

AQS110 – Introduction to Quality and Metrology – Fall 2015

LABORATORY EXERCISE #7

DATA ANALYSIS**Purpose**

The purpose of this lab is to evaluate the data collected in Lab #4 – measurement.

Format

- The spreadsheet containing the raw data is posted on blackboard.
- Analysis and graphs shall be completed in Excel®.

Due Date

November 9, 2016 at beginning of class

Printed graphs, statistical summary and post-lab review questions

Laboratory Exercise

The data collected for machined washer and 90° bracket in Laboratory #4 will be analyzed. The prints for these parts have been included on page(s)

The data for the materials exercise (ID measurements on steel, plastic and tubing) will be used as examples.

PROCEDURE**A. Excel Set-up**

Completing this step initially will ensure the data analysis tools are available when they're needed.

Screen shots of the actions below are located at the end of the lab. (pages

1. Excel contains a data analysis tool pack; however, this requires installation
2. With a worksheet open:
 - a. Click on File tab
 - b. Click on Options (far left, near the bottom of list)
 - c. Click on "Add-ins" (far left, near the bottom of list)
 - d. Click on "Analysis ToolPak" (main screen, at top of list)
Be sure "analysis toolpak" is highlighted in blue; this indicates it has been selected.
 - e. *Click on "Go" at the bottom of the list and then click on "OK" in the bottom right corner.*
 - f. *Return to the Data tab and "data analysis" should now be visible on the ribbon.*

B. Reviewing the data

The purpose of reviewing the data prior to beginning any analysis is to ensure the values have been entered as numbers (rather than text); get a visual picture of whether the results are in or out of specification.

1. Is all data entered as a number
2. Are the measurement units all the same
3. Highlight values that are out of specification
 - a. The filter tool can be helpful here

C. Statistical Summary

1. For each dimension and tool used, determine the following
 - a. Mean, median, mode
 - b. Minimum, Maximum, range
 - c. Standard Deviation

The Excel functions (formula's) are as follows

*the "=" must be the first character, this tells Excel that a calculation or function will follow
format is important, there are no spaces between the data; the data range can be one column or multiple columns.*

=average(data range) *example: =average(f3.f64)*

data in column "f" from cell 3 to cell 64 will be averaged

=median(data range)

=mode(data range)

=min(data range) *example: =min(f3.h64)*

the minimum value in columns "f, g, h" from cell 3 to cell 64 will be located

=max(data range)

=stdev(data range)

Range is calculated by subtracting the minimum value from the maximum value

2. Review the results, do they make sense?
 - Is the minimum or maximum value within the specification range?
 - Is the calculated range larger than the specification range?

At this point, mixed data and typographical errors can be located.

Example: specification is 0.370 – 0.390

Minimum value = 0.037 -- looks like a typo; locate this point in the dataset and review original record to establish actual value

Maximum value = 9.87 -- could this be mm instead of inches; locate this point in the dataset and review original record to establish actual value and/or units

D. Graphical Representations

When creating histograms in Excel, there are two options for creating the "bins" or categories that the data will be counted in. Refer to Lab #6 for a discussion on histograms.

First, Excel will divide the data into equal bins

Second, based on the range (min and max values) calculated above you (the analyst) can create the bins.

Both methods for creating the graph will be discussed here. Screen shots are located at the end of the lab.

Reminder - A histogram is a bar graph that depicts the frequency of data that has been recorded within a range of values. Each bin is a small division of the overall range. Refer back to Lab #6 for a more detailed explanation.

1. **Create histograms for the dimension and tool combinations for the washer and bracket as follows, a total of 4 graphs will be generated:**
 - **Washer: Thickness measured with micrometer and Outer Diameter measured with caliper**
 - **Bracket: Thickness measured with micrometer and thickness measured with caliper.**
 - a. Using both the calculated range and specification range will be helpful for determine bin sizes.

