Managing Six Sigma: Understanding the Importance of Self Study

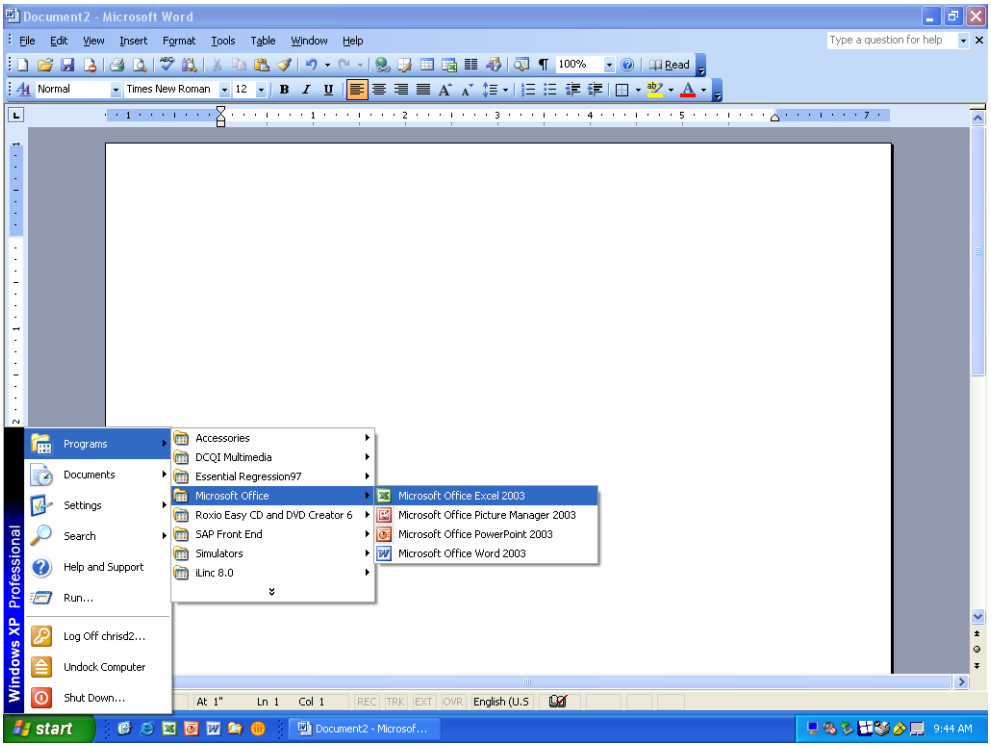
By Dean Christolear

Chapter One - Define

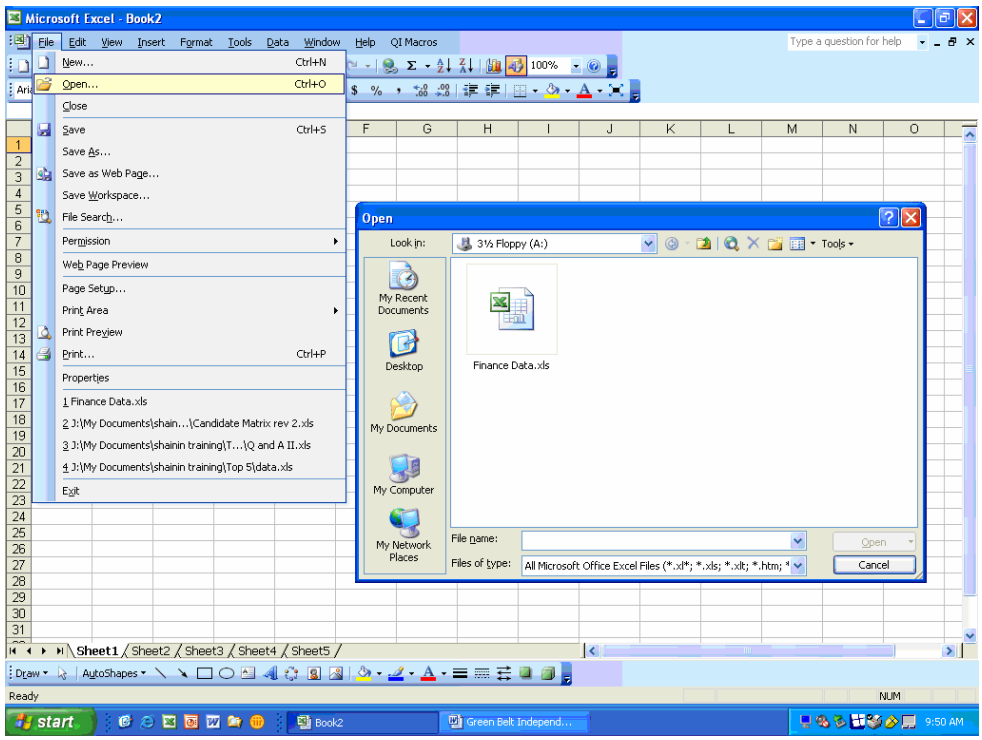
Your company has recently posted the financial results of the last quarter. Scrap is above budgeted levels and is impacting the profitability of the company. Competition is growing in your industry, and profit margins are expected to become smaller. Management is looking for ways to improve the financial performance of the company.

You have recently attended a Green Belt training class, and your supervisor is committed to supporting you through the certification process. He has asked you to look at the company metrics to identify an effective Green Belt project. A good project definition is vital to a successful project, so you contact the Finance department and schedule a meeting with the plant Controller. He is able to give you a list of the part numbers manufactured by your company and the scrap cost associated for each. The data is provided in the file `Finance Data.xls`.

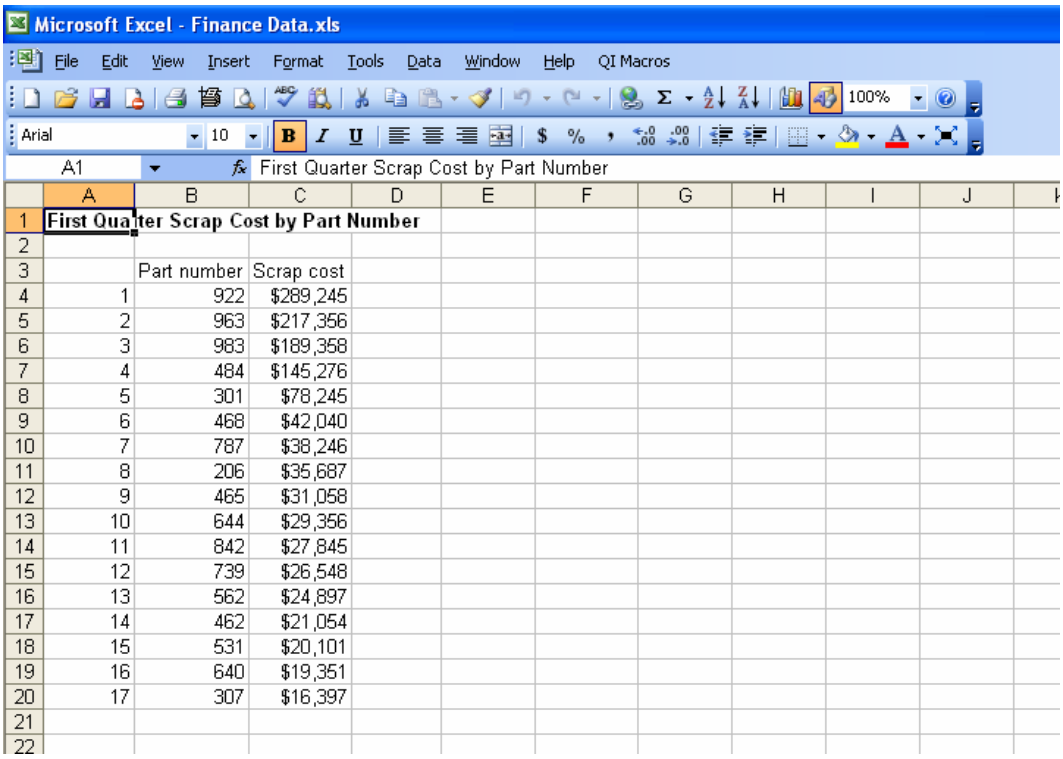
Open Microsoft Excel® by clicking Start, Programs, Microsoft Office then Microsoft Excel as shown below. After Excel® has loaded, click File, Open, then navigate to your CD drive--most likely, this is Drive D.



Open the file `Finance Data.xls`.



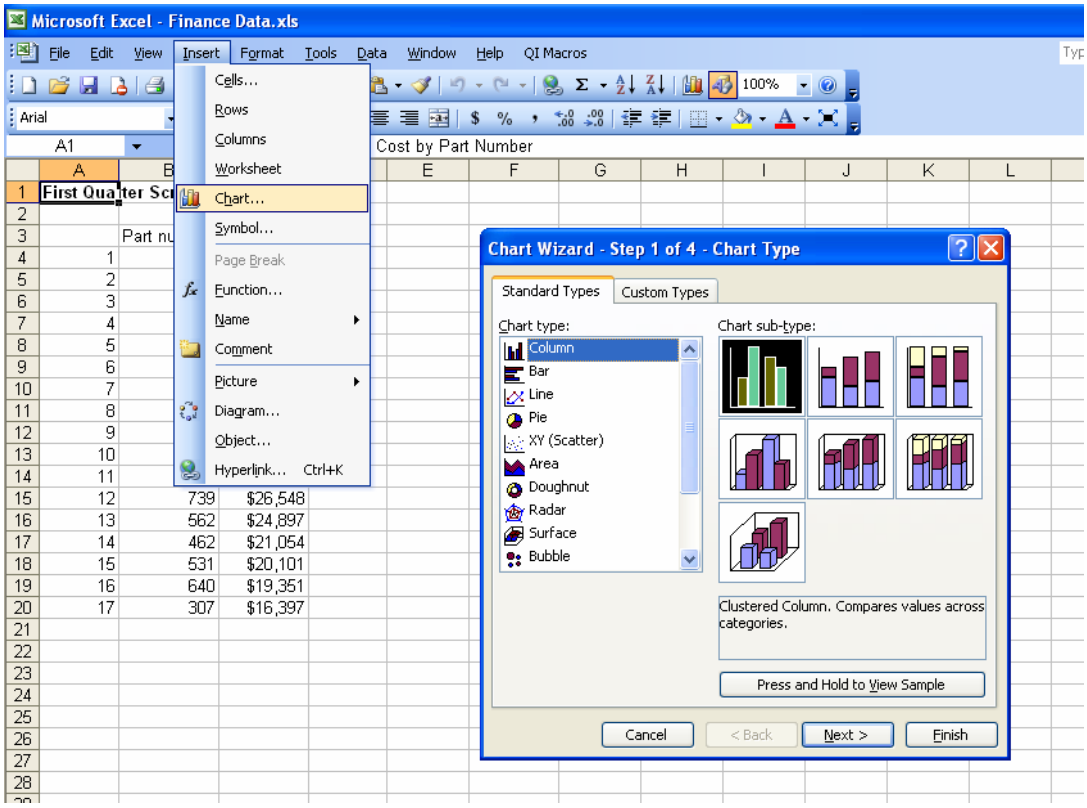
Your screen should look like this:



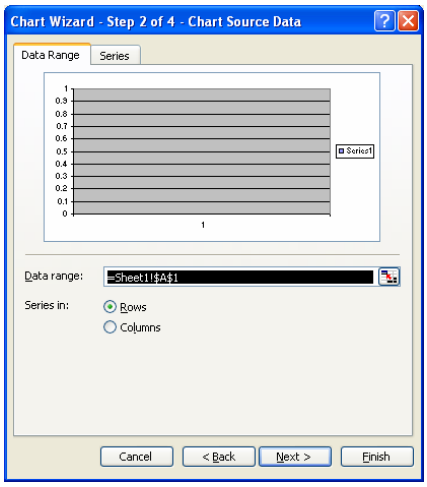
	A	B	C
1	First Quarter Scrap Cost by Part Number		
2			
3		Part number	Scrap cost
4	1	922	$289,245
5	2	963	$217,356
6	3	983	$189,358
7	4	484	$145,276
8	5	301	$78,245
9	6	468	$42,040
10	7	787	$38,246
11	8	206	$35,687
12	9	465	$31,058
13	10	644	$29,356
14	11	842	$27,845
15	12	739	$26,548
16	13	562	$24,897
17	14	462	$21,054
18	15	531	$20,101
19	16	640	$19,351
20	17	307	$16,397

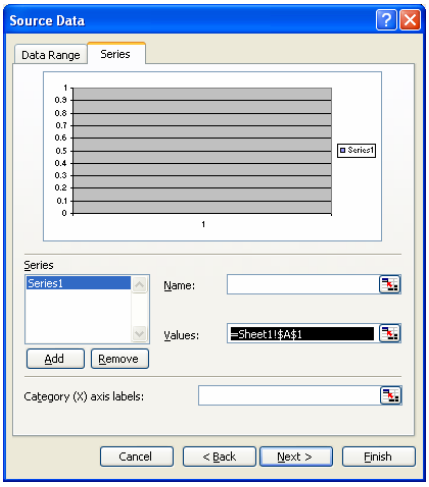
You will need to make a Pareto chart of the data. A Pareto chart shows the ranking from high to low of existing information. You can find an excellent reference on Pareto Charts at http://quality.disa.mil/pdf/pareto.pdf. You are expected to have a thorough understanding of this tool.

