not automatically populate the Name and Values fields, you must do so as you did before in Chapters 1 and 3. The dialog box should appear as shown.

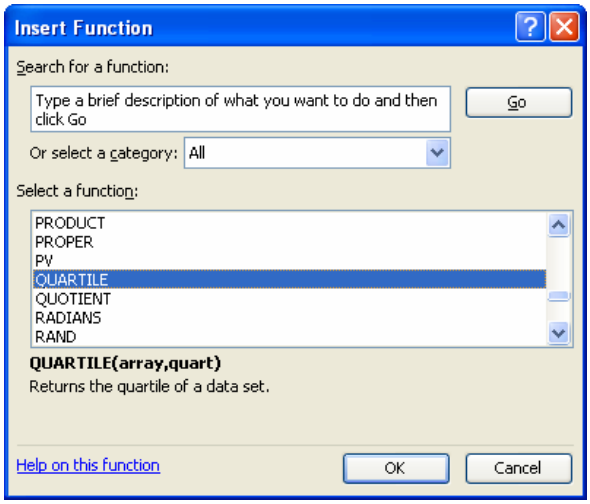


Notice in the preview pane that the chart is very busy. It is difficult to see the variation between the machines with this chart. A better way to compare the three machines is with a box and whisker chart (commonly called a box plot). Click Cancel to close the Chart Wizard.

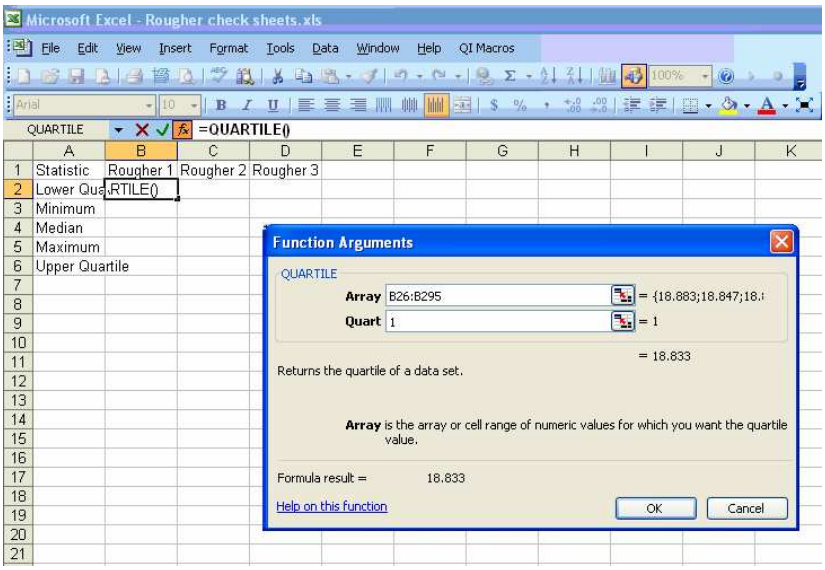
A box plot is a very effective tool that will reduce individual data points to a graph that shows the range of each quartile of a data set. A quartile represents 25 percent of the data set. A box plot will show the spread of the first, second, third and fourth quartiles. You can find an excellent reference on Box Plots at http://www.itl.nist.gov/div898/handbook/eda/section3/boxplot.htm. You are expected to have a thorough understanding of this tool.

The Excel® Chart Wizard does not chart box plots. You will have to create them using a line chart and the Excel® function QUARTILE. Return to Sheet 1 and go to Cell A1. In Cells A1 through A6 type "Statistic", "Lower Quartile", "Minimum", "Median", "Maximum" and "Upper Quartile." In Cells B1 through D1, type "Rougher 1", "Rougher 2" and "Rougher 3."

Click on Cell B2, then select Insert, Function and the category All. Scroll down to QUARTILE, select it and click OK.



As before, click the button for Array and paint the range of data for Rougher 1. Do not include the header. In the Quart box, enter "1" as the value. The spreadsheet should look as shown.



Click OK. You have entered a function that will analyze the range of data for Rougher 1 and return a single value representing the location of the first quartile in the data set.

