



# Discrete Event Simulation for QPM – Can it Really be That Easy?



CMMI LEVEL 3 | ISO 9001:2008

- ◀ Introduction
- ◀ Background
  - ▶ QPM
  - ▶ Discrete Event Simulation
- ◀ Case study
  - ▶ Using discrete event simulation for QPM

- Optimal Solutions & Technologies (OST, Inc)
- Washington DC-based, founded in 1999
- Core competencies
  - Integrated IT solutions
  - Managed Services
  - Management consulting
  - Research, development & engineering
- CMMI L3 (CMMI-DEV v1.2)
- ISO 9001:2008 certified
- ANSI 748 compliant



## ◀ QPM

- ▶ Requires PPM's and PPB's
- ▶ Most intimidating for us!

## ◀ Discrete Event Simulation

- ▶ Step-by-step or Succession of events
- ▶ Time Matters!
- ▶ Events are not allowed in between time units
- ▶ Non – stochastic/deterministic

# *Our case study...*



## ◀ Invoices were late resulting in

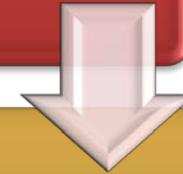
- ▶ Customer complaints
- ▶ Financial exposure

## ◀ Possible solutions

- ▶ Add more staff (implies increases overhead cost)
- ▶ Improve the process to make it LEAN

**What we found useful:** (1) A Jumpstart Method for Business Goals and Project Objectives Supporting CMMI High Maturity, Bob Stoddard, <http://www.sei.cmu.edu/library/abstracts/webinars/21aug2008.cfm>

Steps we took

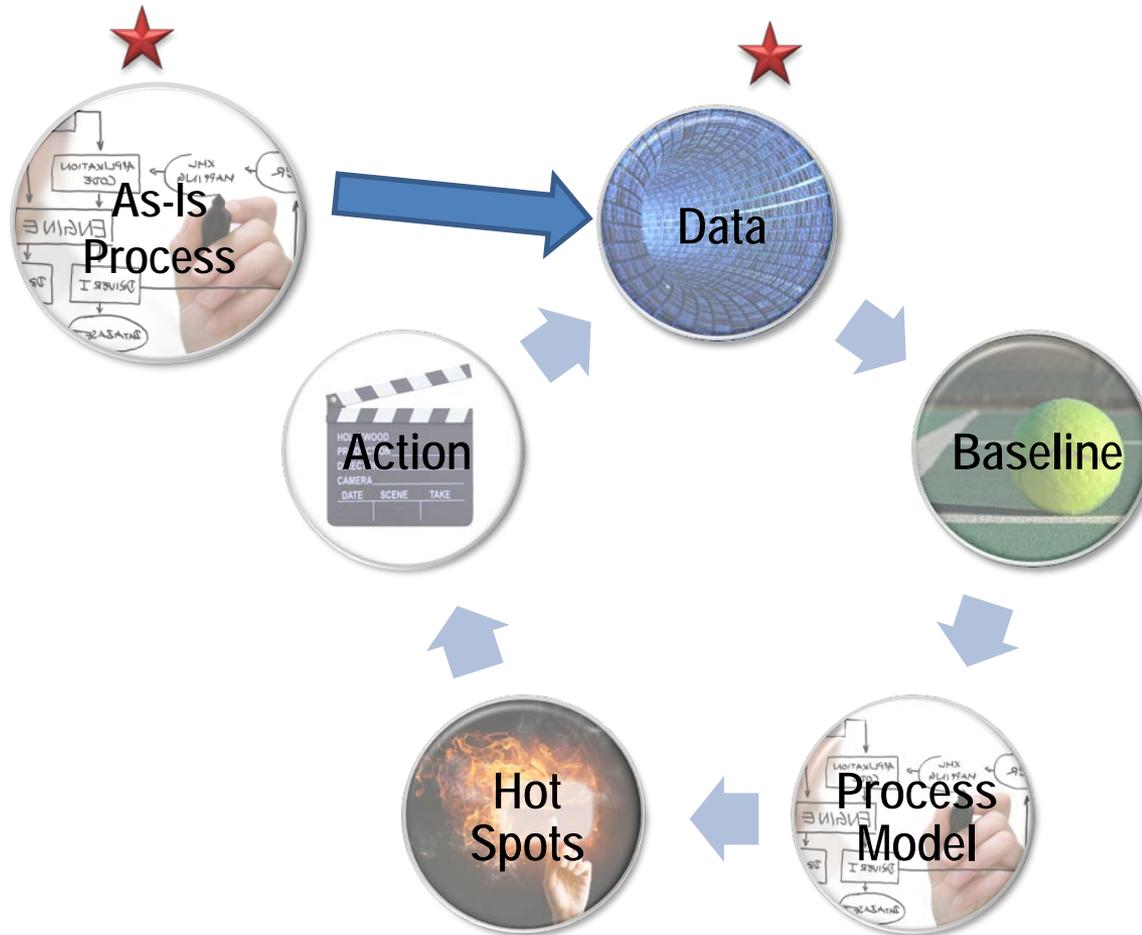


Resources we used



Mapping to "requirements"  
(step-by-step guide)

**\* Demonstration steps are captured in Appendix for your reference**



What we found useful:  
Process Model Tutorial  
<http://www.processmodel.com/support/tutorials.html>

What we found useful: (3) A Practical Approach for Building CMMI Process Performance Models  
<http://www.sei.cmu.edu/library/abstracts/presentations/28apr2009webinar.cfm>

	In office - 7/27
Client	FAA-ESVMS (Jun)
Generated cover sheet	12/20-12/22
Run proj staffing & check outstanding ts report	P: 12/22-12/23 C: 12/23-12/24
resolve ts issues	<del>12/22</del> N/A
Generate billing report	12/25-12/25
Resolve billing report issues	N/A
Initialize invoice	12/26-12/27
Populate labor	12/28-12/28
Generate expense report	12/28-12/29
resolve expense issues	N/A
Populate ODCs and enter G&A expense	N/A
Print and check (inv check reports & contract only)	P: 12/29-12/31 C: 12/31-12/31
Generate additional reports	N/A
PM approval (scan, send, & check for response)	S: [12/38-12/39] + [12/42-12/43] S: 12/43-12/44
Get Signed	
Redate, scan & upload, and copy	7/3 R: 1/41-1/46 S: 1/47-1/49 (no copies)
Sent	" 2/22-2/27
Notify Linda	" 2/27-2/29
Entered into contract tracking	" 2/29-2/34 (incl. notifying of law-funders)
Marked off master chart	" 2/35-2/35
Add to quarterly reporting	N/A
Notes	

