



Graphical Methods (Green Belt)

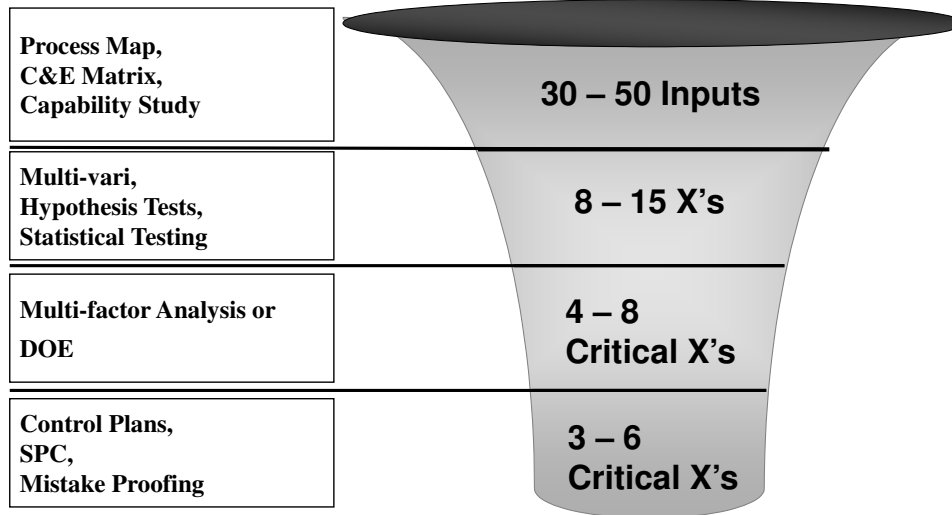
Module Objectives



- ☐ Introduce a few methods of graphical analysis
 - Box plots
 - Main effects and interaction plots
 - Scatter Plot
- ☐ Demonstrate a method for conducting multi-vari studies
- ☐ Introduce and practice data mining

A picture is, indeed, worth a thousand numerals
- Sony

Reducing the Inputs

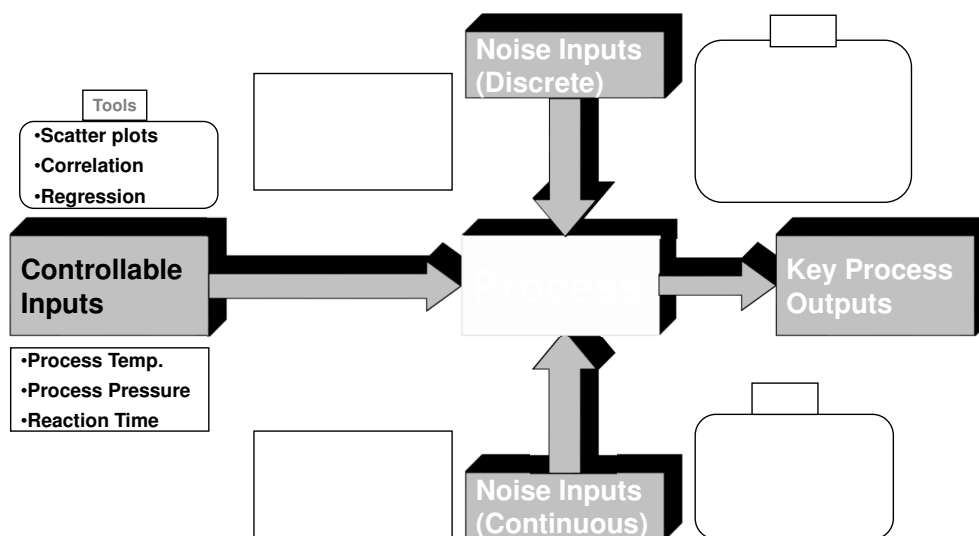


Reduce inputs by Identifying sources of variation.

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Identifying Inputs & Outputs



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Graphical Analysis – Example



- ☐ A process is used to make a type of socket, four pieces at a time, one piece per slot. Measurements of the sockets consist of thickness values in excess of 5.00 millimeters. The gauges measure in hundredths of a millimeter. The specification is 11 ± 6 .
- ☐ Four times a day the supervisor would go to the press and gather up the parts produced by five consecutive cycles of the press.
- ☐ The supervisor collected data for five days . The data are lying in **Data Sheet**.