Pareto charts are easily done in Excel® using the Chart Wizard function. In Excel®, select Insert, Chart and the Chart Wizard dialog box will appear beginning with Step 1 of 4. Column charts are selected by default. Click Next.

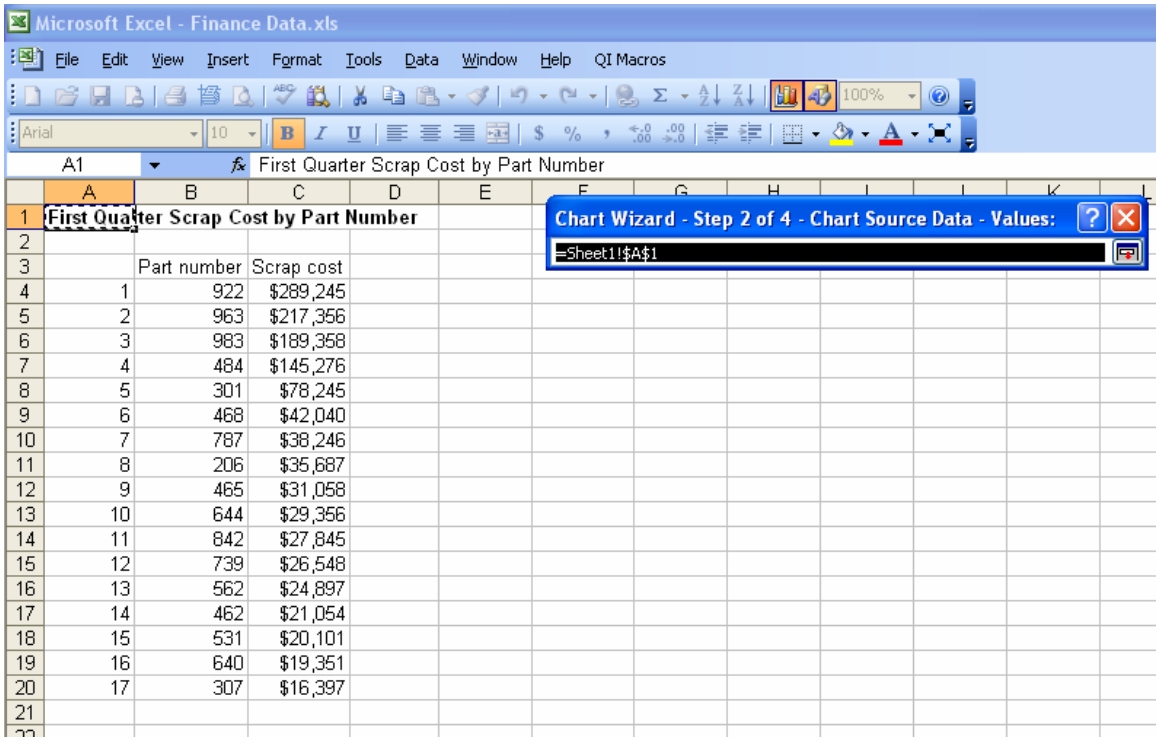


When Step 2 of 4 appears, click on the tab labeled Series in the upper left hand corner.

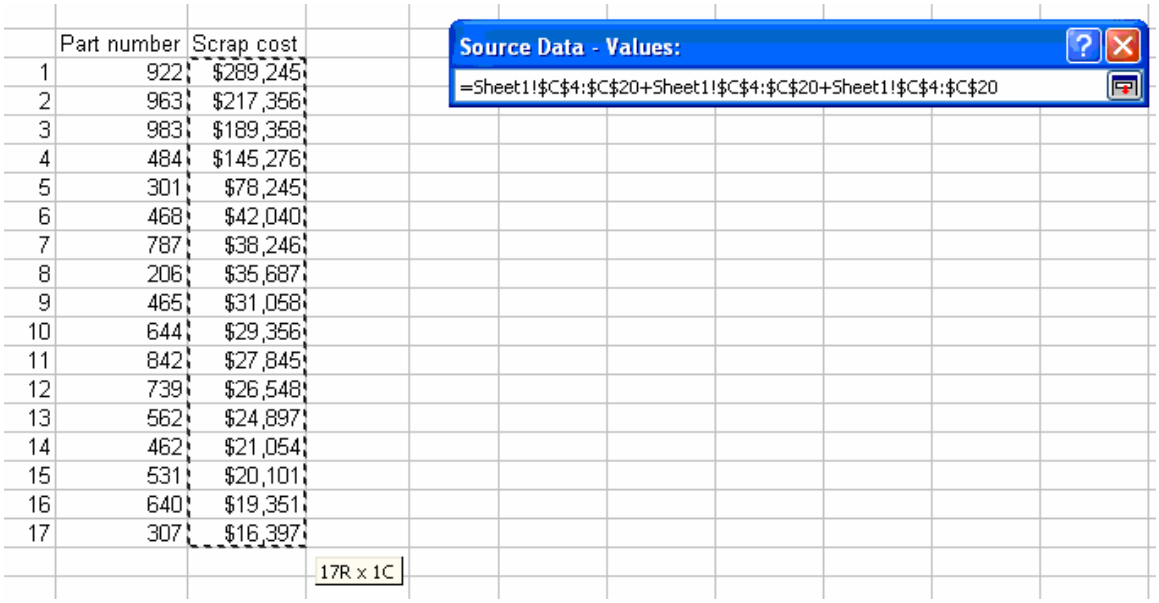




Locate the data entry field labeled Values and click the button. The Chart Wizard will minimize as shown below.



Locate the column labeled "Scrap cost". Click and hold on the first data value cell ($289,245) and drag the mouse down the column. Stop when all data values have been highlighted--this is called "painting."



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15	531	$20,101
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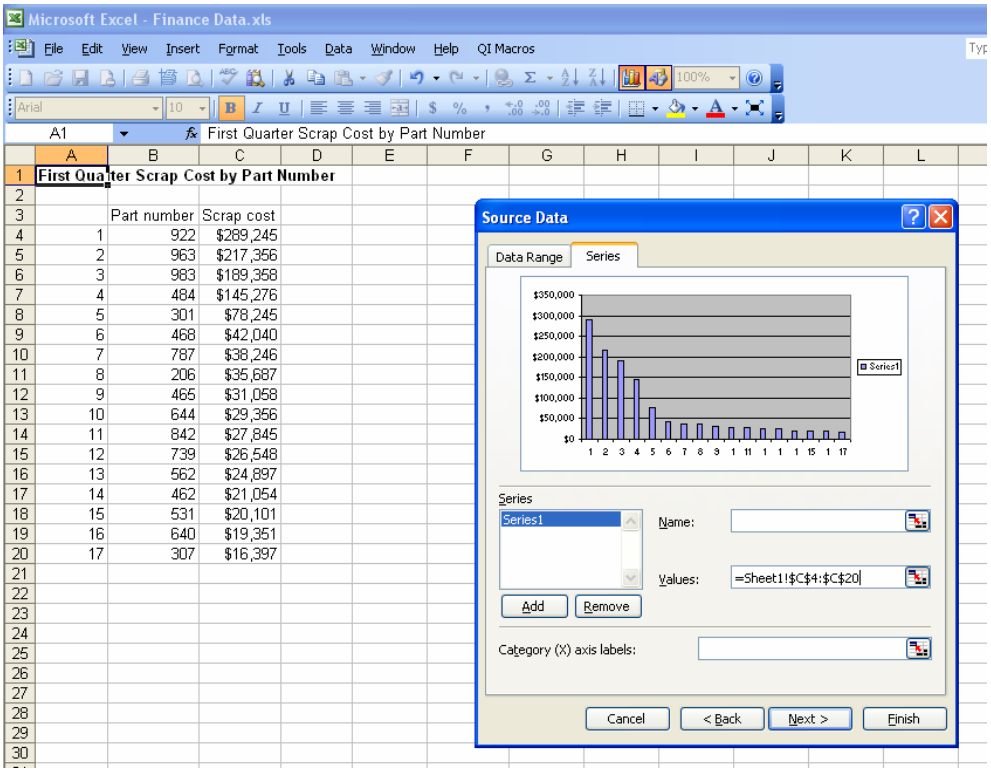
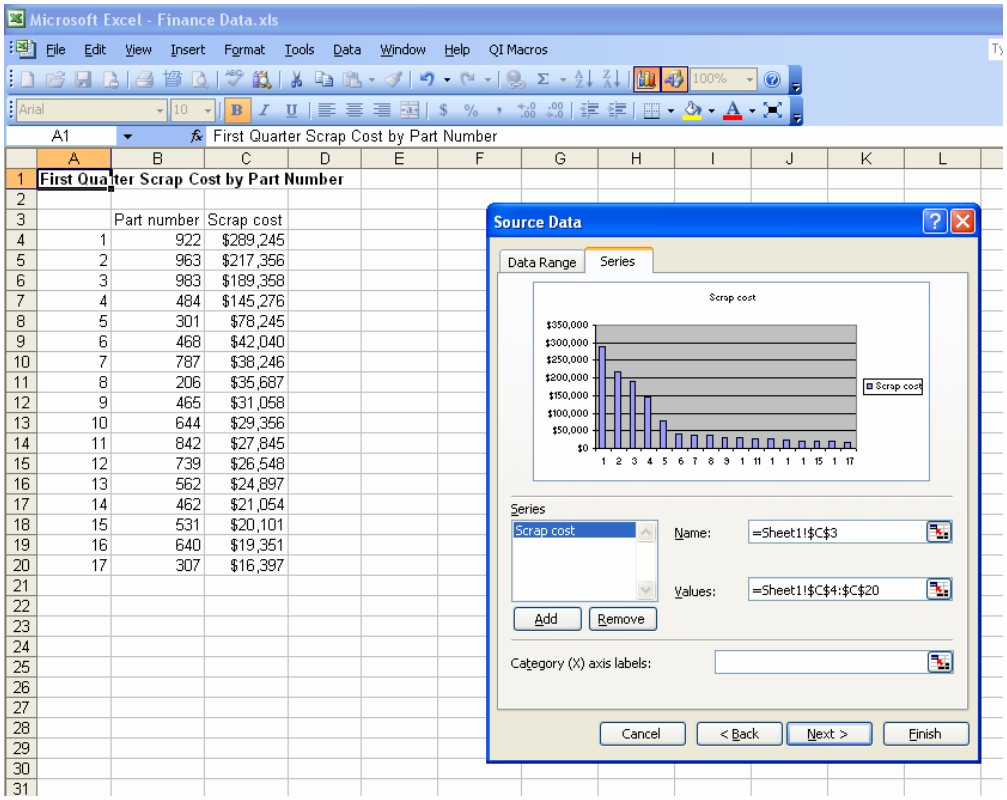
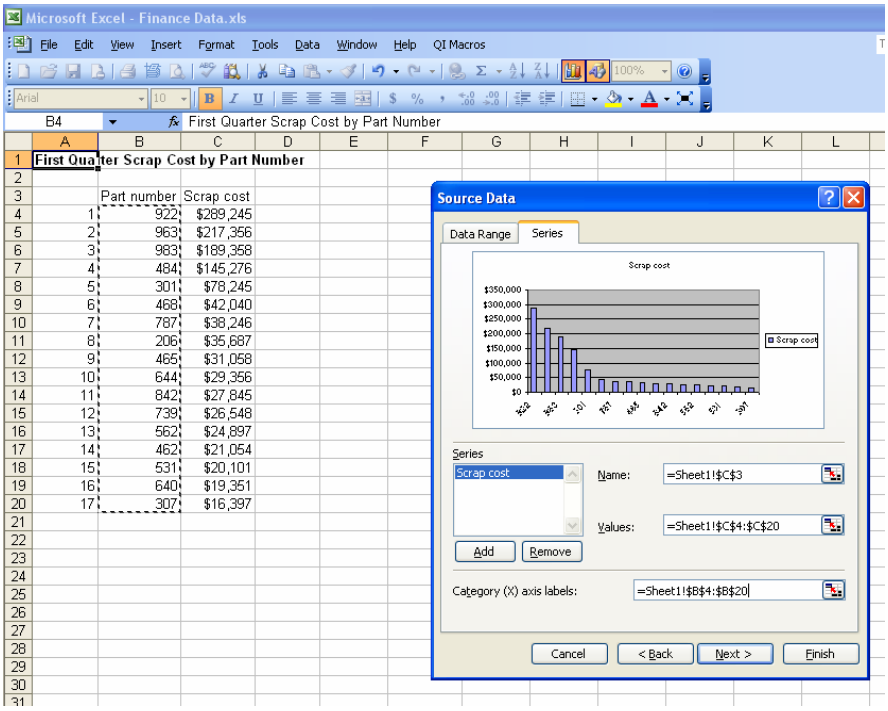
Click the button again and the Chart Wizard dialog box will reappear as shown.



Locate the field labeled Name and click on the button. Click on the cell labeled "Scrap Cost", then click on the button again. The Chart Wizard dialog box will appear as shown.