What we found useful: (2) Process Performance Baselines and Models: Duh, I Don't Get It, Diane Mizukami (Williams)

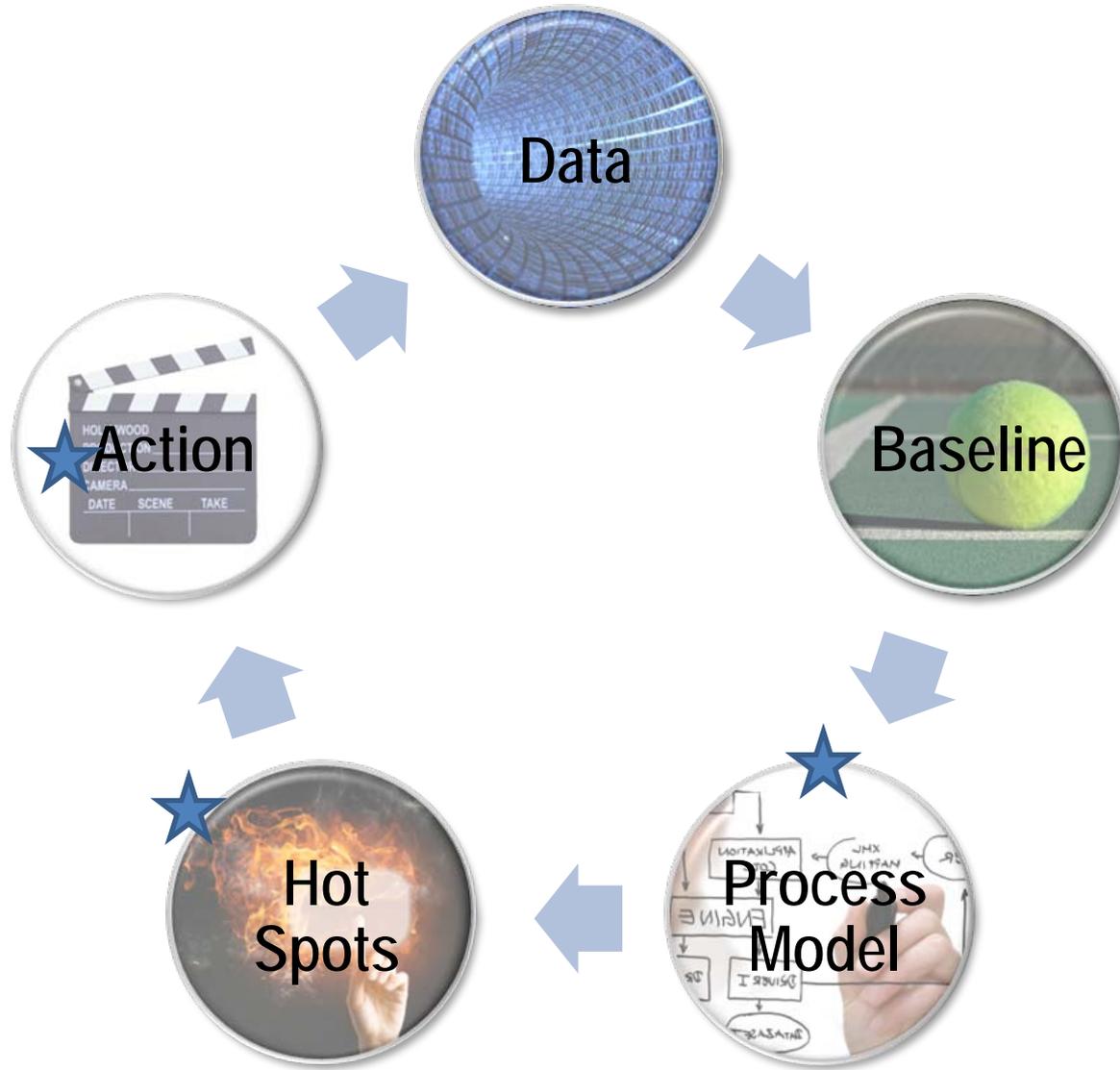
<http://www.dtic.mil/ndia/2007cmmi/Thursday/4amMizukami.pdf>

◀ Minitab

◀ Graphical Summary

All screen shots are presented in the Appendix for your reference.