☐ Is socket quality varies

- Slot to slot
- Cycle to cycle



What are the types of noise variables here?

Graphical Analysis – Example



- ☐ A lending company expects its loan officers (LO) to review 120 applications every 2 hrs.
- ☐ Process performance is monitored using a computer tracking system.
- ☐ The following data is collected:
 - Loans applications reviewed per 2 hr period
 - Total Dollar Value of Applications reviewed
 - Month
 - Day of Week
 - Loan Officer
 - Time of Day

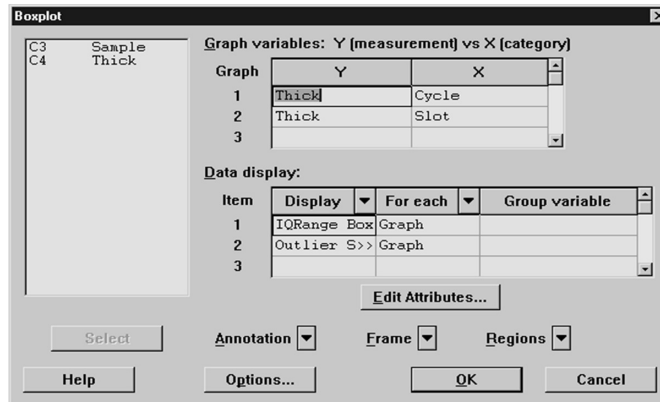
What are the types of noise variables here?

Box Plot Comparisons



❑ Construct a Box plot for Thick by Cycle and by Slot

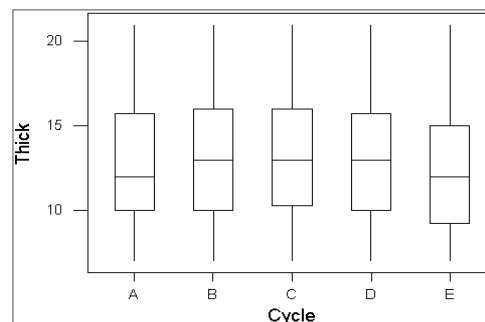
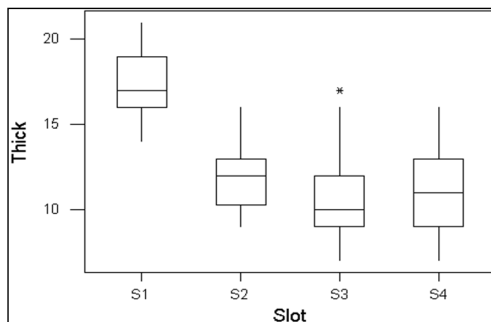
- In Minitab select Graph > Box plot...
- Enter the data this way:



Box Plot Output



- ❑ Notice that box plots do NOT require “numeric” x variables. This plot will accept “categorical” text variables.



What conclusions can you draw?

The Box Plot Interpretation



❑ Whisker definition:

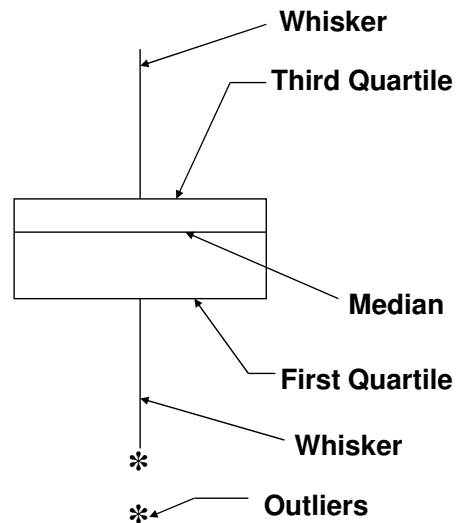
- Upper and lower whiskers extend from the quartile lines to the highest and lowest values inside the upper and lower limits, respectively