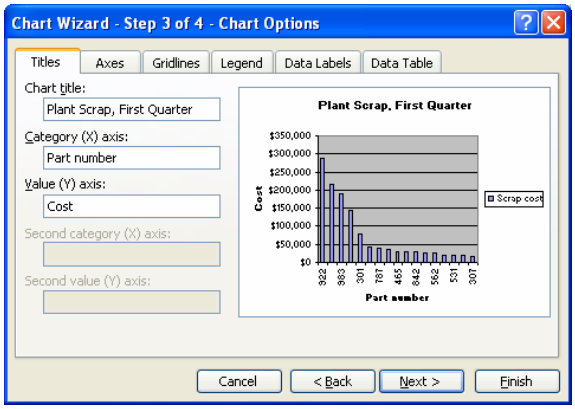


Locate the field labeled Category (X) axis labels. Click on the button as before, and paint all of the part numbers. Do not include the column heading "Part numbers." Click the button again, and the Chart Wizard dialog box will reappear.

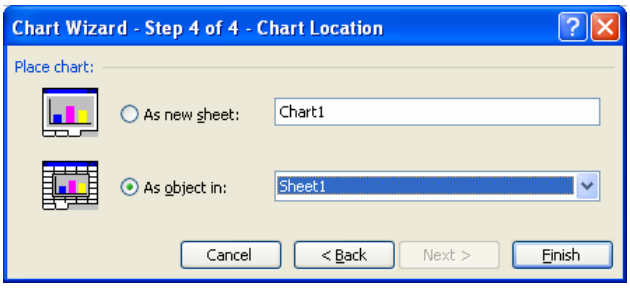


Notice that the preview now shows the plant scrap data in a bar chart with the part numbers shown on the X-axis. Click Next to continue.

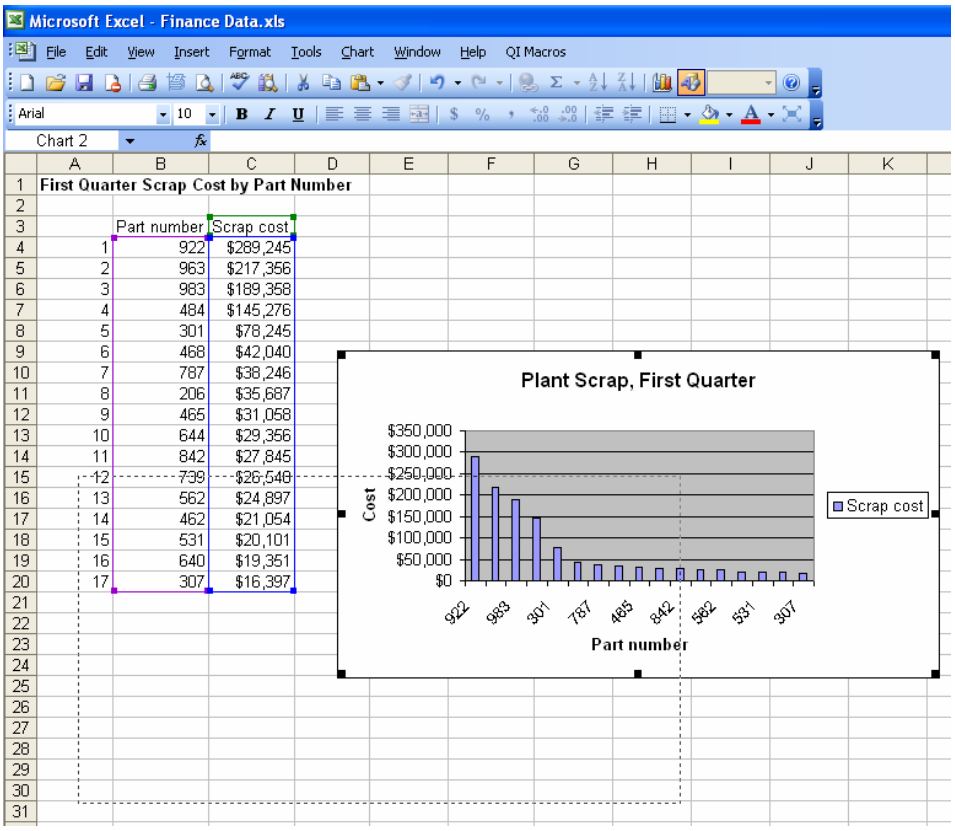
The Chart Wizard's Step 3 of 4 dialog box will appear. Type "Plant Scrap, First Quarter", "Part number" and "Cost" in the fields labeled Chart title, Category (X) axis and Value (Y) axis, respectively.



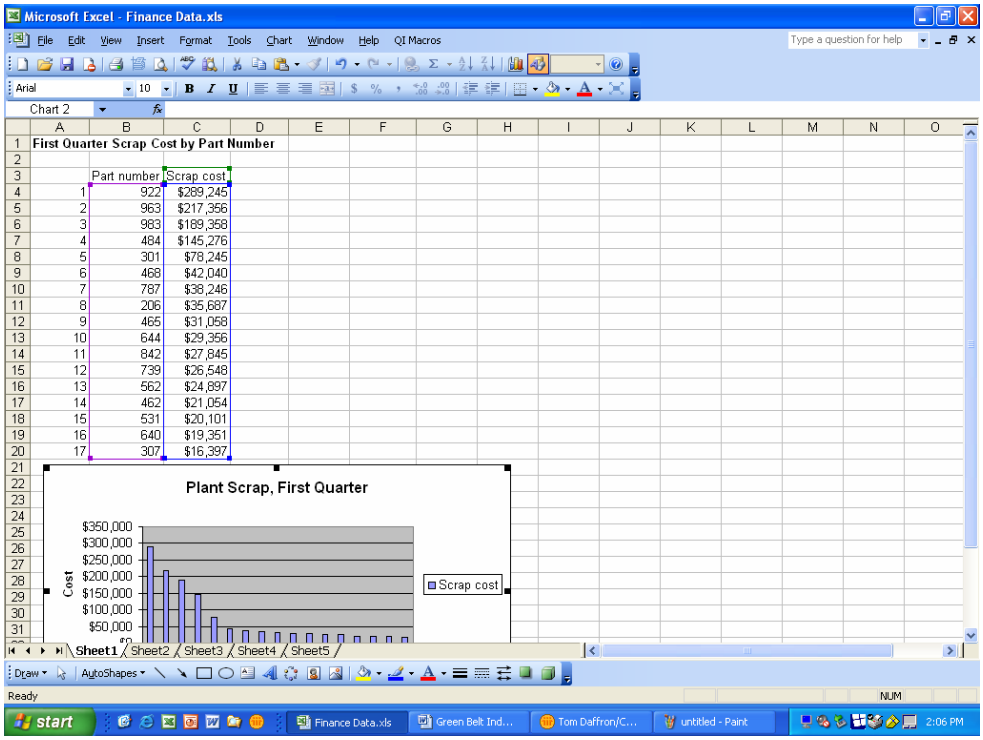
Click Next to continue. Chart Wizard's Step 4 of 4 will appear. We wish to only insert the chart into the spreadsheet we are using, so click Finish.



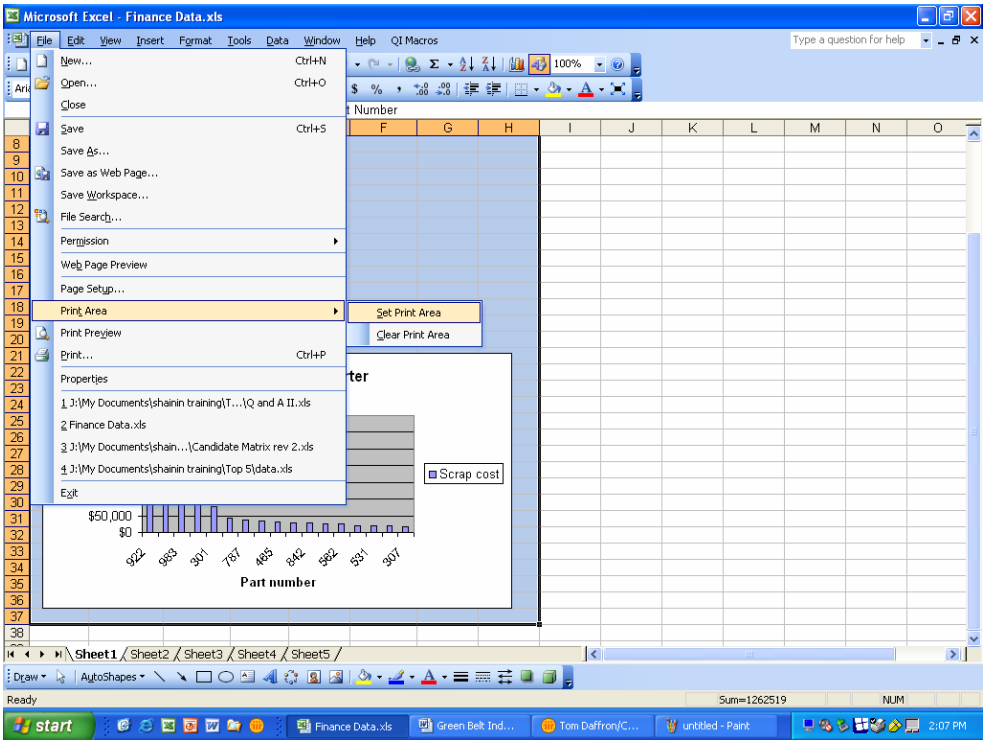
The Chart Wizard dialogue box will close and the Pareto chart will appear. Click and hold in the white area of the chart near the edge. While holding down the mouse button, position the chart below the column of data.



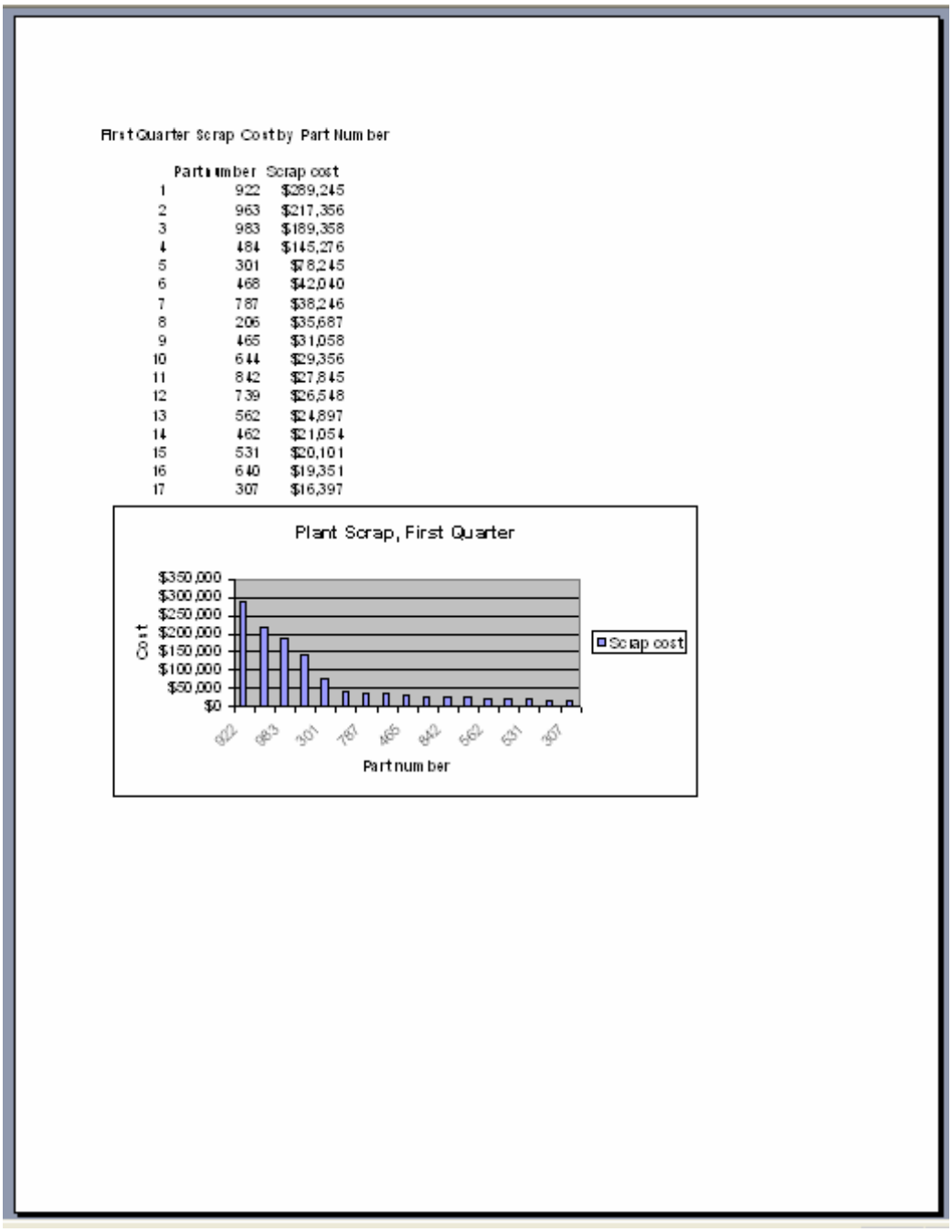
The spreadsheet should now look like this.



Paint Cells A1 to H37 by clicking, holding and dragging as previously discussed. Select File, Print Area and Set Print Area as shown.