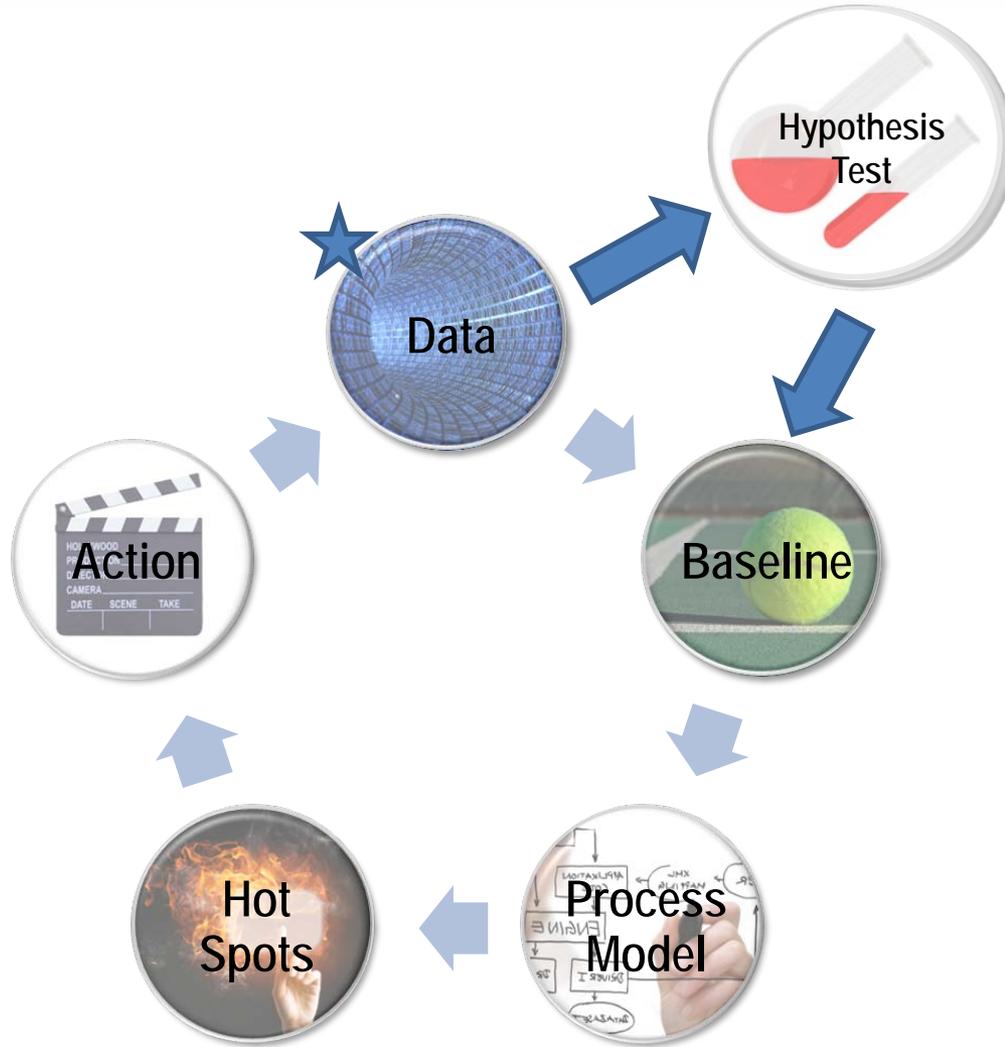
- ▶ Build as-is model
- ▶ Collect data
- ▶ Assess data quality and integrity
- ▶ Build PPB's
  - ▶ Minitab
  - ▶ Statfit



## Process Model

All screen shots are presented in the Appendix for your reference.

- ▶ Run the simulation
- ▶ Identify hot spots
- ▶ Run "What-If" scenarios
- ▶ Take Action



## Hypothesis tests

All screen shots are presented in the Appendix for your reference.

- ▶ Select the right test
- ▶ Interpret the results
- ▶ Update your model
- ▶ Evaluate results
- ▶ Repeat steps if needed

## ▶ Prediction Interval (PI)

- ▶ Expected interval for next data point

## ▶ Confidence Interval (CI)

- ▶ Expected interval for the central tendency (mean or median)

▶ Beware!! Don't use CI's to make a prediction!!

- ◀ Determining Confidence Intervals
- ◀ Determining Prediction Intervals

All screen shots are presented in the Appendix for your reference.

- ▶ Start with a simple model
- ▶ Check the model with intuition
- ▶ Quantify savings in \$ if possible
- ▶ Keep your stakeholders engaged
  - ▶ Share positive and negative news

- ▶ 1. Identify or Reconfirm Business Goals
- ▶ 2. Identify the sub-processes/process
- ▶ 3. Identify Outcomes to Predict (y's)
- ▶ 4. Identify Controllable factors (x's) to predict outcomes
- ▶ 5. Include Uncontrollable x factors
- ▶ 6. Collect Data
- ▶ 7. Assess Data Quality and Integrity – *Not covered today*
- ▶ 8. Identify data types of all y outcomes and x factors
- ▶ 9. Create PPBs
- ▶ 10. Select the proper analytical technique and/or type of regression equation
- ▶ 11. Create Predictions with both Confidence and Prediction Intervals
- ▶ 12. Statistically manage sub-processes with PPMs
- ▶ 13. Take Action Based on PPM Predictions
- ▶ 14. Maintain PPMs including calibration and reconfirming relationships
- ▶ 15. Use PPMs to assist in CAR and OID

Ensures mapping to requirements and compliance!

## ◀ Goal 1

- ▶ Objectives
- ▶ Selecting sub processes
- ▶ Taking action

## ◀ Goal 2

- ▶ Applying analytical techniques
- ▶ Monitoring performance
- ▶ Actual records

Any Questions?





Thank You!