❑ Outliers

- Points beyond the upper and lower limits

Upper Limit: $Q3 + 1.5*(Q3-Q1)$

Lower Limit: $Q1 - 1.5*(Q3-Q1)$



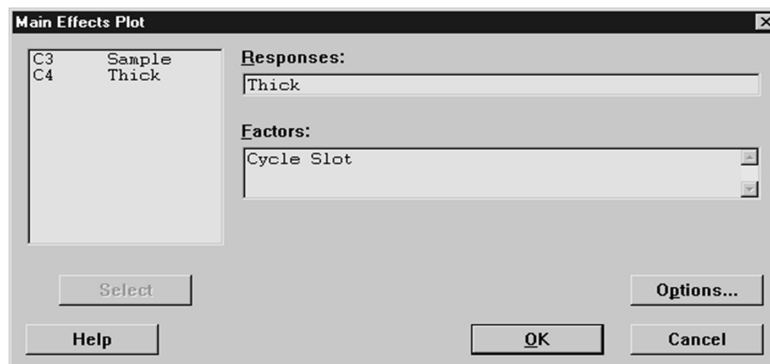
Box plots are great for non-normal data.

Main Effects Plots



❑ Plots averages of the data at the factor levels

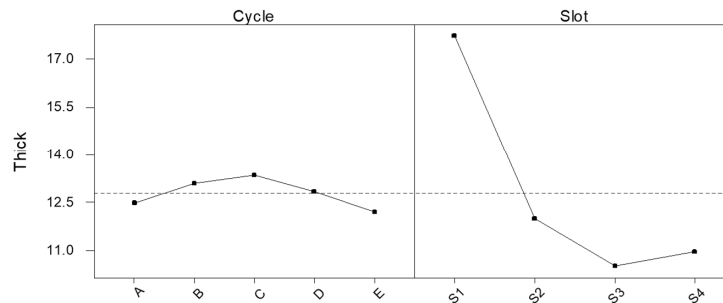
- Stat > ANOVA > Main Effects Plot...



Main Effects Output



Main Effects Plot - Data Means for Thick



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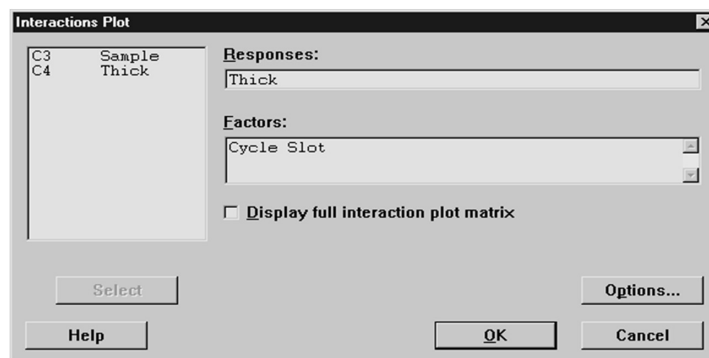
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Interaction Plots



- ☐ An interactions plot is a plot of means for each level of a factor with the level of a second factor held constant.
- ☐ Parallel lines
- ☐ indicate no interaction is present.

Stat > ANOVA > Interactions Plot...



More on these plots in ANOVA.

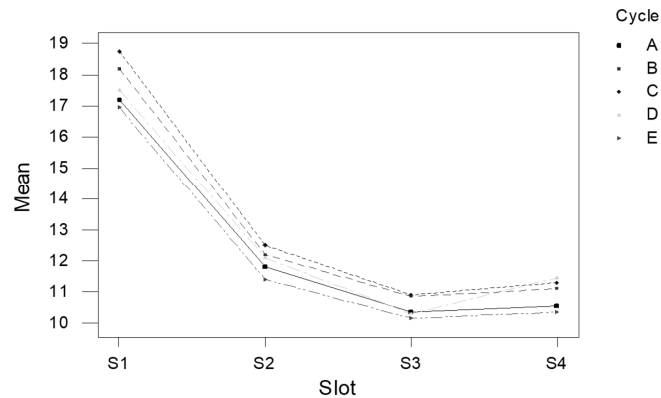
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Interaction Plots – Output



Interaction Plot - Data Means for Thick



Is there an interaction?