Now select File, Print to print a hard copy. The printed page should look as shown.



First Quarter Scrap Cost by Part Number

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

From the Pareto chart it is easily seen that Part No. 922 is the largest source of scrap. After showing the chart to your supervisor he agrees that Part No. 922 should be the target of your project.

You now have a project defined in terms of a management metric. Your project aims to reduce the scrap for Part No. 922. A good Green Belt project will strive to define the project in terms of a scientific measure. You will need to investigate the process to determine what feature of Part No. 922 is the source of the majority of the scrap.

To begin, you will need to develop a Process Flow Chart for Part No. 922, which is a steel shaft used in electric motor manufacturing. The Quality Engineer in the area is able to provide a PFMEA (Process Failure Mode and Effects Analysis) that lists the steps in the process. However, after walking through the production area, you notice that the part flows through some steps that have two or three machines while other steps require only one. There are also steps in the process where parts are placed into inventory and later removed. Quality inspections can also change the part flow depending on their outcome.

It is your responsibility to develop a Process flowchart showing the detailed part flow. A Process flowchart provides a graphical representation of the flow of materials through a production process. You can find an excellent reference on Flow Charts at http://quality.disa.mil/pdf/flowchrt.pdf. You are expected to have a thorough understanding of this tool.

The steps in the process are listed below:

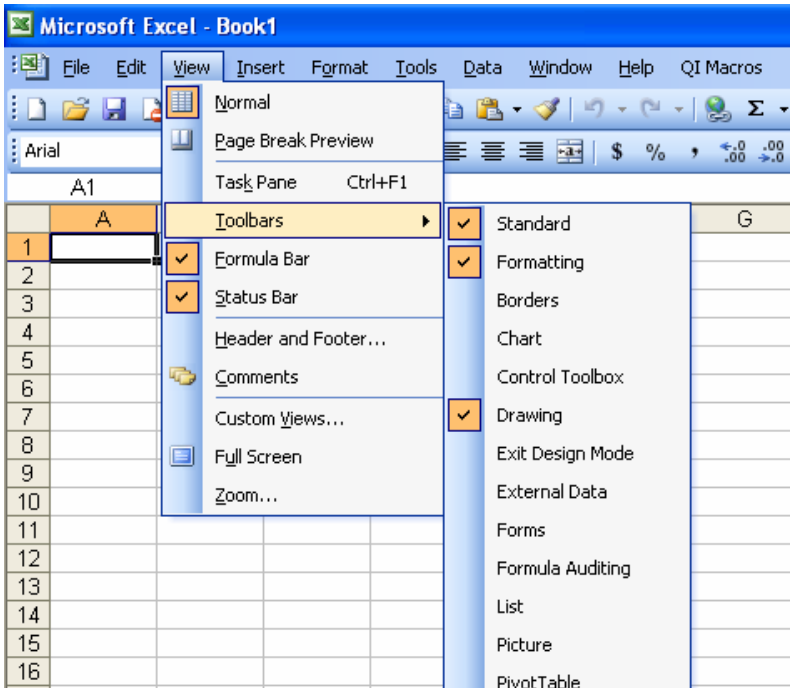
1. Receive raw billets from billet supplier
2. Transfer billets to the Shaft department
3. Machine billet in roughing lathe
4. Check part diameter
    a. If acceptable, continue running
    b. If unacceptable, scrap the part and adjust the process
5. Machine rough shaft in finishing lathe
6. Check part diameter
    a. If acceptable, continue running
    b. If unacceptable, scrap the part and adjust the process
7. Transfer finished shaft to Heat Treat department
8. Heat treat finished shaft
9. Check hardness from a sample of 10 parts
    a. If acceptable, load parts into container
    b. If unacceptable, tag the batch as reject and notify the Quality Engineer
10. Transfer heat treated shaft to the Shaft department
11. Finish grind heat treated shaft
12. Check part diameter
    a. If acceptable, continue running
    b. If unacceptable, scrap the part and adjust the process
13. Polish bearing journal diameters
14. Check bearing journal diameters
    a. If acceptable, continue running
    b. If unacceptable, scrap the part and adjust the process

15. Transfer completed shaft to Material Control

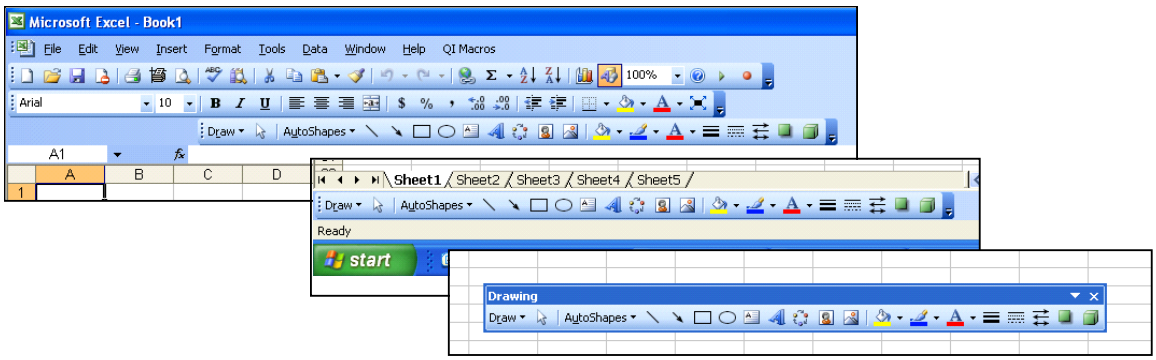
Your review of the process has shown the following equipment is in use:

- 3 roughing lathes
- 1 finishing lathe
- 2 heat treat furnaces
- 2 grinders
- 3 polishers

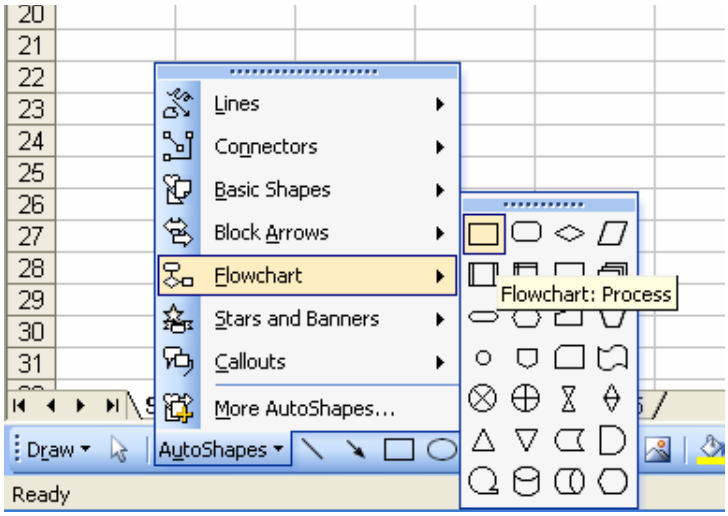
You will need to use Microsoft Excel® to develop the flowchart. Open Excel® as you did in Chapter 1. Go to View, Toolbars and make sure that the Standard, Formatting and Drawing options are checked.



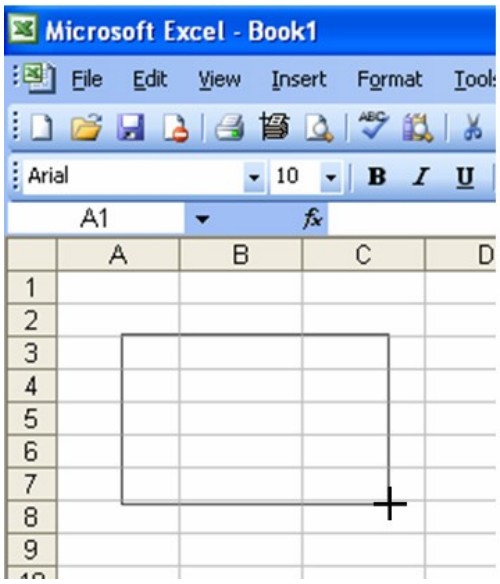
Somewhere on your screen you will find the Drawing Tool Bar. It will look something like one of these:



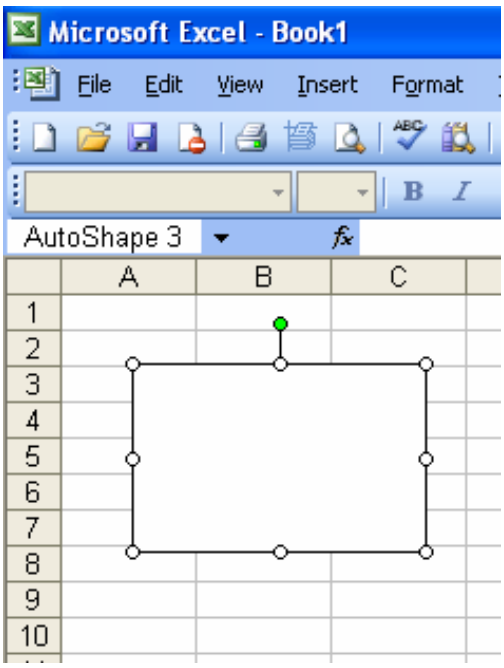
You will be using the AutoShapes button for your flowchart. Click once on the button to see the list of shapes available. Move the mouse to the Flowchart option and you will see a selection of shapes. Move the mouse to the top left selection and click it.



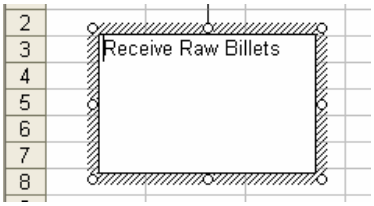
The mouse curser will change to a cross. Click and hold the mouse generally in the area of Cell A2. Paint down and to the right generally to the Cell C7. Let go of the mouse button and a white box will appear with round handles at the corners and the sides.

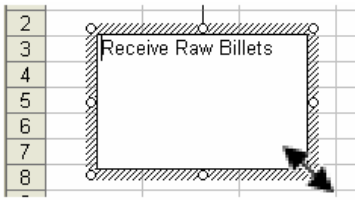


These handles show the box is active.

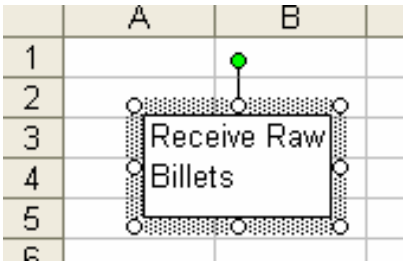


Type the words “Receive Raw Billets”; do not hit “Enter.” The box should look as shown. To size the box, click and hold the bottom-right corner when the double-headed arrow appears, and drag the corner toward the top left corner.

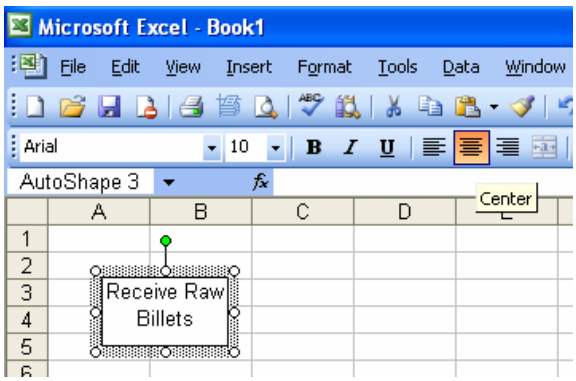




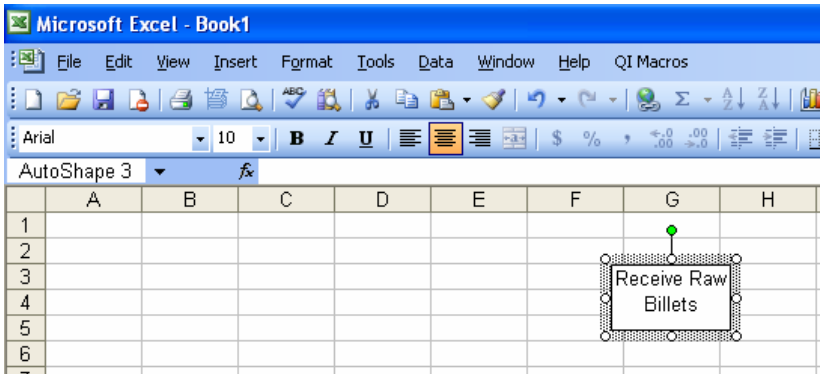
The text will wrap to the next line as shown.



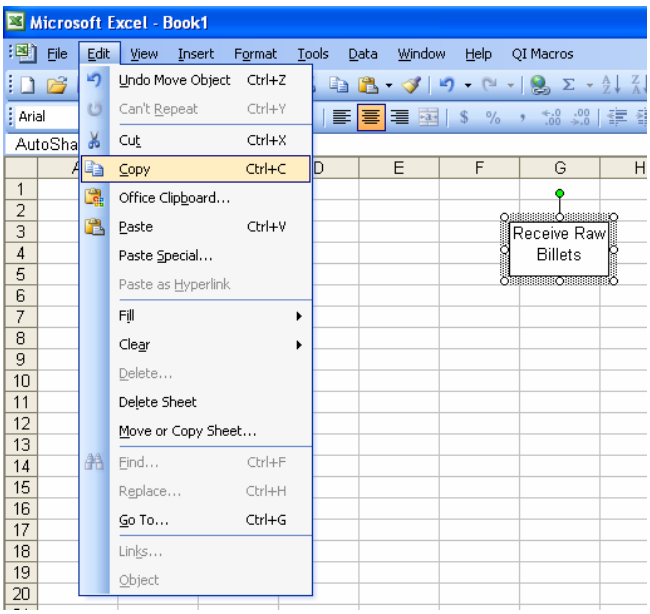
While the box is active, click the Center text alignment button on the Formatting tool bar as shown. The text will center itself in the box.