Student Name	Student Address	Student Age
1. John Smith	123 Main St	18
2. Jane Doe	456 Elm St	19
3. Michael Brown	789 Oak St	20
4. Sarah White	101 Pine St	17
5. David Lee	202 Maple St	21
6. Emily Taylor	303 Cedar St	18
7. James Wilson	404 Birch St	19
8. Lisa King	505 Walnut St	20
9. Robert Green	606 Cherry St	17
10. Jennifer Adams	707 Poplar St	21
11. Christopher	808 Hickory St	18
12. Amanda	909 Cypress St	19
13. Matthew	1010 Spruce St	20
14. Ashley	1111 Fir St	17
15. Daniel	1212 Redwood St	21
16. Victoria	1313 Sycamore St	18
17. Benjamin	1414 Dogwood St	19
18. Hannah	1515 Magnolia St	20
19. Alexander	1616 Tulip St	17
20. Isabella	1717 Rose St	21
21. William	1818 Sunflower St	18
22. Charlotte	1919 Dandelion St	19
23. Joseph	2020 Clover St	20
24. Olivia	2121 Lavender St	17
25. Ethan	2222 Zucchini St	21
26. Sophia	2323 Pumpkin St	18
27. Noah	2424 Watermelon St	19
28. Ava	2525 Strawberry St	20
29. Lucas	2626 Blueberry St	17
30. Mia	2727 Raspberry St	21
31. Owen	2828 Blackberry St	18
32. Isabella	2929 Elderberry St	19
33. Sebastian	3030 Elderflower St	20
34. Emily	3131 Elderflower St	17
35. Daniel	3232 Elderflower St	21
36. Victoria	3333 Elderflower St	18
37. Benjamin	3434 Elderflower St	19
38. Hannah	3535 Elderflower St	20
39. Alexander	3636 Elderflower St	17
40. Isabella	3737 Elderflower St	21
41. William	3838 Elderflower St	18
42. Charlotte	3939 Elderflower St	19
43. Joseph	4040 Elderflower St	20
44. Olivia	4141 Elderflower St	17
45. Ethan	4242 Elderflower St	21
46. Sophia	4343 Elderflower St	18
47. Noah	4444 Elderflower St	19
48. Ava	4545 Elderflower St	20
49. Lucas	4646 Elderflower St	17
50. Mia	4747 Elderflower St	21
51. Owen	4848 Elderflower St	18
52. Isabella	4949 Elderflower St	19
53. Sebastian	5050 Elderflower St	20
54. Emily	5151 Elderflower St	17
55. Daniel	5252 Elderflower St	21
56. Victoria	5353 Elderflower St	18
57. Benjamin	5454 Elderflower St	19
58. Hannah	5555 Elderflower St	20
59. Alexander	5656 Elderflower St	17
60. Isabella	5757 Elderflower St	21
61. William	5858 Elderflower St	18
62. Charlotte	5959 Elderflower St	19
63. Joseph	6060 Elderflower St	20
64. Olivia	6161 Elderflower St	17
65. Ethan	6262 Elderflower St	21
66. Sophia	6363 Elderflower St	18
67. Noah	6464 Elderflower St	19
68. Ava	6565 Elderflower St	20
69. Lucas	6666 Elderflower St	17
70. Mia	6767 Elderflower St	21
71. Owen	6868 Elderflower St	18
72. Isabella	6969 Elderflower St	19
73. Sebastian	7070 Elderflower St	20
74. Emily	7171 Elderflower St	17
75. Daniel	7272 Elderflower St	21
76. Victoria	7373 Elderflower St	18
77. Benjamin	7474 Elderflower St	19
78. Hannah	7575 Elderflower St	20
79. Alexander	7676 Elderflower St	17
80. Isabella	7777 Elderflower St	21
81. William	7878 Elderflower St	18
82. Charlotte	7979 Elderflower St	19
83. Joseph	8080 Elderflower St	20
84. Olivia	8181 Elderflower St	17
85. Ethan	8282 Elderflower St	21
86. Sophia	8383 Elderflower St	18
87. Noah	8484 Elderflower St	19
88. Ava	8585 Elderflower St	20
89. Lucas	8686 Elderflower St	17
90. Mia	8787 Elderflower St	21
91. Owen	8888 Elderflower St	18
92. Isabella	8989 Elderflower St	19
93. Sebastian	9090 Elderflower St	20
94. Emily	9191 Elderflower St	17
95. Daniel	9292 Elderflower St	21
96. Victoria	9393 Elderflower St	18
97. Benjamin	9494 Elderflower St	19
98. Hannah	9595 Elderflower St	20
99. Alexander	9696 Elderflower St	17
100. Isabella	9797 Elderflower St	21

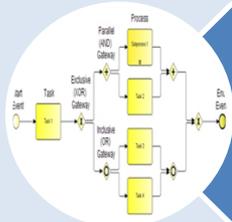
To create database  
Easy to access data

Access Data base



Used to Plot I-MR charts,  
Summary charts, Individual  
charts

Minitab



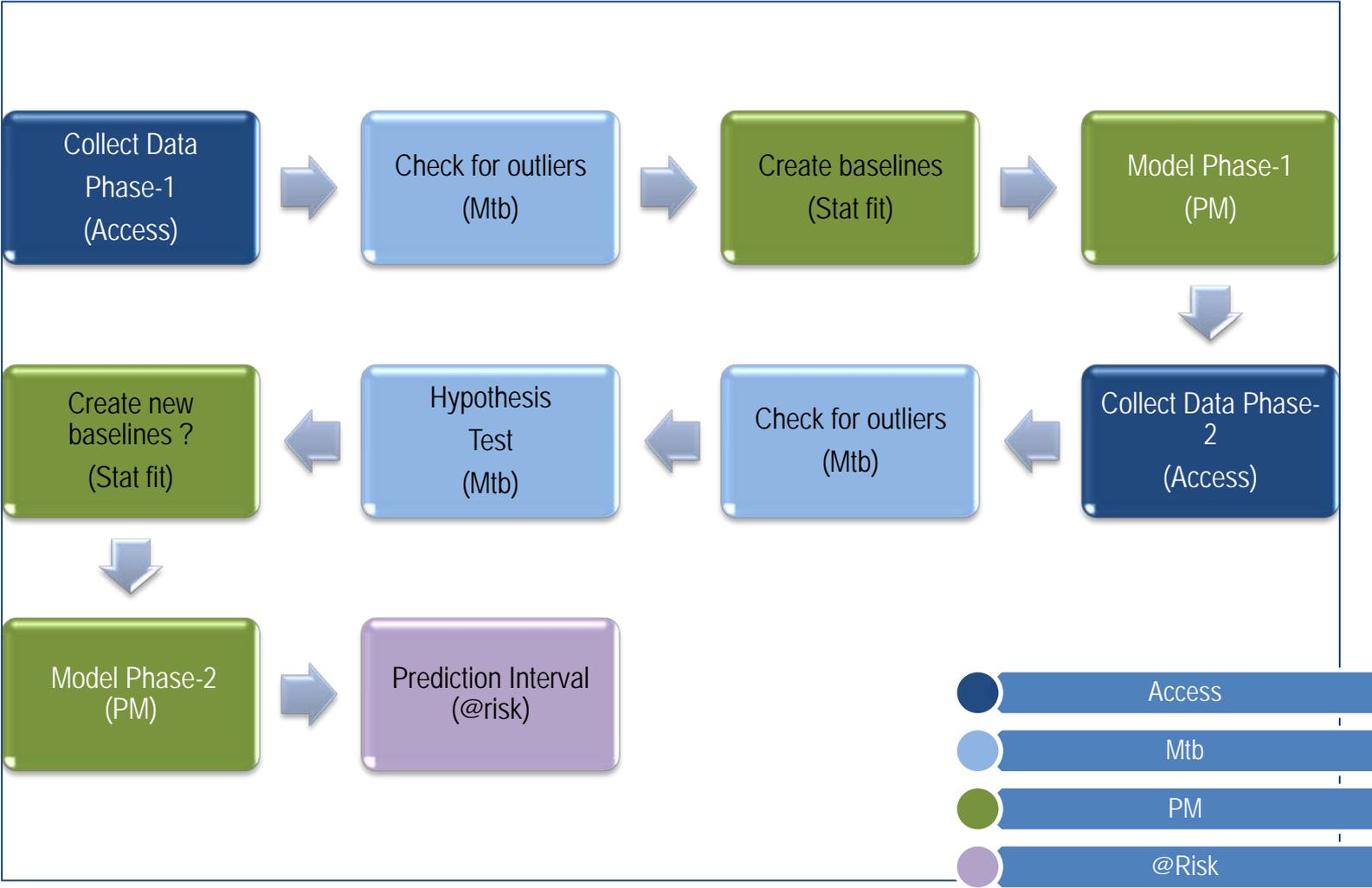
Stat fit , creating baseline ,  
plotting Hot spots , Produce  
average .