- b. *Note: If the analysis toolpak has not been added, it should be now, as it will be needed.*
 - c. *Note: The ID dimension on the bracket can be pooled to create one graph rather than four.*
 - d. *This may take more than one try to get the bin spacing correct.*
2. **Print out of the various graphs created shall be printed and submitted.**

Method 1 - Creating a histogram, allowing Excel to create the bins (pages 12-13)

1. *Beginning on the "Data Tab", select data analysis.*
2. *Scroll down through list to locate "histogram" and select by clicking OK*
3. *Using the "grid icon" in the "input data" field, select the data set that will be charted*
4. *In "output options"*
 - a. *Select either output range or new worksheet (radial buttons)*
 - b. *Select "chart output" (check boxes)*
5. *Click OK*
6. *The histogram will either appear in a new worksheet or the location in the current worksheet that you selected.*

Method 2 - Creating a histogram, Analyst creates bins (pages 14-15)

1. *Using the specification range for the data and the minimum/maximum values create at least 5 bins that the data will be categorized into*
2. *Insert a blank column next to the data you wish to graph in the histogram*
3. *Enter the individual values for each bin to be created. The column shall have the title "bin"*
4. *Beginning on the "Data Tab", select data analysis.*
5. *Scroll down through list to locate "histogram" and select by clicking OK*
6. *Using the "grid icon" in the "input data" field, select the data set that will be charted*
7. *Using the "grid icon" in the "bin" field, select the data entered in the bin column (step #3)*
8. *In "output options"*
 - a. *Select either output range or new worksheet (radial buttons)*
 - b. *Select "chart output" (check boxes)*
9. *Click OK*
10. *The histogram will either appear in a new worksheet or the location in the current worksheet that you selected.*

*Example: specification range is 0.380 – 0.390,
minimum data value recorded was 0.372 and the maximum value was 0.407*

bins (to count frequency of occurrence) could be

*0.370 – 0.374
0.375 – 0.379
0.380 – 0.384
0.385 – 0.389
0.390 – 0.394
0.395 – 0.399
0.400 – 0.404
0.405 – 0.409
≥ 0.410*

The resulting graph will then depict how many times an individual data point was recorded for the range in that bin.

E. EXERCISE

Using the worksheet “class combined data” for the washer, generate the statistical summary described in Section C.

Using the worksheet “Class combined” data for the washer, Bottom ID – caliper and OD – caliper dimensions create a histogram, as described in Section D.