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Scatter Plot



- ☐ In a random sample of nine invoice processing employees, their years of experience (x) and the number of transactions processed per hour (y) were recorded.
- ☐ Use the data to draw a scatter plot.
- ☐ Does it indicate any thing?

x	y
4.2	2.8
3.8	2.5
4.8	3.1
3.4	2.1
4.5	2.9
4.6	2.8
4.3	2.6
3.7	2.4
3.9	2.5

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Scatter Plot

❑ A graphical analysis Tool

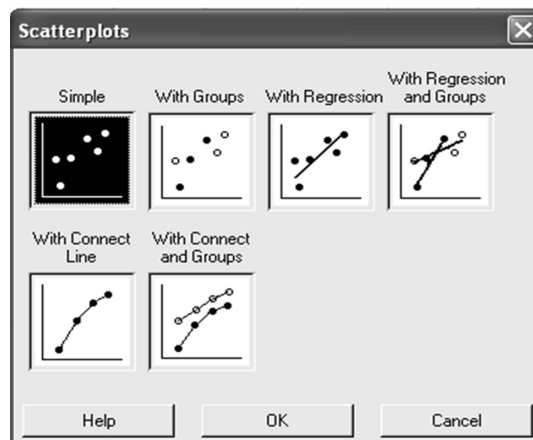
- Analyzes the effect of continuous X on continuous Y.



x	y
4.2	2.8
3.8	2.5
4.8	3.1
3.4	2.1
4.5	2.9
4.6	2.8
4.3	2.6
3.7	2.4
3.9	2.5

Scatter Plot - Minitab

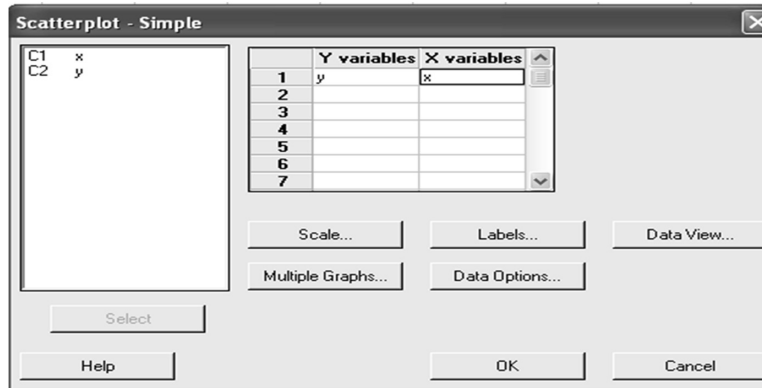
❑ Minitab: Graph> Scatter plot



x	y
4.2	2.8
3.8	2.5
4.8	3.1
3.4	2.1
4.5	2.9
4.6	2.8
4.3	2.6
3.7	2.4
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Scatter Plot - Minitab

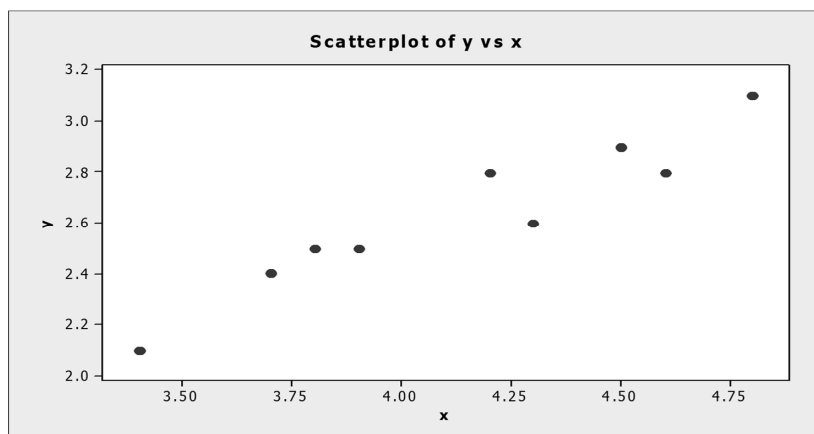
- ☐ In dialogue box attach columns containing x & y variable



x	y
4.2	2.8
3.8	2.5
4.8	3.1
3.4	2.1
4.5	2.9
4.6	2.8
4.3	2.6
3.7	2.4
3.9	2.5

Scatter Plot - Minitab

- ☐ Minitab response



x	y
4.2	2.8
3.8	2.5
4.8	3.1
3.4	2.1
4.5	2.9
4.6	2.8
4.3	2.6
3.7	2.4
3.9	2.5



Any conclusion?