Restated, 25% of the data lies below the value displayed and 75 % lies above the displayed value. The Quart box in the quartile function will accept the values "0" through "4." For the given range of data, "0" through "4" will display the following values:

0 – Minimum Value

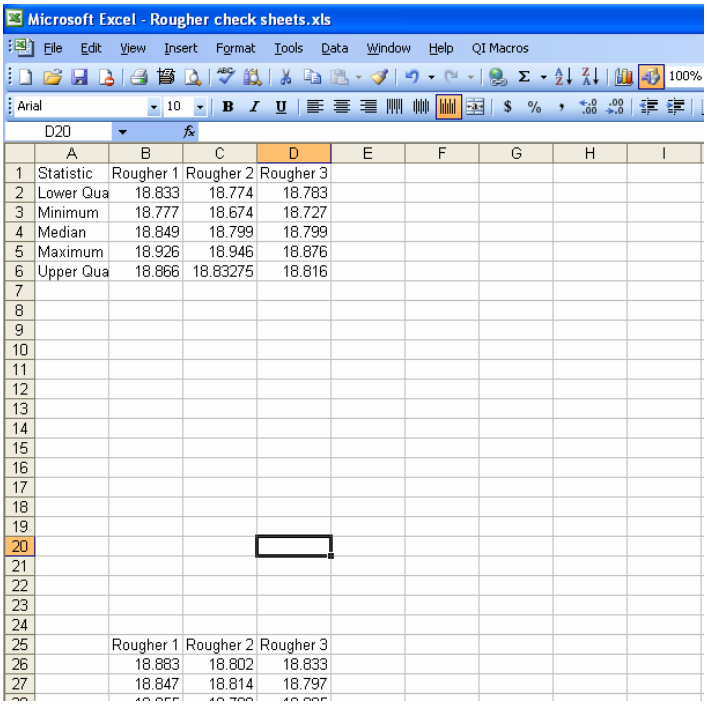
1 – First Quartile

2 – Median Value

3 – Third Quartile

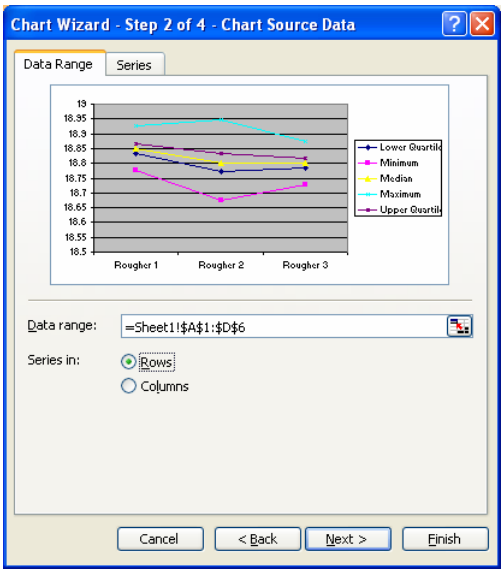
4 – Maximum Value

For your chart, the first required result is "Lower Quartile" and so the value "1" was used in the Quart box. Click on Cell B3 and insert the QUARTILE function again for the "Minimum" value ("0"). Repeat this procedure for the "Median", "Maximum" and "Upper Quartile." Once the functions have been entered for Rougher 1, copy and paste the functions in the cells under Rougher 1 to the cells under Rougher 2 and Rougher 3. Your spreadsheet should look as shown.



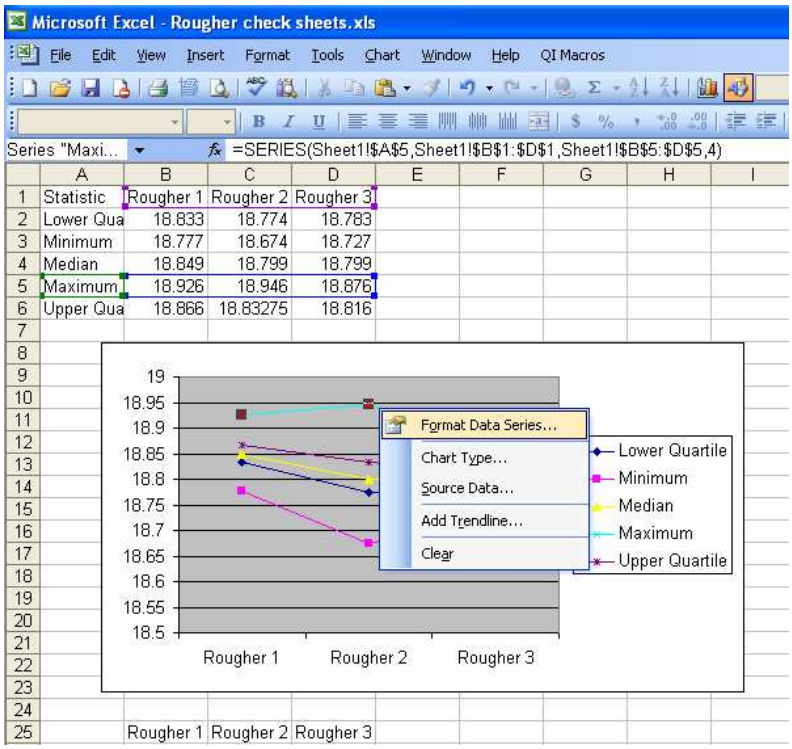
	A	B	C	D
1	Statistic	Rougher 1	Rougher 2	Rougher 3
2	Lower Qua	18.833	18.774	18.783
3	Minimum	18.777	18.674	18.727
4	Median	18.849	18.799	18.799
5	Maximum	18.926	18.946	18.876
6	Upper Qua	18.866	18.83275	18.816
25		Rougher 1	Rougher 2	Rougher 3
26		18.883	18.802	18.833
27		18.847	18.814	18.797