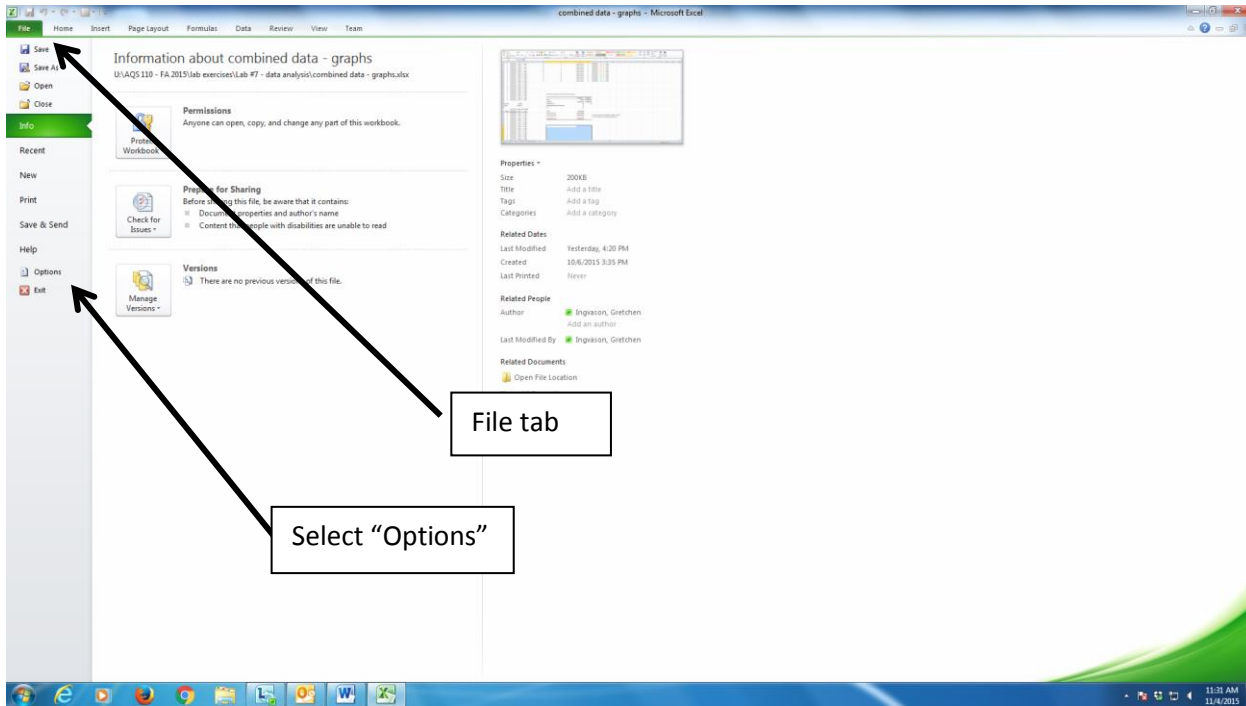
F. Post Lab Questions

- Were there any unusual observations in the data?
 - a. During initial review? Describe.

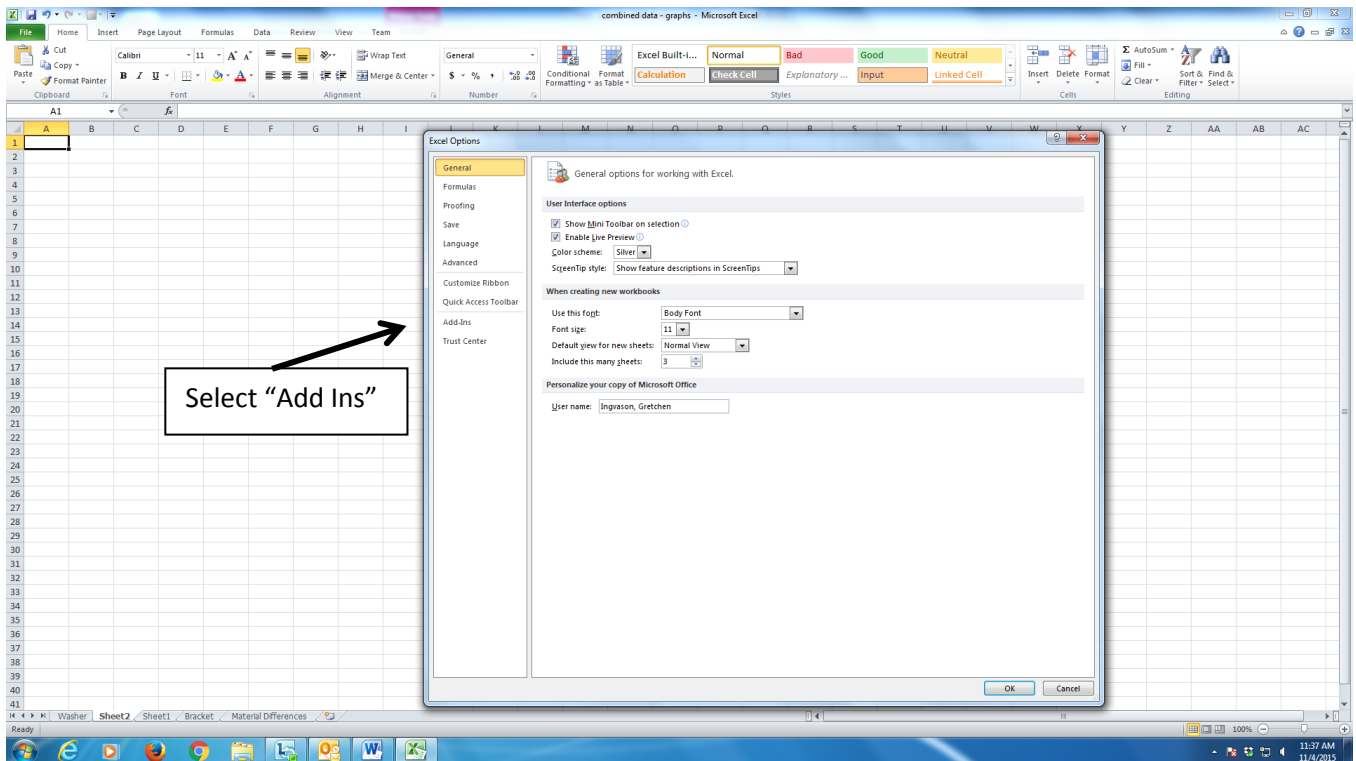
 - b. After calculations for statistical summary? Describe.