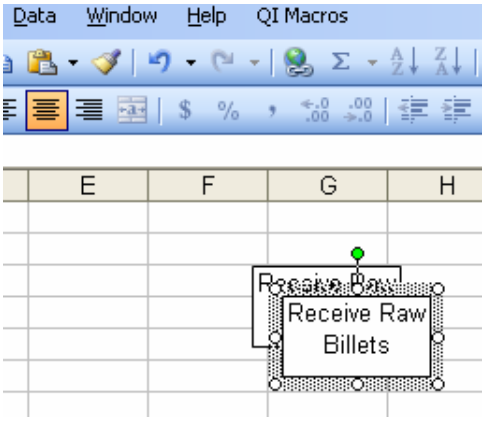
Click and hold on any edge (being careful to avoid the handles) and move the box generally to the area of Cell G3. Your screen should look as shown.



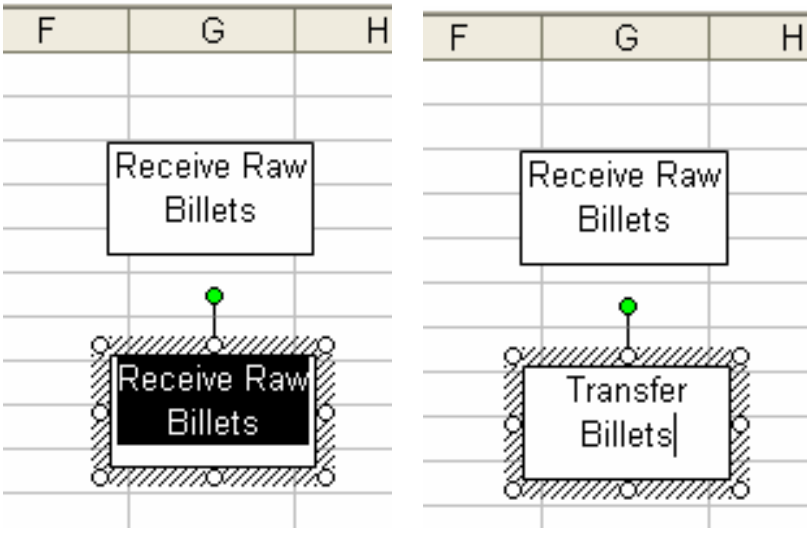
While the box is active, select Edit, Copy, then select Edit, Paste. You can short cut this process by holding the "Ctrl" key and pressing the "C" key to copy. Then hold the "Ctrl" key and press the "V" key to paste.



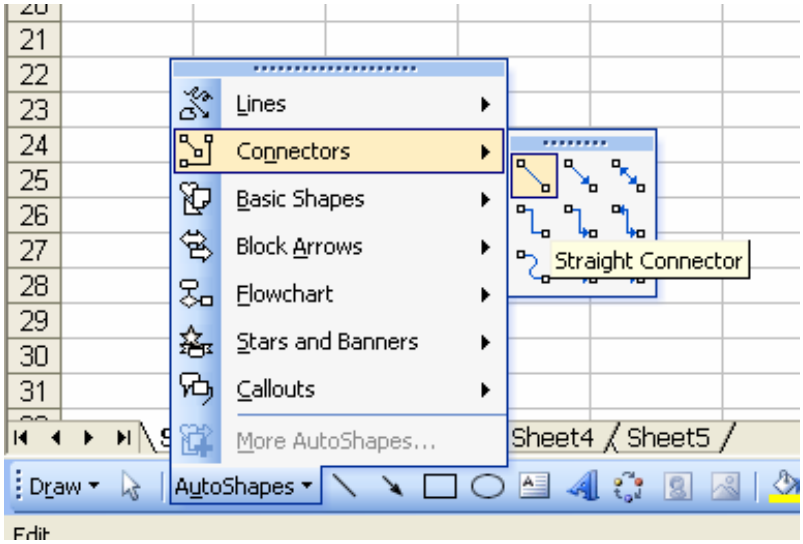
A duplicate box should appear.



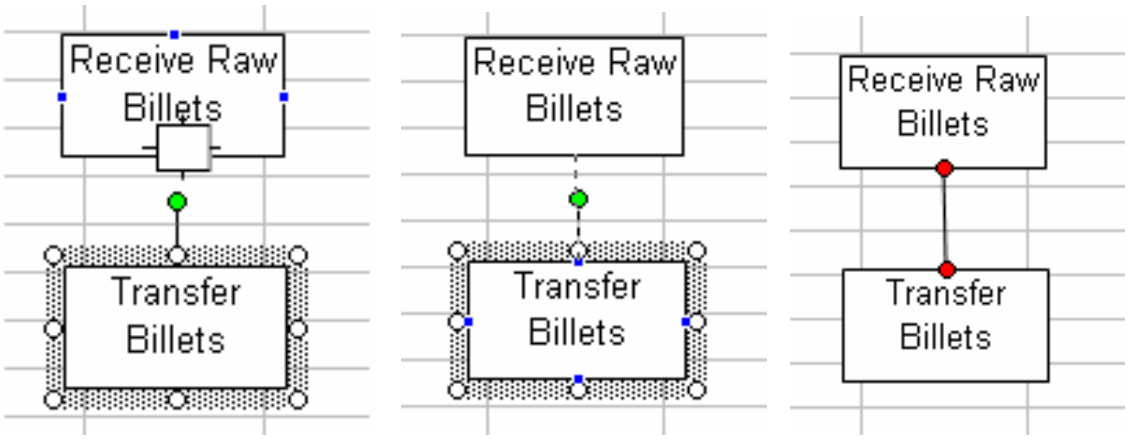
Click and hold the box and move it generally to the area of Cell G8. While the box is active, paint the text in the box. Type the words "Transfer Billets." Size the box and center the text as needed. Your screen should look generally as shown.



Return to the Drawing toolbar and select Connectors, Straight Connector.

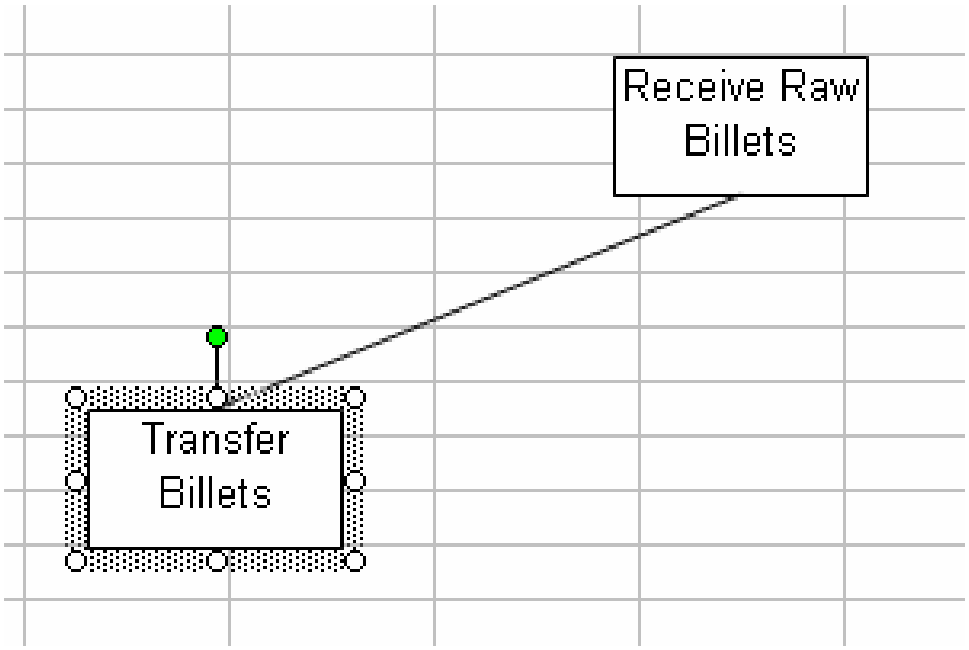


Move the curser to the middle-bottom edge of the "Receive Raw Billets" box. Blue, square handles will appear. Click and release on the middle-bottom handle. A dotted line will appear that is connected to the box and your curser. Move the curser to the middle-top edge of the "Transfer Billets" box.



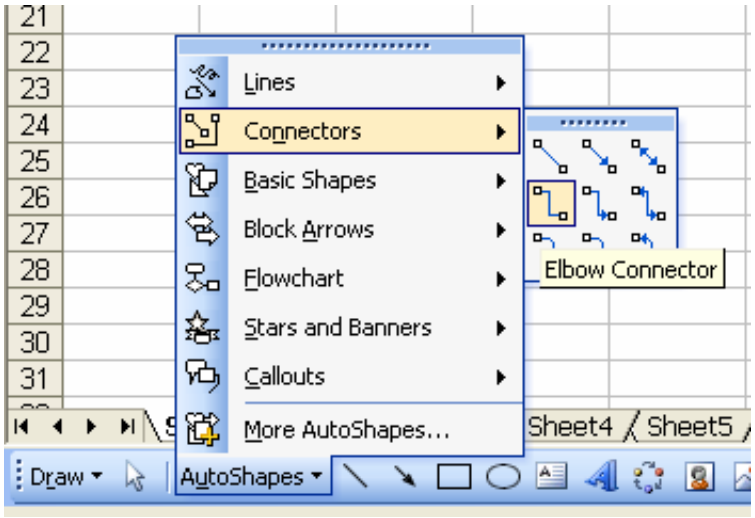
Blue handles will appear when you are connected to the "Transfer Billets" box. Click and release to finish. Your screen should look as shown.

These two boxes will remain connected regardless of their location on the screen. If you like, you can move one to see how it works.

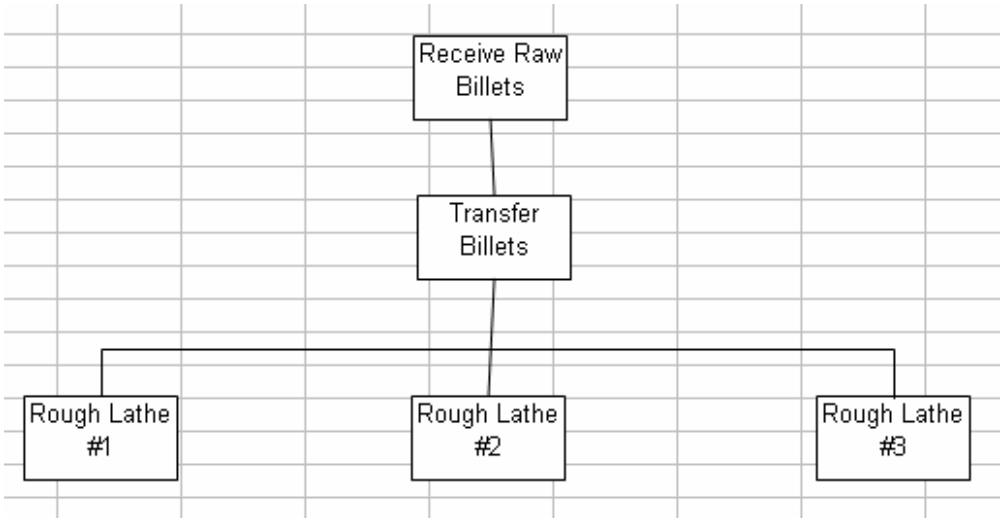


The rough turning lathes are the next step in the process. Remember, your review of the process has shown that there are three of these machines. Copy and paste the "Transfer Billets" box three times and arrange them evenly below the existing "Transfer Billets" box. Edit the text to say "Rough Lathe #1", "Rough Lathe #2" and "Rough Lathe #3." Your screen should look as shown.

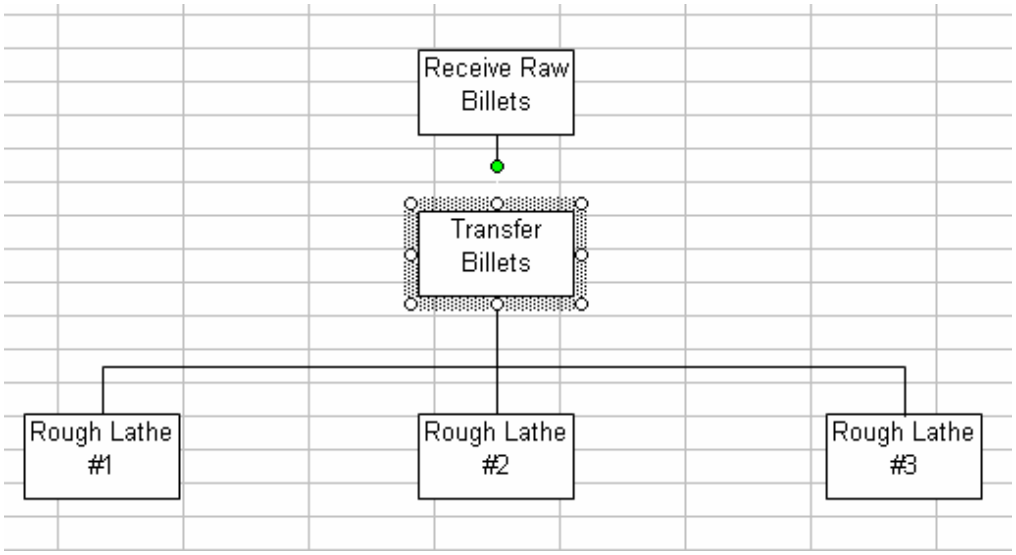
Use the Drawing toolbar and select Connectors, Straight Connector. Connect the "Transfer Billets" box to the "Rough Lathe #2" box. Next, return to Connectors, but select the Elbow Connector.