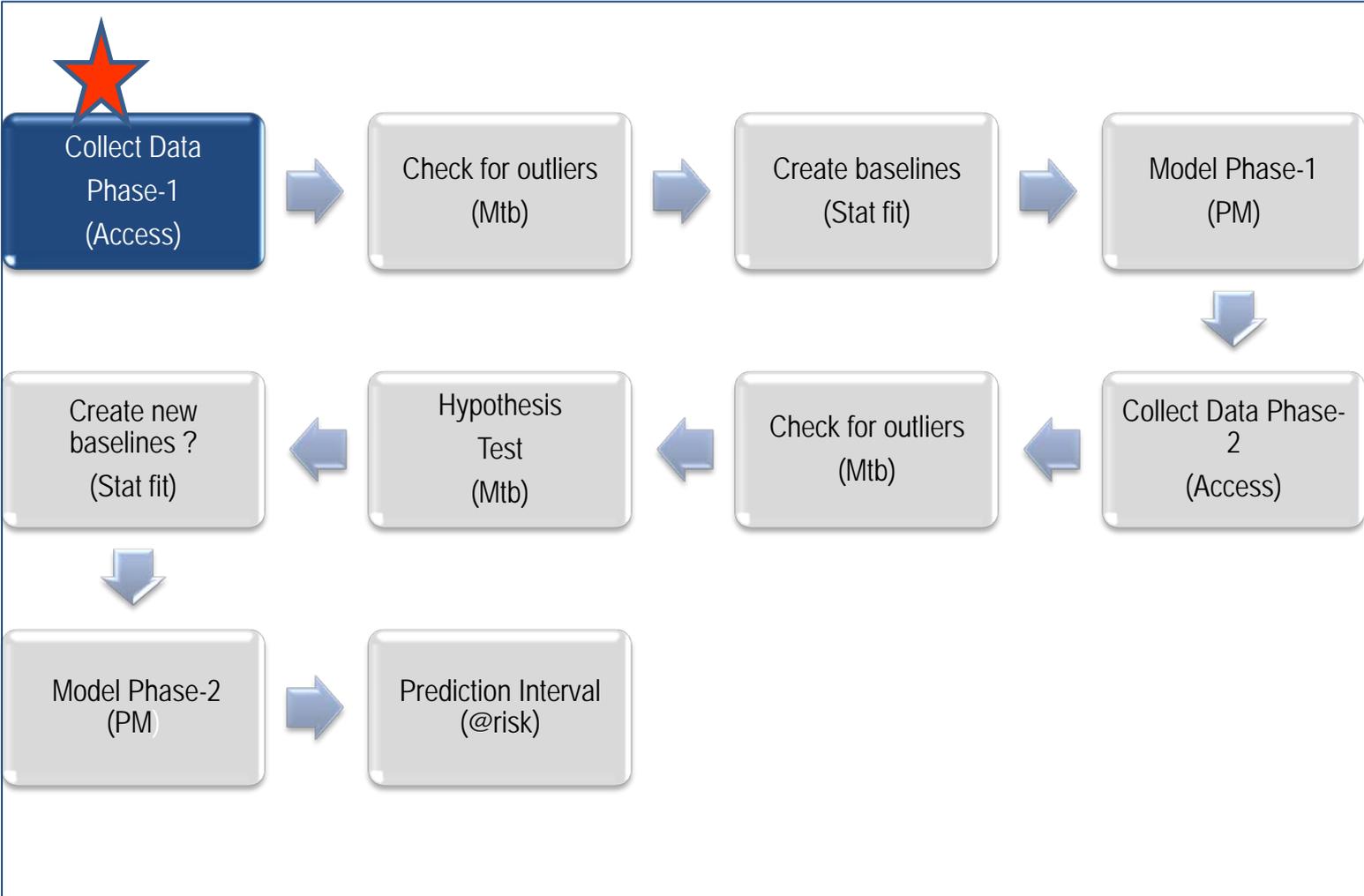
Process Model



Produce Prediction Interval

@Risk





## Collecting Data

XI Sheet

Gather Information

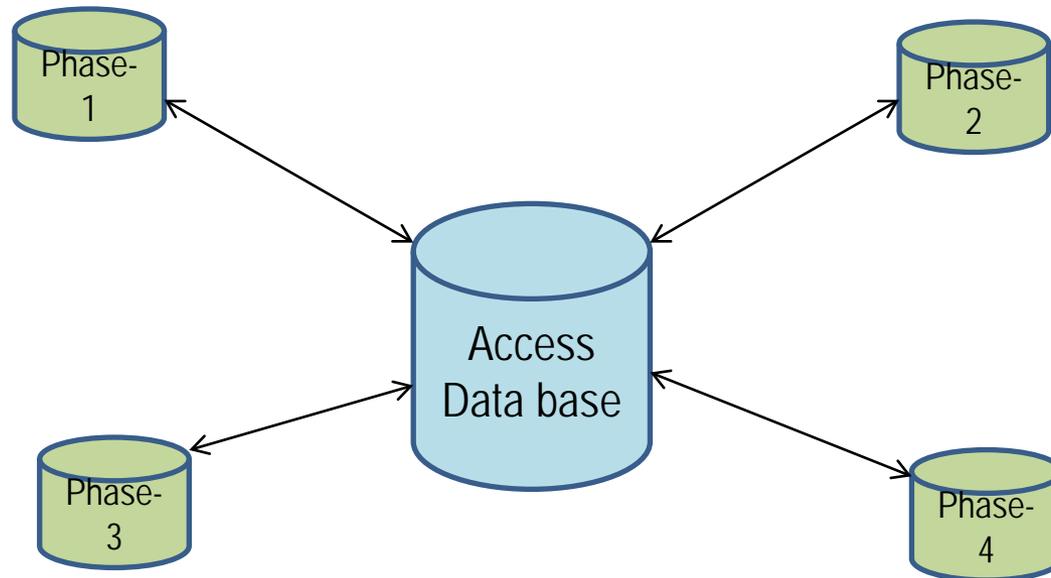
Access Database

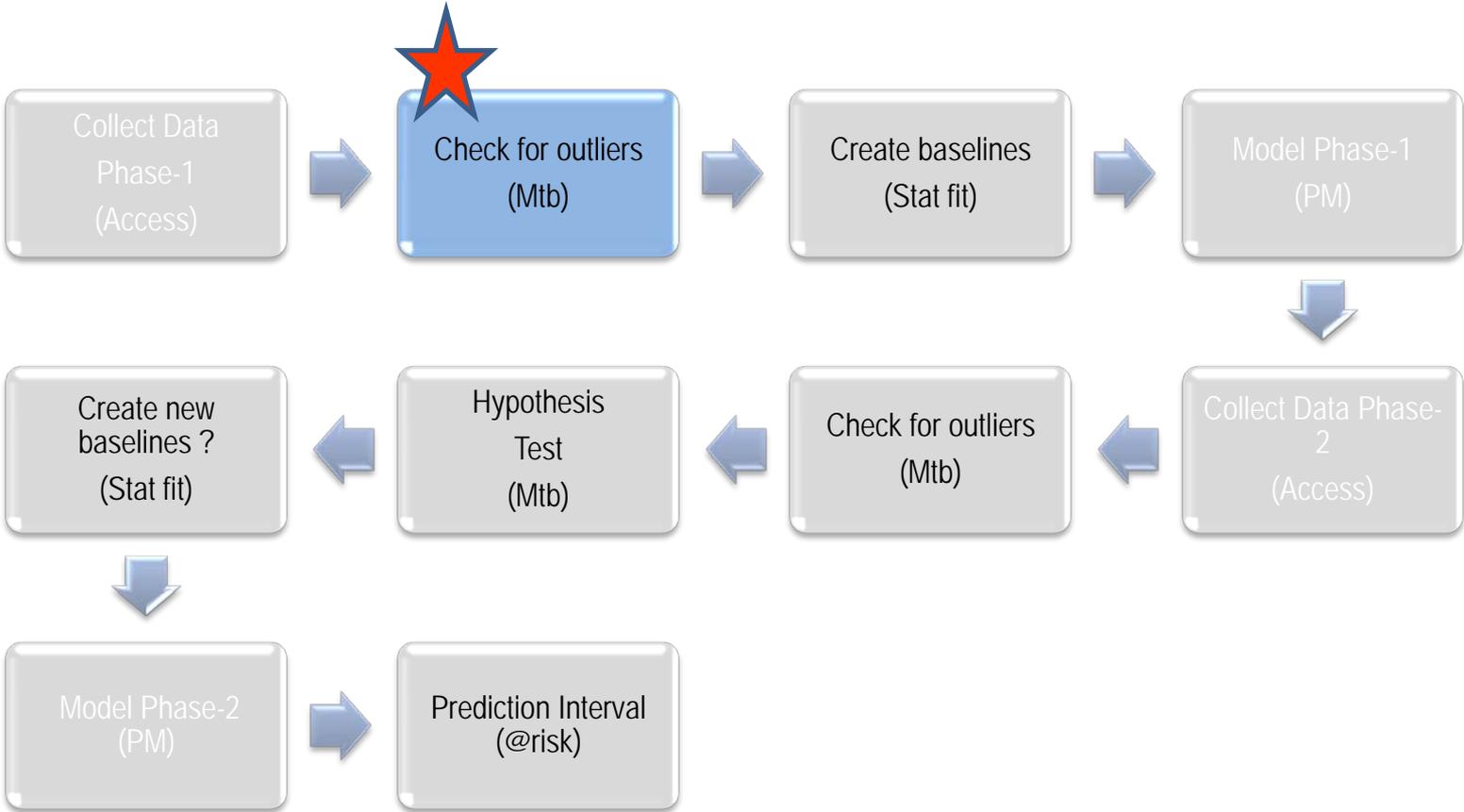
Store Information

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q						
1	Location	Date	Client	Month	Year	CoverShe	BurnRate	Run Proj	SCheck Our	Resolve T	Total	OTS Total	Time	Billing	Report	Billing	issues	Total Billing	Initializ	voic	Populate	T	
2	In office	3/24/2009	FEINA	Feb		6		167				167		6		6		2	24				
3	In office	3/6/2009	DHS-S&T	Jan		2				2	2	2	2			2		2					
4	In office	3/6/2009	DHS-S&T	Feb		2				2	2	2	1			1		3					
5	At home	3/18/2009	FEINA-IT	Oct																			