- For each component, the dimensions measured were obtained using at least 2 different tools. Referencing the statistical summary data (mean, median, mode, range, standard deviation) describe the differences observed between the tools.
 - A. Machined washer:

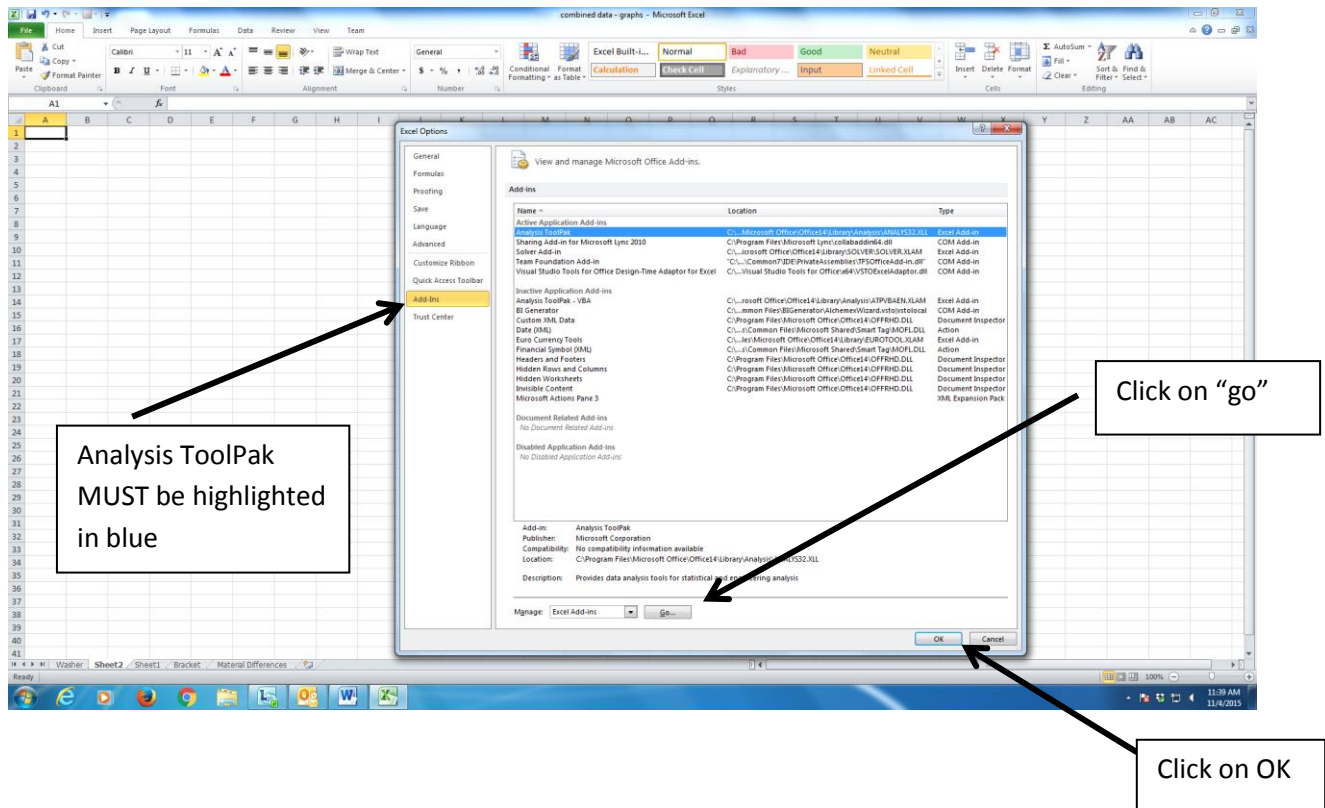
Adding the “Analysis ToolPak”