Connect "Rough Lathe #1" to "Rough Lathe #3" in the same manner as before. Your screen should appear as shown.



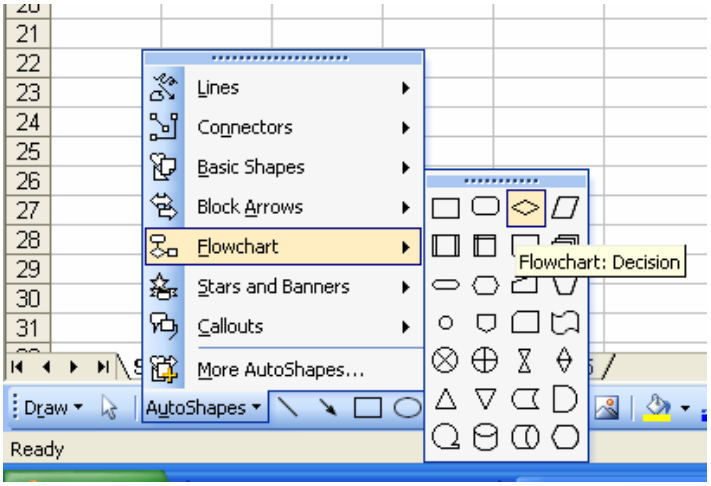
If your lines do not appear straight, some of your boxes may be a little off location. You can correct this by activating the appropriate box and using the arrow keys on your keyboard to nudge the box into the correct position.



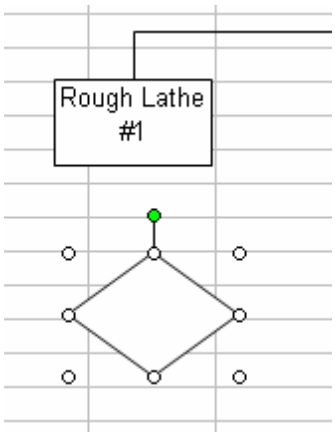
If the box is not moving when you hit an arrow key you may not have activated the box correctly. Look closely at the borders of the activated box and compare to the images below.

The image on the left shows a text box correctly highlighted. The image on the right shows a blinking curser indicating that the text is ready to be edited. You cannot move the box until it is activated as shown on the left. To correct the problem, click once on the border of the box to activate it correctly.

Continue adding boxes to the process flowchart to completely represent the entire process. You will need to use a different style of box for the steps in the process where parts are checked and decisions are made. Return to AutoShapes, Flowchart and select the Decision box.

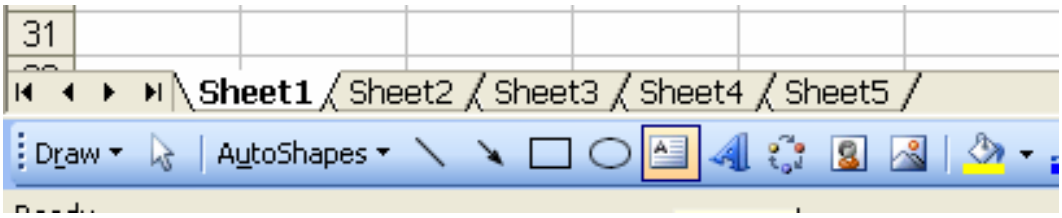


Once the curser changes to a cross, draw the decision box below "Rough Lathe #1."

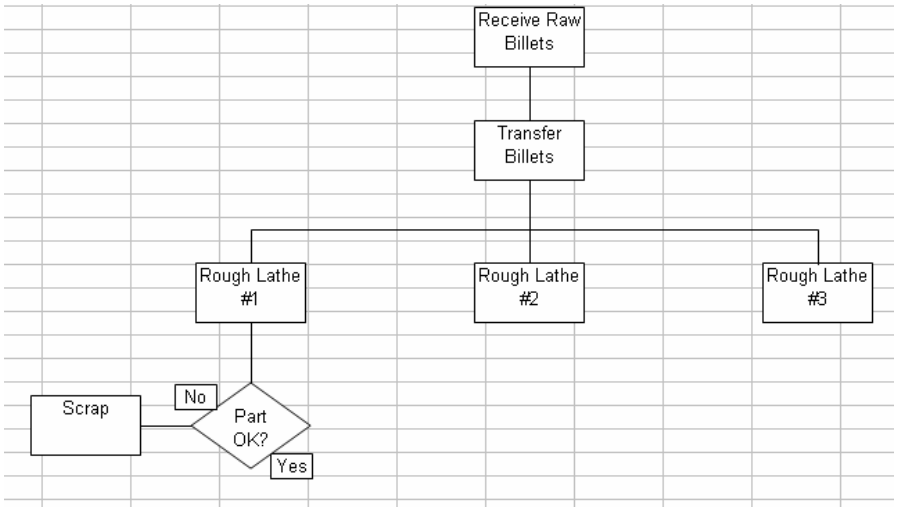


Connect the top of the decision box to the bottom of the “Rough Lathe #1” box. Enter the text “Part OK?” in the box. Copy and paste a new box to the left of the “Part OK?” box and change the text to “Scrap.” Connect the “Part OK?” box to the “Scrap” box.

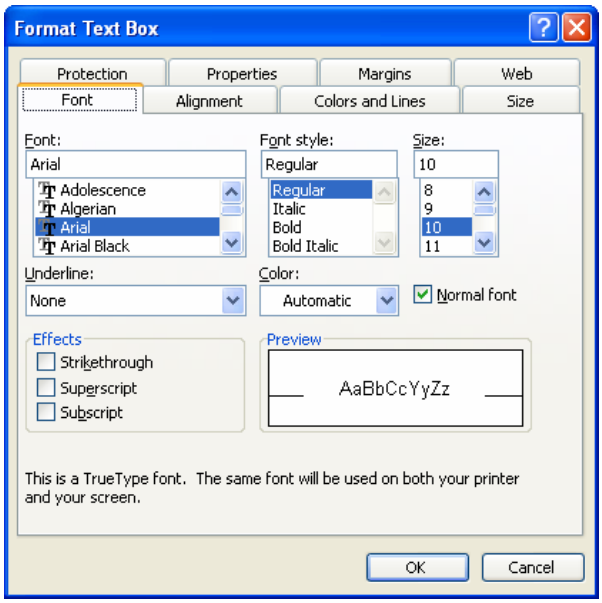
You will need to add text to the decision box to show which route the part will take, depending on whether or not the part is acceptable. Locate the Text Box button on the Drawing toolbar and select it.



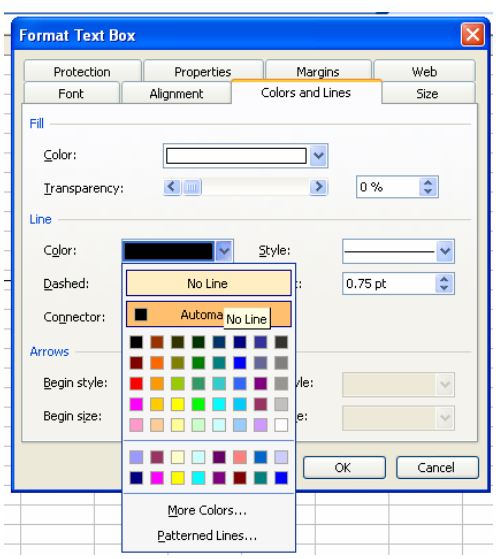
Draw the text box near the left side of the “Part OK?” box and add the text “No.” Add a second text box near the bottom of the “Part OK?” box and add the text “Yes.” Your screen should look as shown.

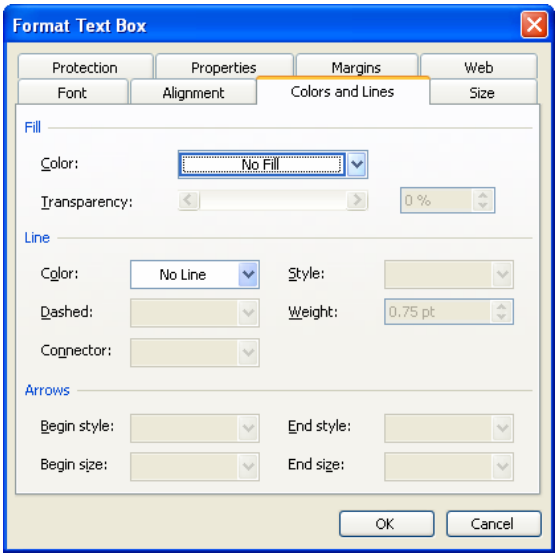


You should remove the borders from the “Yes” and “No” boxes. Activate a box and select Format, Text Box. The dialogue box shown should appear.

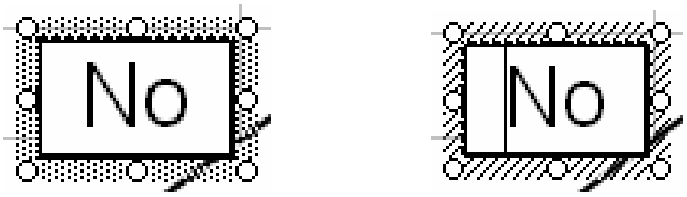


Next, click on the Colors and Lines tab. Locate the area of the box labeled Line and select No Line. Click on the down arrow for the Color box, and change the Color box to No Fill. Click OK to close the dialogue box.



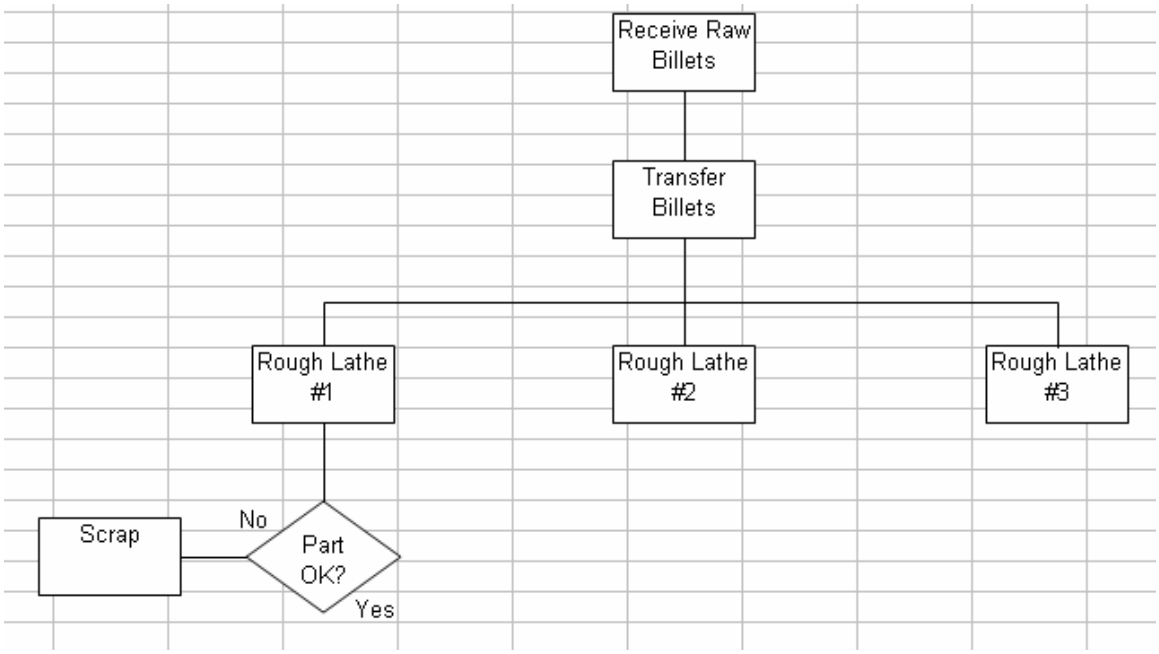


As before, if you don't see the changes to the text box, you may not have activated it correctly. Look closely at the borders of the activated box and compare to the images below.