Next, paint the range of cells from Cells A1 to D6. Select Insert, Chart. Select the Line option, then click Next. Change the Series in selection from Columns to Rows. The dialogue box should look as shown.

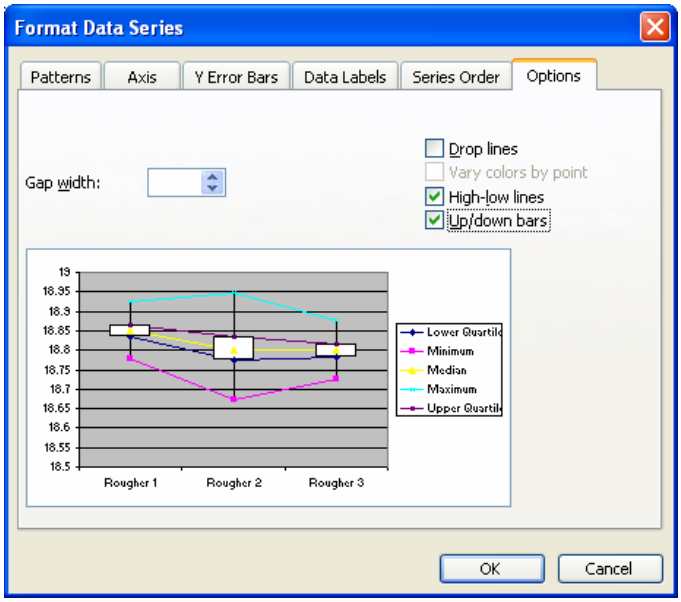


You can click Finish at this point.

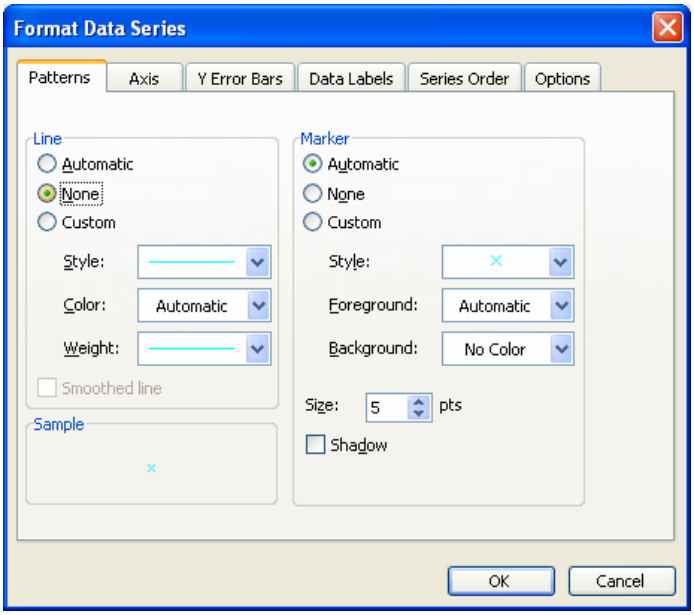
The resulting line chart needs some editing. Click once on any data series in the chart. After it is activated, right click the line and the following menu will appear.