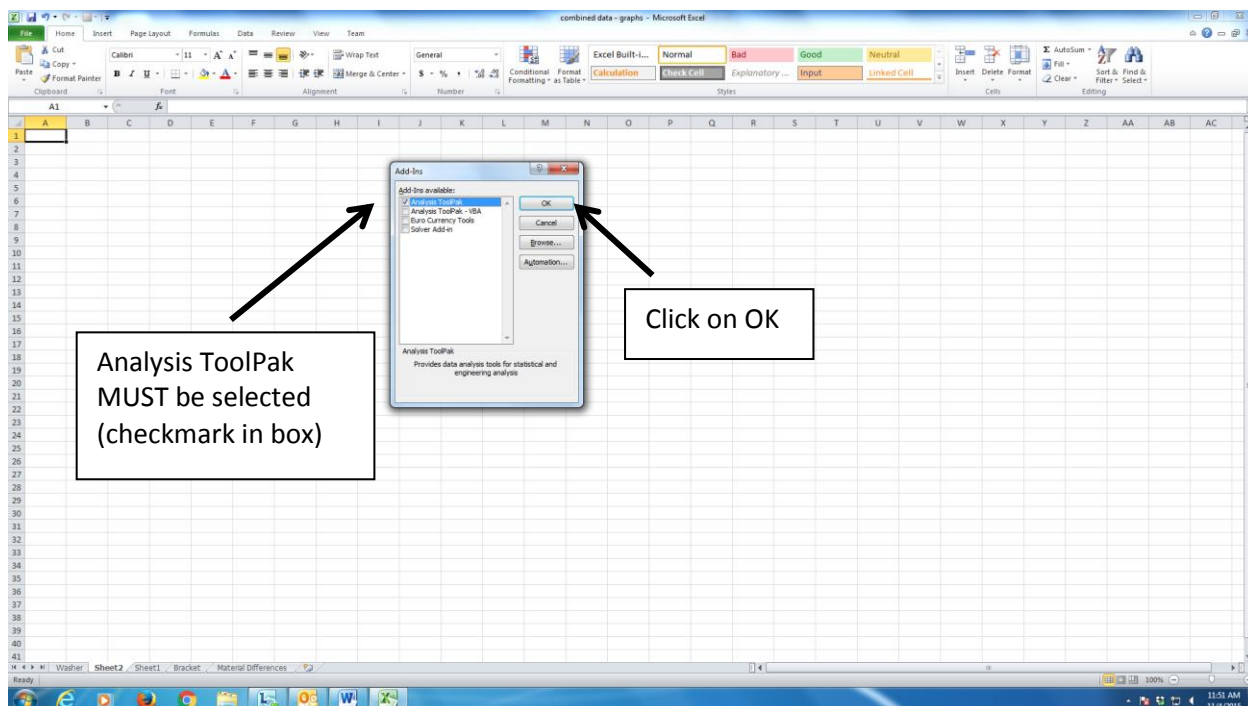
Options window will appear



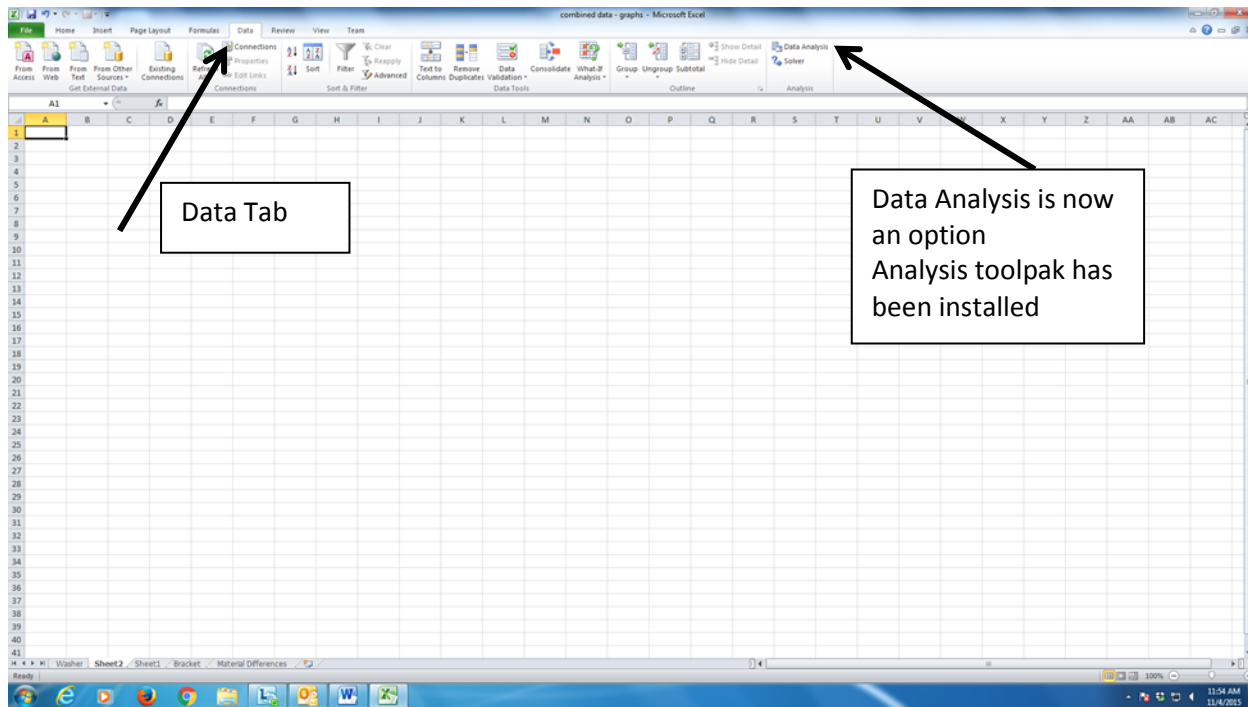
Add-Ins screen will appear



Add-Ins confirmation will appear



“data analysis” now appears on Data tab



METHOD 1 – Excel Creates bins for Histogram

The screenshot shows the Microsoft Excel interface with the 'Data' tab selected in the ribbon. The 'Data Analysis' button is highlighted. A 'Data Analysis' dialog box is open, showing a list of analysis tools. The 'Histogram' option is selected. Callouts identify the 'Data Analysis Option' in the ribbon, the 'Data tab', the 'Data Analysis Selection Window', and the 'Data set' in the worksheet.

Outer Diameter (OD)

	Outer Diameter (OD)
1	0.444
2	0.446
3	0.438
4	0.446
5	0.441
6	0.442
7	0.438
8	0.439
9	0.452
10	0.44
11	0.436
12	0.434
13	0.436
14	0.431
15	0.435
16	0.434
17	0.433
18	0.437
19	0.436
20	0.444
21	0.448
22	0.447
23	0.452
24	0.454
25	
26	
27	
28	specification 0.43 - 0.47
29	minimum 0.431
30	maximum 0.454

