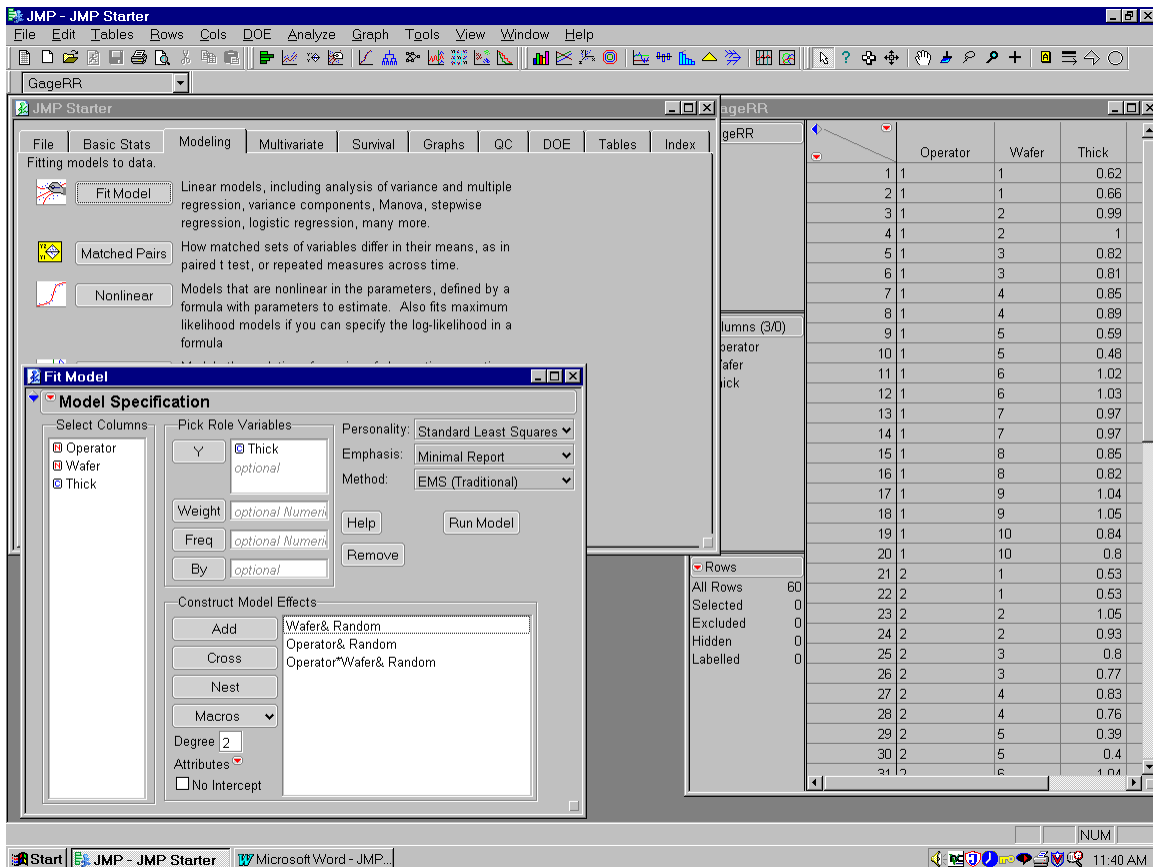


JMP Analysis for Gauge R&R

The JMP statistical computing program allows you to perform calculations similar to the ones presented in class. The example presented in class used ranges to estimate standard deviations, and components of variability. JMP, through its Modeling platform, calculates variance components based on sums of squared deviations rather than ranges. The answers obtained using JMP may be slightly different from those computed using the hand formulas.

To enter the data you will need three columns, so add 2 columns to your work sheet using the Column pull down on the data sheet. The first column is for Operator identifiers, the second column is for Wafer identifiers, and the third column is for the actual Thickness measurements. It is important that the Operator and Wafer columns have a Character Data Type. The Thickness column should be a Numeric Data Type and Continuous Modeling Type (the default for JMP).



Go to the Modeling part of the JMP Starter or Modeling under the Analysis pull down and click on Fit Model. Thickness is the Y variable. Add Wafer and Operator to the Construct Model Effects box by highlighting them and clicking on Add. Next, highlight both Wafer and Operator (hold down the shift key) and then click on Cross. All of the

variables in the Construct Model Effects need to have a Random designation. To do this, highlight the three terms (again us the shift key when you click) in the Construct Model Effects box. Click on the red triangle next to Attributes and select Random Effect. Go to the Emphasis pull down in the upper right portion of the Fit Model dialog box and choose Minimal. For Method, select EMS(Traditional). Then click on Run Model.

There will be more in the output than needed for our purposes. In particular, you can click on the blue triangle next to Parameter Estimates or any of the other headings to hide that information. The most important information appears in the Variance Components Estimates portion of the output.

Response Thick

Summary of Fit

RSquare	0.985601
RSquare Adj	0.971682
Root Mean Square Error	0.032736
Mean of Response	0.812167
Observations (or Sum Wgts)	60

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model	29	2.2006683	0.075885	70.8104	<.0001
Error	30	0.0321500	0.001072		
C. Total	59	2.2328183			

Variance Component Estimates

Random Effect	Var Component	Pct of Total
Wafer&Random	0.037598	90.553
Operator&Random	0.001446	3.483
Operator*Wafer&Random	0.001405	3.383
Residual	0.001072	2.581
Total	0.041520	100.000

From this it is easy to read off the Variance Component attributable to Repeatability (Residual) as 0.001072. The Variance Component attributable to Reproduceability is the sum of the components for Operator and Operator*Wafer ($0.001446 + 0.001405 = 0.002851$). The Total (for the measurement process) is 0.003923. The percentages are: Repeatability: 27.3% and Reproduceability: 72.7%.

Note: JMP includes the Wafer variability in the Total and computes percentages using this larger total.