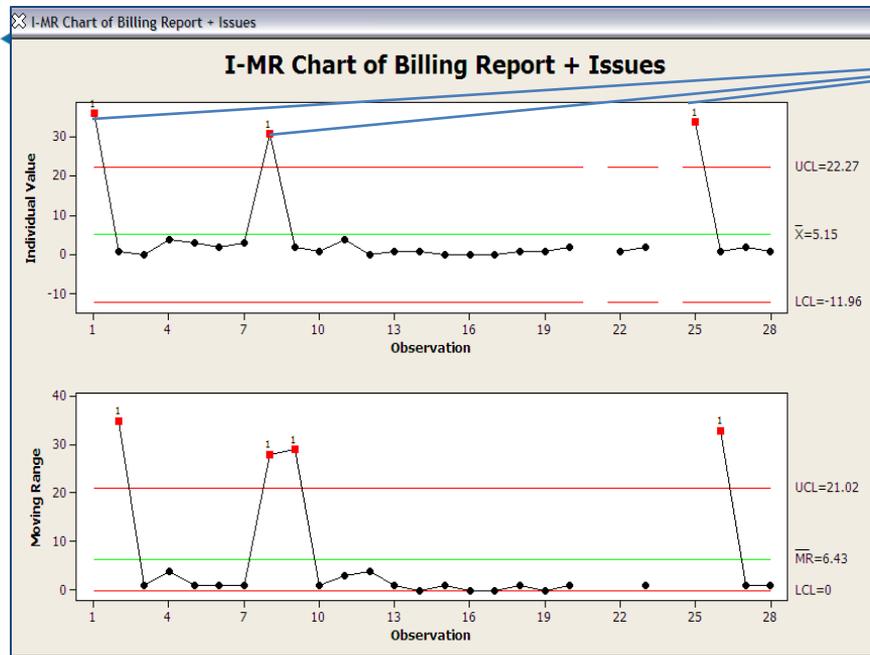
Location	Date	Client	Month	Year	CoverSheet	BurnRate	RunProjStaf	CheckOutstz	ResolveTimi	TotalTime
In office	5/13/2009	HUD-eGrants	Mar							
In office	5/11/2009	DHS-HSEEP	Apr							
In office	5/12/2009	DHS-HSEEP	Apr							
In office	5/13/2009	DHS-HSEEP	Apr							
In office	5/14/2009	DHS-HSEEP	Apr							
In office	5/22/2009	HUD-eGrants	Apr							
In office	5/26/2009	HUD-eGrants	Apr				1			8
In office	5/28/2009	HUD-eGrants	Aor							

- ❑ Its easy to store and retrieve data as needed
- ❑ Multiple Phases can be stored
- ❑ Easy to access data using Queries





◀ Outliers: Is an observation that is numerically distant from the rest of the data points



Outliers

- ◀ This can be done by Plotting I-MR Charts.
- ◀ I-MR Chart: Is a graphical tool that displays process variation over time. It signals when a process may be going out of control and shows where to look for sources of special cause variation.

# I-MR Charts Using Minitab



The screenshot shows the Minitab interface with the 'Stat' menu open. The path to create an I-MR chart is highlighted: Stat > Control Charts > Variables Charts for Individuals > I-MR... The data table below shows the input data for the chart.

	C1-T	C2-D	C5	C6	C7	C8	Rate	Run Proj	Staffing	Check Outs
	Location	Date								
1	In office	5/11/2009								1
2	In office	5/12/2009								*
3	In office	5/13/2009								
4	In office	5/14/2009								
5	In office	5/18/2009								
6	In office	5/19/2009								
7	In office	5/20/2009			2					
8	In office	5/18/2009			*					1
9	In office	5/21/2009			5					1
10	In office	5/26/2009	BITS-IRS	Jan	2					*
11	In office	5/28/2009	FAA-ATOHR	Apr	1					2
12	In office	5/28/2009	CSC-Crown	Apr	2					1
13	In office	5/28/2009	CSC-Crown	Mar	2					2
14	In office	6/1/2009	HUD-FHA2	May	2					3

Select I-MR charts

# Options in I-MR chart

Minitab - 35 & 75 Merge MINITAB.MPJ - [Worksheet 1 \*\*\*]

File Edit Data Calc Stat Graph Editor Tools Window Help

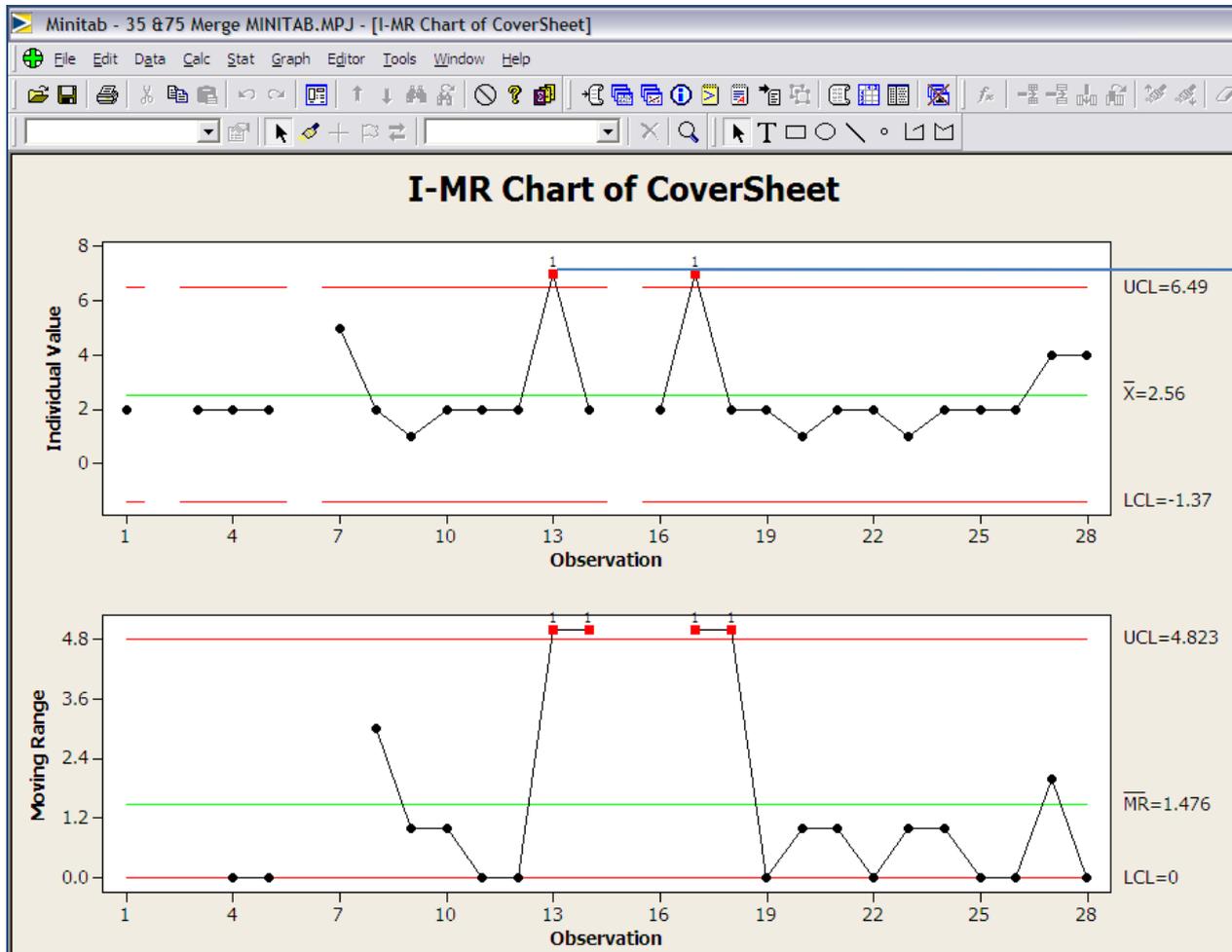
	C1-T	C2-D	C3-T	C4-T	C5	C6	C7	C8	
	Location	Date	Client	Month	Year	CoverSheet	BurnRate	Run Proj Staffing	Check
1	In office	5/11/2009							1
2	In office	5/12/2009							*
3	In office	5/13/2009							*
4	In office	5/14/2009							*
5	In office	5/18/2009							2
6	In office	5/19/2009							1
7	In office	5/20/2009							1
8	In office	5/18/2009							1
9	In office	5/21/2009							1
10	In office	5/26/2009							*
11	In office	5/28/2009							2
12	In office	5/28/2009							1
13	In office	5/28/2009							2
14	In office	6/1/2009							3
15	In office	6/2/2009							1
16	In office	6/2/2009							3
17	In office	6/2/2009	FAA-SEAS	May					1
18	In office	6/2/2009	HUD-EIV3	May		2			1