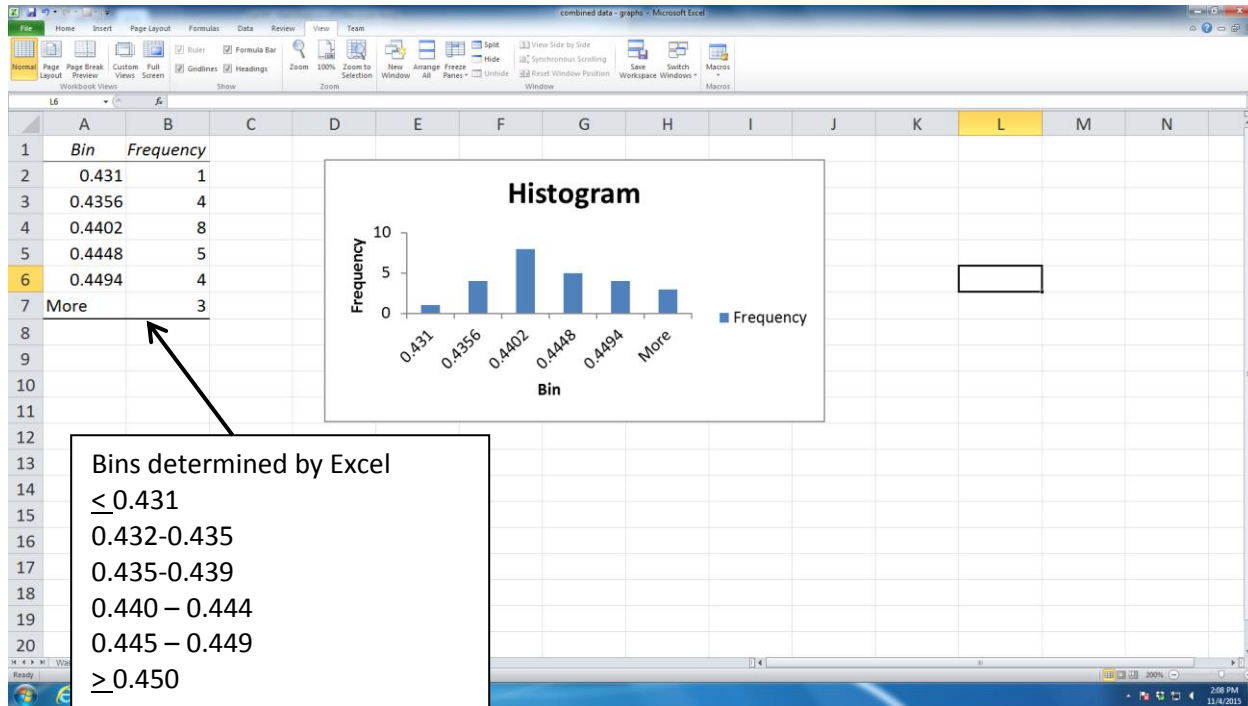
Selecting data to chart

The screenshot shows the 'Histogram' dialog box in Microsoft Excel. The 'Input Range' is set to '\$B\$2:\$B\$25'. The 'Output Range' is set to '\$D\$2:\$D\$25'. The 'Chart Output' checkbox is checked. Callouts identify the 'Column(s) that contain data to be charted', 'Selecting where output will display', and 'Create graph'.

Outer Diameter (OD)

	Outer Diameter (OD)
1	0.444
2	0.446
3	0.438
4	0.446
5	0.441
6	0.442
7	0.438
8	0.439
9	0.452
10	0.44
11	0.436
12	0.434
13	0.436
14	0.431
15	0.435
16	0.434
17	0.433
18	0.437
19	0.436
20	0.444
21	0.448
22	0.447
23	0.452
24	0.454
25	
26	
27	
28	specification 0.43 - 0.47
29	minimum 0.431
30	maximum 0.454

Histogram Results



METHOD 2 – Excel Creates bins for Histogram

The screenshot shows an Excel spreadsheet with the following data:

	A	B	C	D
1			Inner Diameter (ID)	bin
53			0.386	0.370
54			0.386	0.375
55			0.407	0.380
56			0.386	0.385
57			0.386	0.390
58			0.386	0.395
59			0.386	0.400
60			0.386	0.405
61			0.386	0.410
62				
63		specification	0.380 - 0.390	
64		minimum	0.372	
65		maximum	0.407	

Callouts:

- Values entered to create bins where data frequency can be counted (points to column D)
- Column added manually prior to creating the histogram (points to column D)
- Data used to create bins. Want to incorporate both the minimum and maximum values recorded AND the specification range (points to columns C and D)

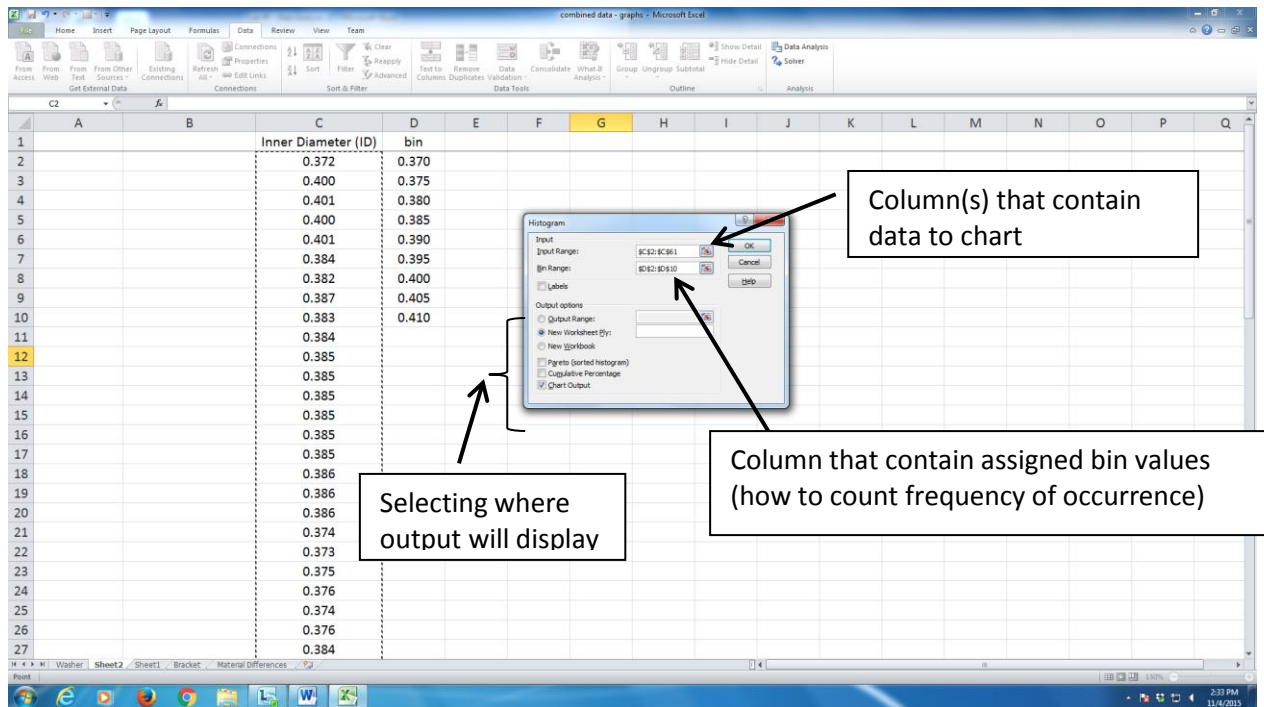
Select data analysis option - histogram

The screenshot shows the Excel spreadsheet with the Data Analysis option selected in the Data tab. The Data Analysis Selection Window is open, showing the list of analysis tools. The histogram option is selected.

Callouts:

- Data Analysis option (points to the Data Analysis button in the Data tab)
- Data Analysis Selection Window (points to the Data Analysis Selection Window)
- Data Tab (points to the Data tab in the ribbon)

Select column(s) to chart AND where bins are located



Histogram Results

