JMP® ENHANCED DATA SET

SEMICONDUCTOR WAFER PLANARIZATION PROCESS

RELEVANT JMP PLATFORMS AND STATISTICAL TECHNIQUES

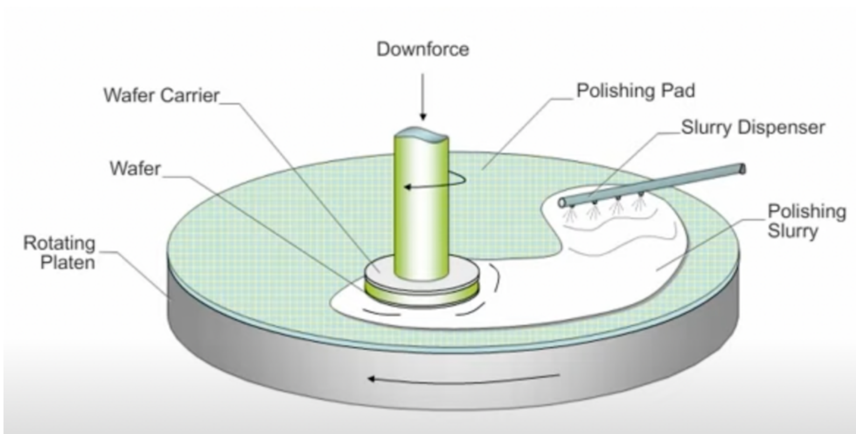
Distribution : Histogram, Boxplot, Summary Statistics

Graph Builder : Comparative Boxplots ; Comparative Dot plots ; Time Series plot of Means and Standard Deviations ; Location Heat Map

PROBLEM STATEMENT

Chemical Mechanical Planarization (CMP) is a critical process in semiconductor manufacturing used to achieve precise and flat surfaces on silicon wafers. This is crucial for ensuring that subsequent layers of materials in the integrated circuit manufacturing process adhere properly and function correctly.

CMP involves the use of a chemical slurry, which typically contains abrasive particles suspended in a liquid solution. Simultaneously, a mechanical force is applied through a rotating polishing pad. The combination of chemical action and mechanical abrasion allows for removal of material creating a thin film on the wafer's surface.



Ideally, the resulting surface will be perfectly uniform across the wafer, and all wafers going through this process will have a thin film surface thickness to specification.

Engineers in one such wafer manufacturing facility have been conducting a comparative analysis of slurries from four different supplies to decide which would be the best to use. One part of this study was to use each slurry in a 50-wafer production run. The resulting thickness of the film was measured on 21 different locations on each wafer. The specification for this particular process is a uniform film thickness of 750 +/- 15 nanometers.

DATA SET

Semiconductor_Wafer_Planarization_Process.jmp

Supplier	Slurry from one of four different suppliers (S1, S2, S3, S4)
Wafer	Wafer in production run (1, 2, ... , 50)
Y Coordinate	Location on wafer in y-coordinate
X Coordinate	Location on wafer in x-coordinate
Thickness	Thickness of thin film on the wafer (nm)

EXERCISES

1. Create a histogram, boxplot, and calculate summary statistics of the 'Thickness' values for each Supplier. Comment on the central location and variation of 'Thickness' for each Supplier.

> *Instructions: Analyze > Distribution. Choose 'Thickness' for the Y Variable, and 'Supplier' for the By Variable. Click OK.*

2. Create comparative boxplots of the 'Thickness' values for each Supplier. How does the resulting 'Thickness' compare between the suppliers, and to target and specifications?

> *Instructions: Use Graph Builder. Place the variable 'Thickness' on the Y axis. Place 'Supplier' on the X axis. Choose the boxplot icon.* 
> *Add references lines for the target of 750 nm, lower specification of 735nm, and upper specification of 765 nm by right-clicking on the Y axis and selecting Axis Settings.*

3. Create a graph displaying the 21 'Thickness' values for each of the 50 wafers for each Supplier. Is the central location and amount of variation in 'Thickness' consistent throughout all wafers within each Supplier? Are there any extreme unusual observations?

> *Instructions: Use Graph Builder. Place the variable 'Thickness' on the Y axis, 'Wafer' on the X axis, and 'Supplier' as the Group X.*
> *Add references lines for the target of 750 nm, lower specification of 735nm, and upper specification of 765 nm by right-clicking on the Y axis and selecting Axis Settings.*

4. Create a graph displaying the average and standard deviation of the 21 'Thickness' values for each of the 50 wafers for each Supplier. Do you prefer using the dot plot graph created in Exercise 3 or the visualization created in this exercise to summarize the performance of each of the slurries?

> *Instructions:* *Use Graph Builder. Place the variable 'Thickness' on the Y axis, 'Wafer' on the X axis, and 'Supplier' as the Group X. Choose the Mean in the Summary Statistics drop-down menus in the Points and Line controls on the left. Choose the line icon (holding the shift key down so both the points and connect lines are displayed).*
> *Add a references line for the target of 750 nm.*
>
> *Place 'Thickness' on the bottom section of the Y axis. Choose Std Dev in the Summary Statistics drop-down menus for the Points and Line controls for that section.*
> *Add a reference line at 5 nm. (Note the specifications are +/- 15 nm. A standard deviation of 5nm would result in +/- 3 standard deviations equating to the specifications).*
>
> *Rename the two titles on the Y axes to "Avg Thickness" and "Std Dev Thickness' to make it clear what is being plotted in each set of graphs.*

5. Create a graph that displays the 'Thickness' values for the 21 locations on each wafer. Is there any indication that the variation in 'Thickness' is non-random across the wafer (i.e., a systematic pattern where high or low values tend to occur in certain areas of the wafers)?

> *Instructions:* *Use Graph Builder. Drag the 'X Coordinate' and 'Y Coordinate' values into the center area. A smoother is added to the graph by default. Remove it by deselecting the smoother icon. Place 'Thickness' into the color role. Right-click on the color legend on the left and choose Gradient > Quantile for the Scale Type.*
>
> *To aid in viewing the data, right-click on the graph and choose Graph > Marker Size > Other, and type in the value "15".*
>
> *The graph is currently showing the average Thickness in each location across all 50 x 4 = 200 wafers. As a way to view and compare the data across the wafers and suppliers, choose Local Data Filter under the red triangle. Select 'Supplier' and 'Wafer' for the variables.*
> *From the Local Data Filter controls on the left, select the first supplier and wafer. The graph is now showing that 'Thickness' values for that one specific wafer. Scroll through the 50 wafers by holding the down arrow after selecting the first wafer. As you scroll through the wafers, look to see if low or high thickness values tend to systematically occur in certain areas of the wafers or does it appear to be randomly distributed throughout the locations on the wafer? Repeat this for each supplier.*