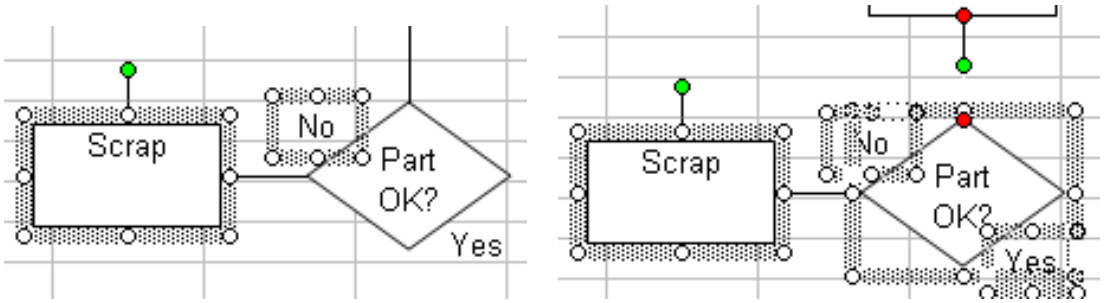


The image on the left shows the text box correctly highlighted. The image on the right shows a blinking curser indicating that the text is ready to be edited. You cannot format the borders of the box until it is activated as shown on the left. To correct the problem, click once on the border of the box to activate it correctly.

Once you have removed the borders and changed the color to No Fill, your process flowchart should look as shown.

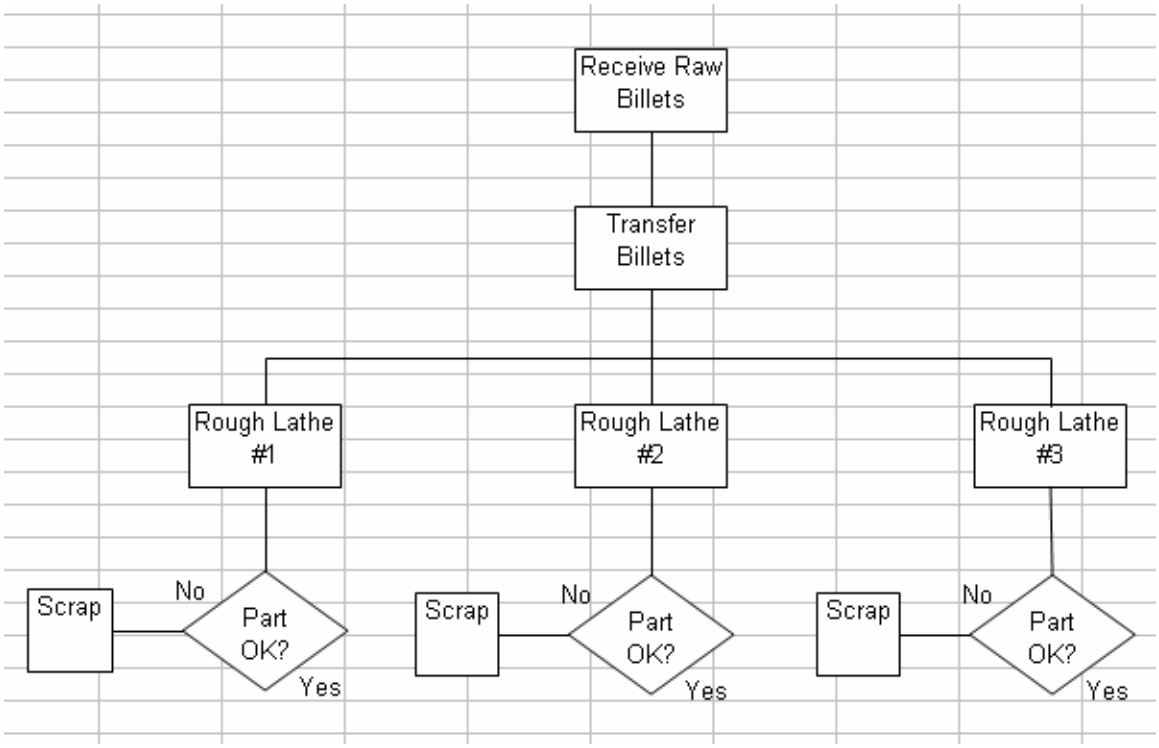


You will need to repeat this process for "Rough Lathe #2" and "Rough Lathe #3." You can create the necessary elements as before, or you can copy and paste them. To select more than one image for copying you can use the "Shift" key. Click on the "Scrap" box to activate it. It does not matter if it is activated correctly for this step. Hold down the Shift key and click on the "No" box. Both boxes will now be activated. Continue clicking with the "Shift" key depressed to activate all of the elements you wish to copy.

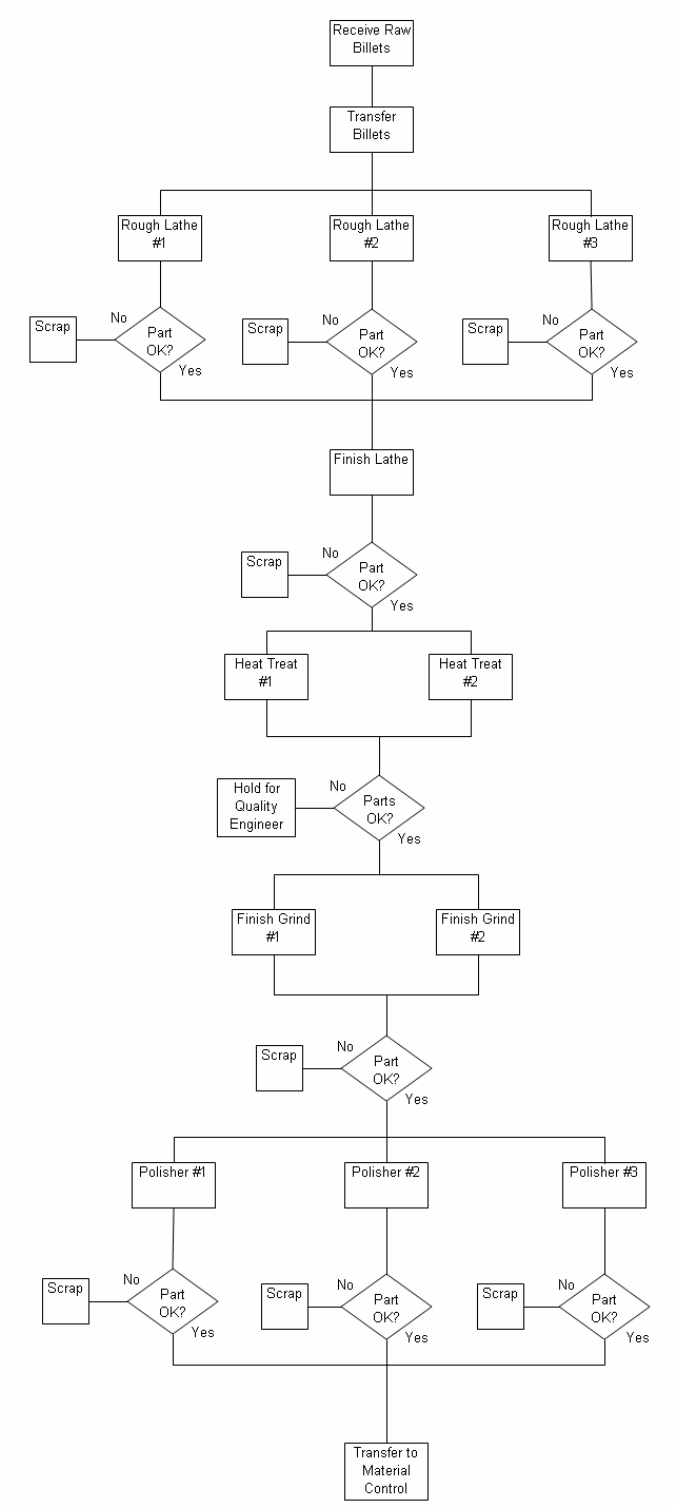


Select Edit, Copy and then select Edit, Paste, or "Ctrl-C" and then "Ctrl-V." A second set of elements will appear. Click and hold on any border, then drag them underneath

“Rough Lathe #2.” Size and center the elements to fit the page. Your screen should look generally as shown. Remember to re-connect the lines between the “Part OK?” boxes and “Rough Lathe #2” and “Rough Lathe #3.”



Continue building the process flowchart. When you have finished, it should look generally as shown below.



Save the file as `Green Belt flow Chart.xls` on your computer. Ensure that the file is kept in a safe place—backup copies are encouraged.

You now have a good understanding of the part flow for Part No. 922. You can easily see all possible locations where parts can be scrapped. While you were building the process flowchart you developed a relationship with the supervisor and many of the operators. Many of them told you that you were the first person to visit the department in months. They were beginning to wonder if management was interested in fixing some of the problems in the department.

Almost every person in the department was able to offer their opinions on what problem needed correcting first. Some people complained that there was a constant lack of parts and that they could not run their machines. Others complained that certain operators were not able to keep up, causing material to build up behind them. Again, this build up prevented many operators from running their machines.

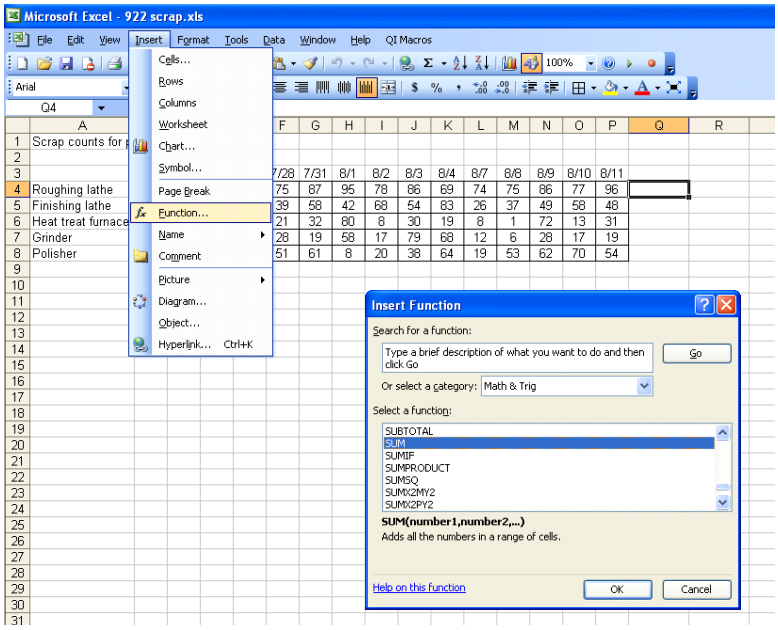
All of the operators complained about scrap. It was not clear from talking with the operators which part of the process was the worst offender. The supervisor in the Shaft department has a dedicated scrap person to manage the constant flow of scrap shafts. You talk to the scrap person, and she agrees to keep a count of the amount of scrap shafts that she picks up at each step of the process. To assist her, you develop the data sheet shown.

Scrap counts for part number 922

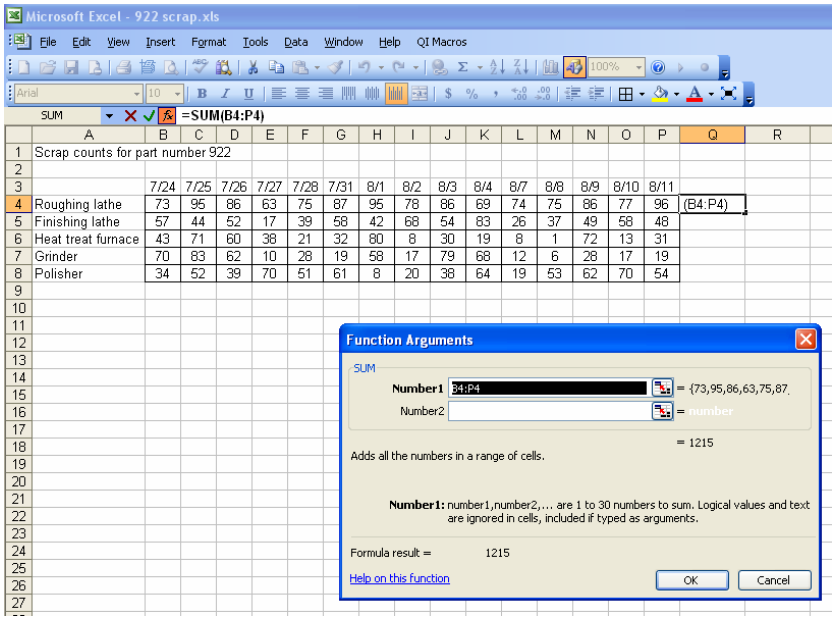
	7/24	7/25	7/26	7/27	7/28	7/31	8/1	8/2	8/3	8/4	8/7	8/8	8/9	8/10	8/11
Roughing lathe															
Finishing lathe															
Heat treat furnace															
Grinder															
Polisher															

After two weeks, the scrap person provides you with the completed data sheet found in the file `922 scrap.xls`. It is not apparent which operation is the largest contributor. You decide to pareto the data as you did before. First, you will need to sum the data. You will need to insert a function at the end of the row for each step in the process.

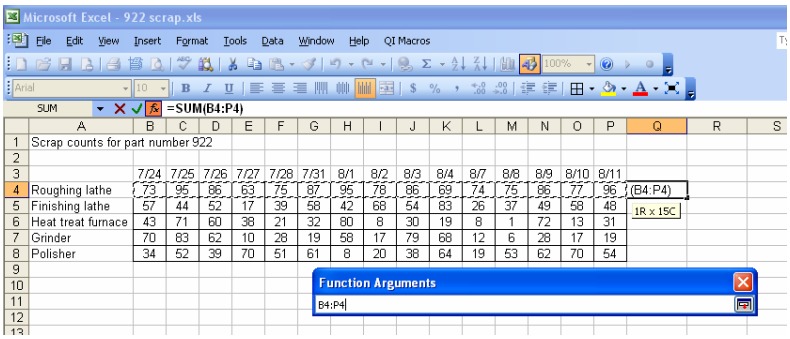
Click on the empty cell at the end of the row of data for the "Roughing Lathe." From the menu select Insert, Function.