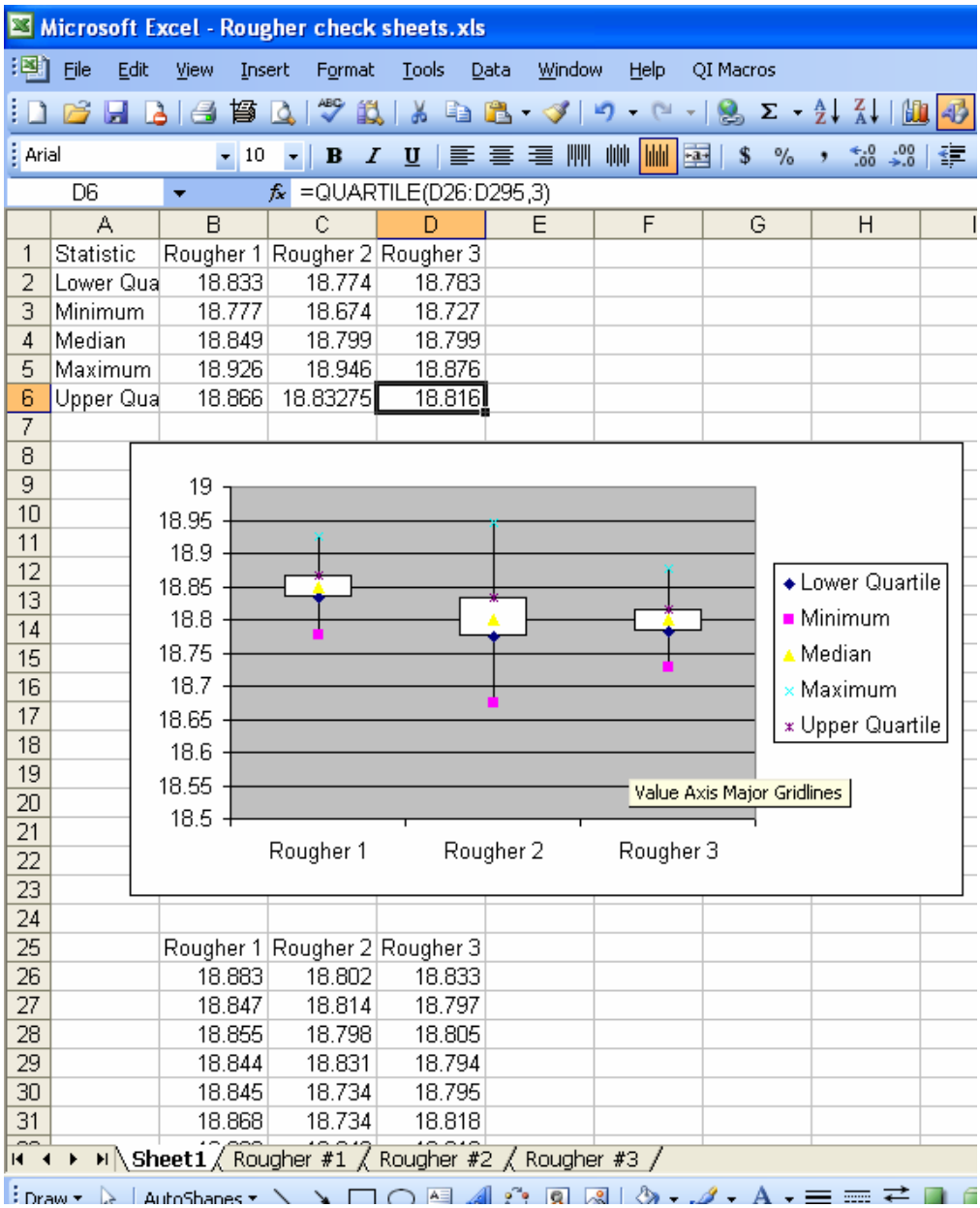
Select Format Data Series. Click on the Options tab and select High-Low Lines and Up/Down Bars.



Click on the Patterns tab and select None in the Line area. Click OK.

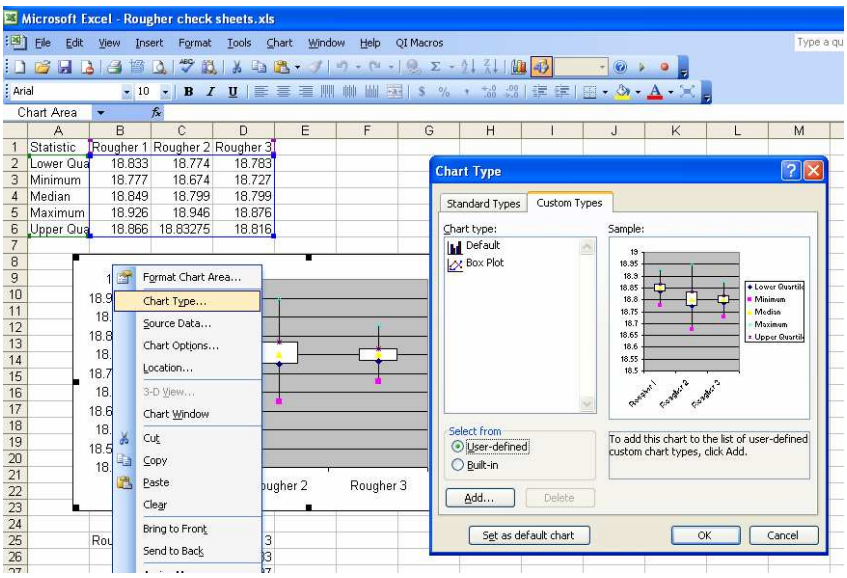


Click on the remaining data series and remove their lines as well. The Box plot should appear as shown.

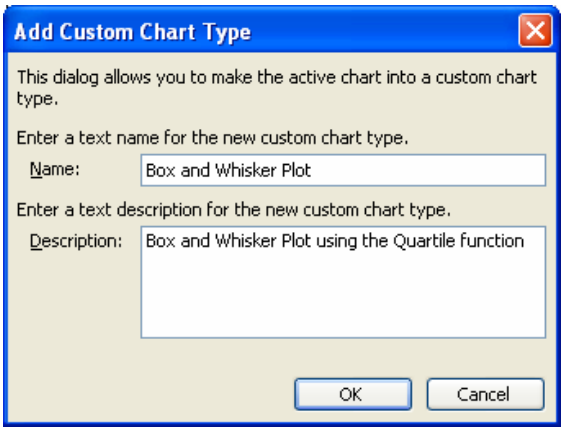


Because Excel® does not provide for creating box plots you will need to create them manually each time you need one. In order to save some effort in future analysis, you can save this chart type in Excel®.

Right click the chart and select Chart Type. Select the Custom Types tab, then select User Defined.

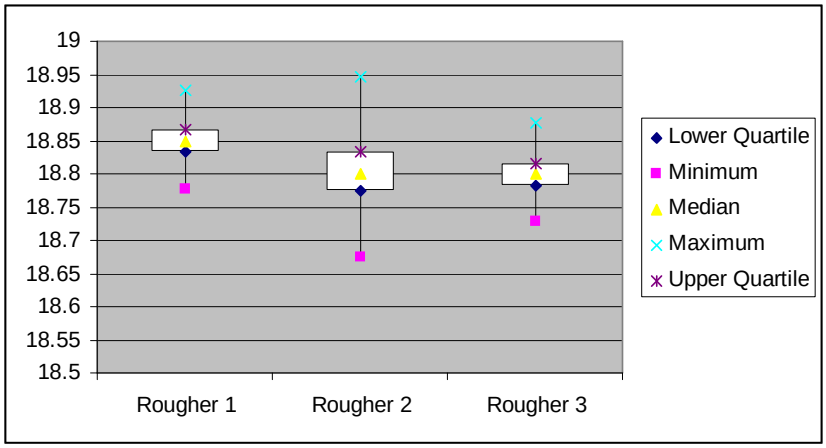


Click the Add button and the following dialogue box should appear. Enter a name and description for the Chart and click OK



The chart type is now available to you for future analysis. You will, however, still need to calculate the quartile values.

Now that you have created the box plot, you can analyze the variation in the three machines more easily.



The Box plot is an effective tool for comparing the variation of each of the three roughers. The center box represents the middle 50% of all parts produced. The vertical lines, or “whiskers”, generally show the remaining upper and lower 25%. It is easily seen that the middle 50% of Rougher 1 and 3 are about the same, even though Rougher 3 is not targeted correctly. Rougher 2 has a much larger center box as well as longer whiskers, showing that the machine exhibits greater variation. Analysis using box plots can be much more powerful than simple line charts when comparing more than one data set.

Save the file to your computer. Ensure that the file is kept in a safe place—backup copies are encouraged.