When the dialog box appears select the category Math & Trig. Scroll down to SUM and select OK.

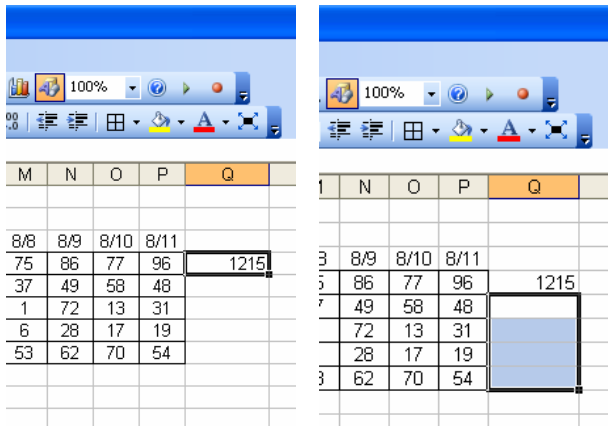


When the Function Arguments dialog box appears, click the button for Number 1. The dialog box will minimize as shown. Paint the range of cells for the Roughing Lathe. Click the button to return to the Function Arguments dialog box then click OK. The total scrap for the Roughing Lathe is displayed.

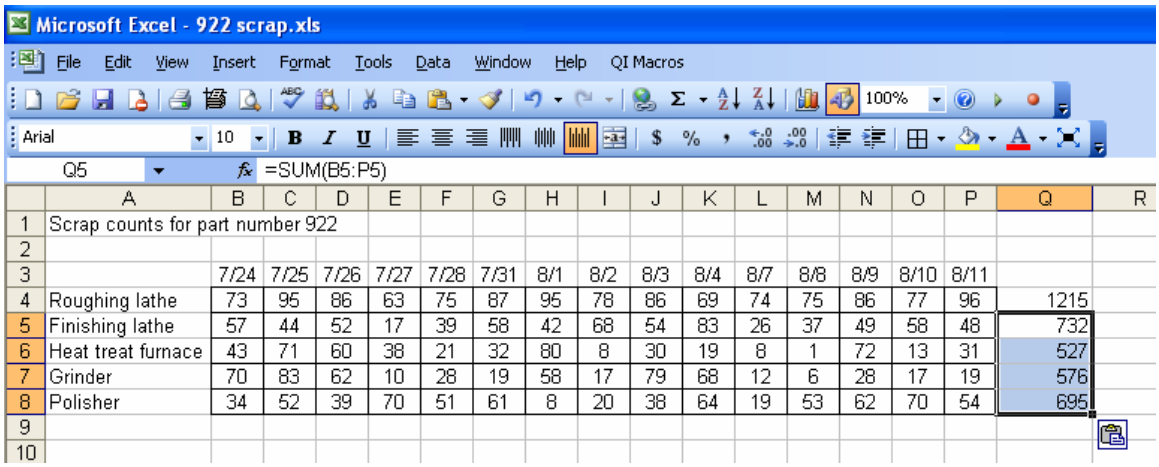


Continue this process for the Finishing Lathe, Heat Treat Furnace, Grinder and Polisher. You can easily do this by copying and pasting the function you just created to the other cells needing summed. Excel® will adjust the cell references automatically. Select Edit,

Copy ("Ctrl-C"), then highlight the remaining range of cells for which you wish to display totals and select Edit, Paste ("Ctrl-V").

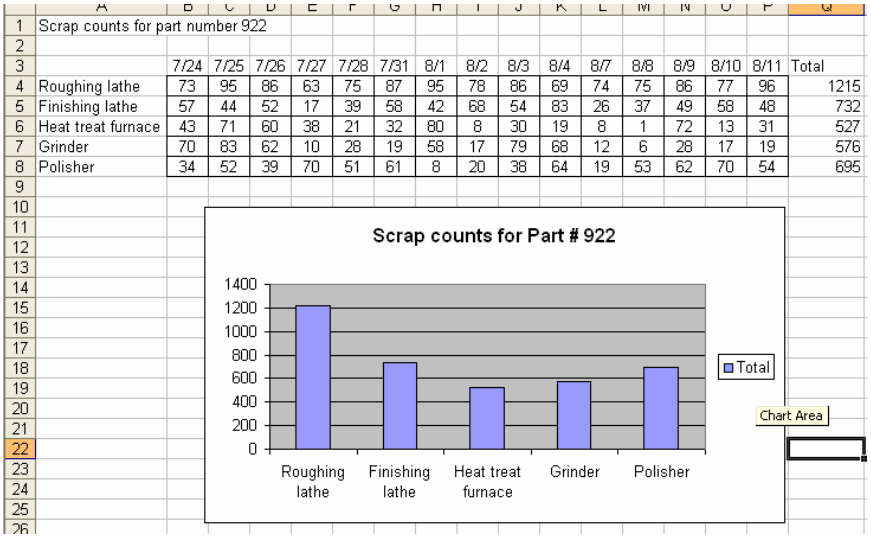


The spreadsheet should look as shown.



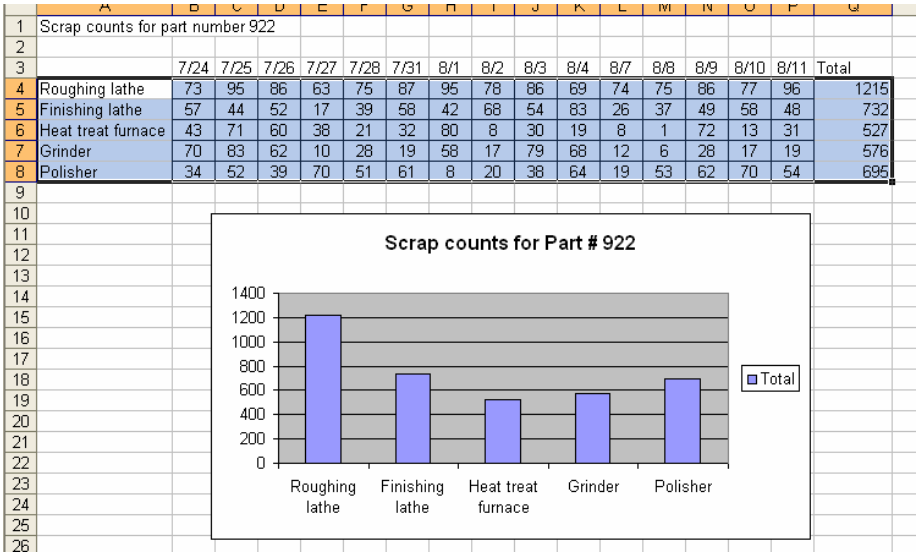
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Scrap counts for part number 922																
2																	
3		7/24	7/25	7/26	7/27	7/28	7/31	8/1	8/2	8/3	8/4	8/7	8/8	8/9	8/10	8/11	
4	Roughing lathe	73	95	86	63	75	87	95	78	86	69	74	75	86	77	96	1215
5	Finishing lathe	57	44	52	17	39	58	42	68	54	83	26	37	49	58	48	732
6	Heat treat furnace	43	71	60	38	21	32	80	8	30	19	8	1	72	13	31	527
7	Grinder	70	83	62	10	28	19	58	17	79	68	12	6	28	17	19	576
8	Polisher	34	52	39	70	51	61	8	20	38	64	19	53	62	70	54	695
9																	
10																	

Add the header "Total" above the new totals. Follow the steps to create the Pareto chart as before. You notice that the data is not ordered from high to low.



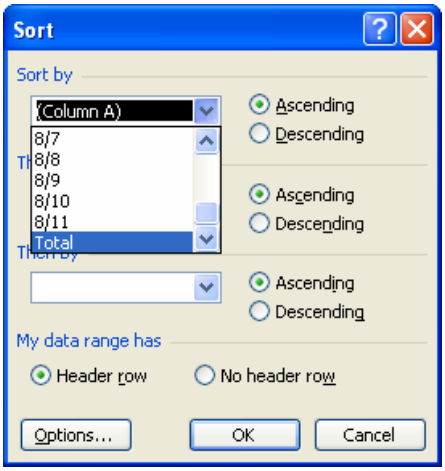
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Scrap counts for part number 922																
2																	
3		7/24	7/25	7/26	7/27	7/28	7/31	8/1	8/2	8/3	8/4	8/7	8/8	8/9	8/10	8/11	Total
4	Roughing lathe	73	95	86	63	75	87	95	78	86	69	74	75	86	77	96	1215
5	Finishing lathe	57	44	52	17	39	58	42	68	54	83	26	37	49	58	48	732
6	Heat treat furnace	43	71	60	38	21	32	80	8	30	19	8	1	72	13	31	527
7	Grinder	70	83	62	10	28	19	58	17	79	68	12	6	28	17	19	576
8	Polisher	34	52	39	70	51	61	8	20	38	64	19	53	62	70	54	695

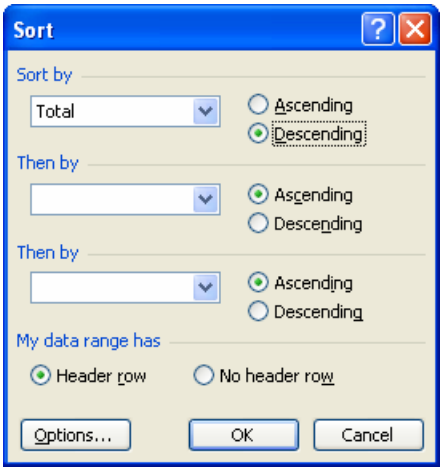
You must sort the data in a descending order. Paint the range of cells starting with the "Roughing Lathe" down to the bottom-right corner containing the total for the Polisher. Your spreadsheet should look as shown.



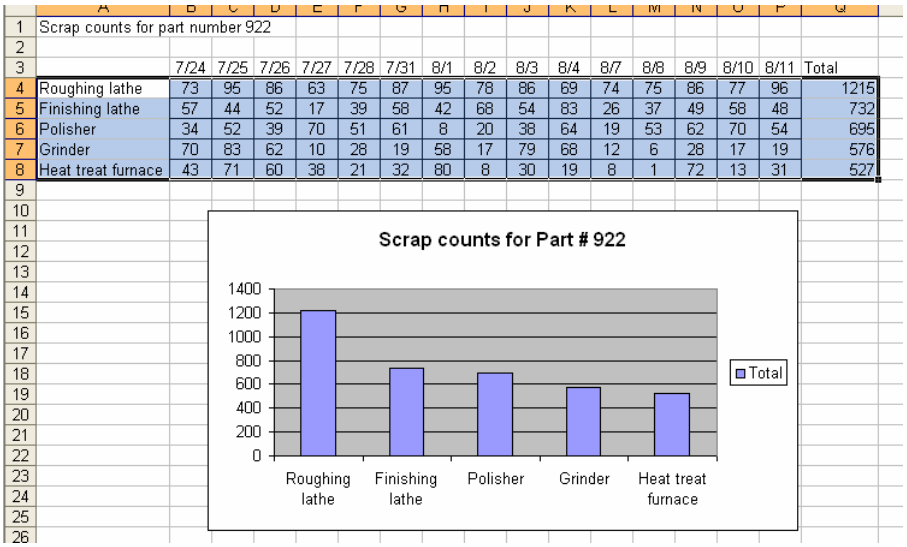
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Scrap counts for part number 922																
2																	
3		7/24	7/25	7/26	7/27	7/28	7/31	8/1	8/2	8/3	8/4	8/7	8/8	8/9	8/10	8/11	Total
4	Roughing lathe	73	95	86	63	75	87	95	78	86	69	74	75	86	77	96	1215
5	Finishing lathe	57	44	52	17	39	58	42	68	54	83	26	37	49	58	48	732
6	Heat treat furnace	43	71	60	38	21	32	80	8	30	19	8	1	72	13	31	527
7	Grinder	70	83	62	10	28	19	58	17	79	68	12	6	28	17	19	576
8	Polisher	34	52	39	70	51	61	8	20	38	64	19	53	62	70	54	695

Select Data, Sort to bring up the Sort dialog box. Make sure the Header Row option is checked. In the Sort By area, scroll down to the selection Total then click it. Next click the Descending button. Now click OK.





Your data will be sorted in descending order and the Pareto chart will be updated as shown.



	7/24	7/25	7/26	7/27	7/28	7/31	8/1	8/2	8/3	8/4	8/7	8/8	8/9	8/10	8/11	Total
Scrap counts for part number 922																
Roughing lathe	73	95	86	63	75	87	95	78	86	69	74	75	86	77	96	1215
Finishing lathe	57	44	52	17	39	58	42	68	54	83	26	37	49	58	48	732
Polisher	34	52	39	70	51	61	8	20	38	64	19	53	62	70	54	695
Grinder	70	83	62	10	28	19	58	17	79	68	12	6	28	17	19	576
Heat treat furnace	43	71	60	38	21	32	80	8	30	19	8	1	72	13	31	527

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