**Individuals-Moving Range Chart**

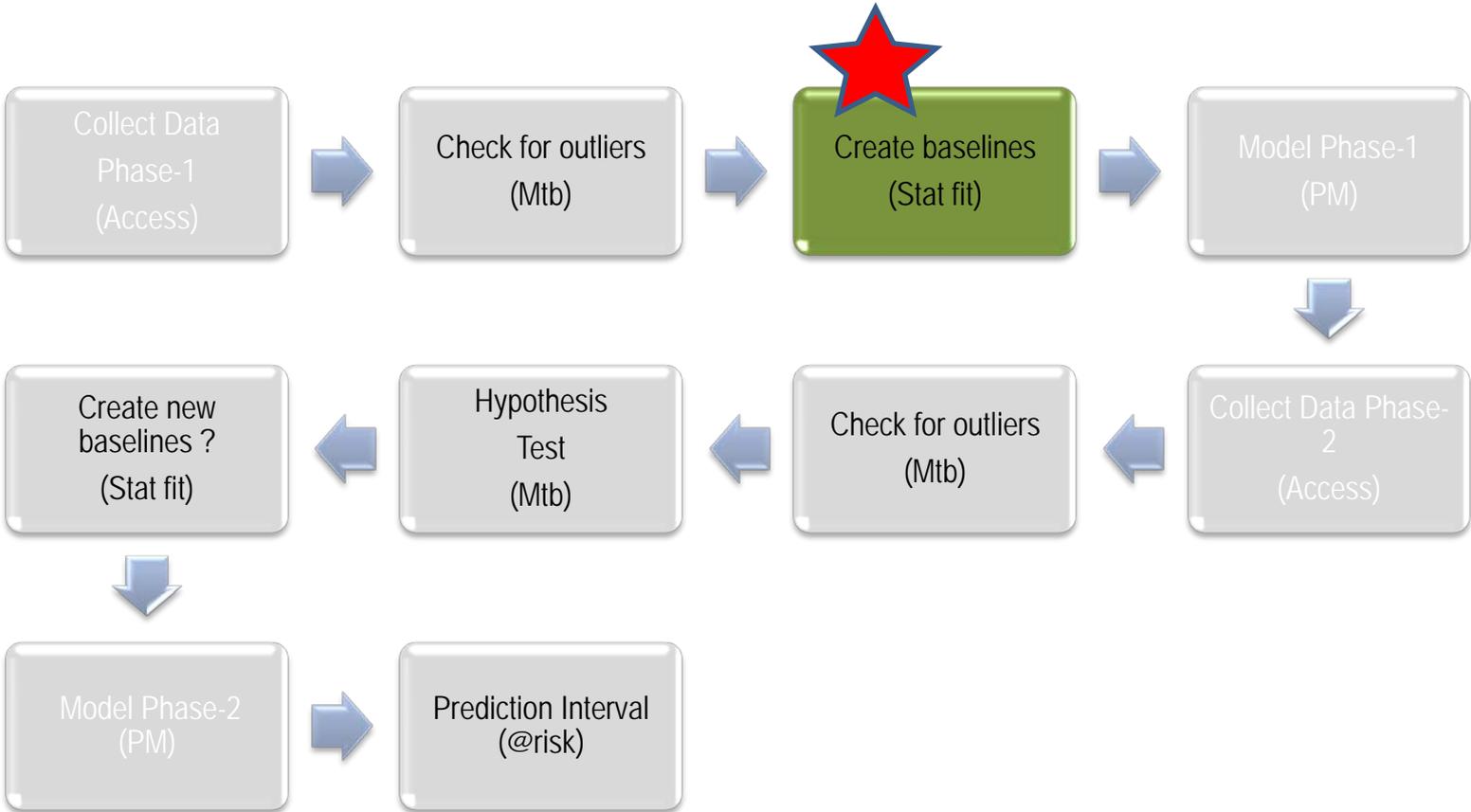
Variables:

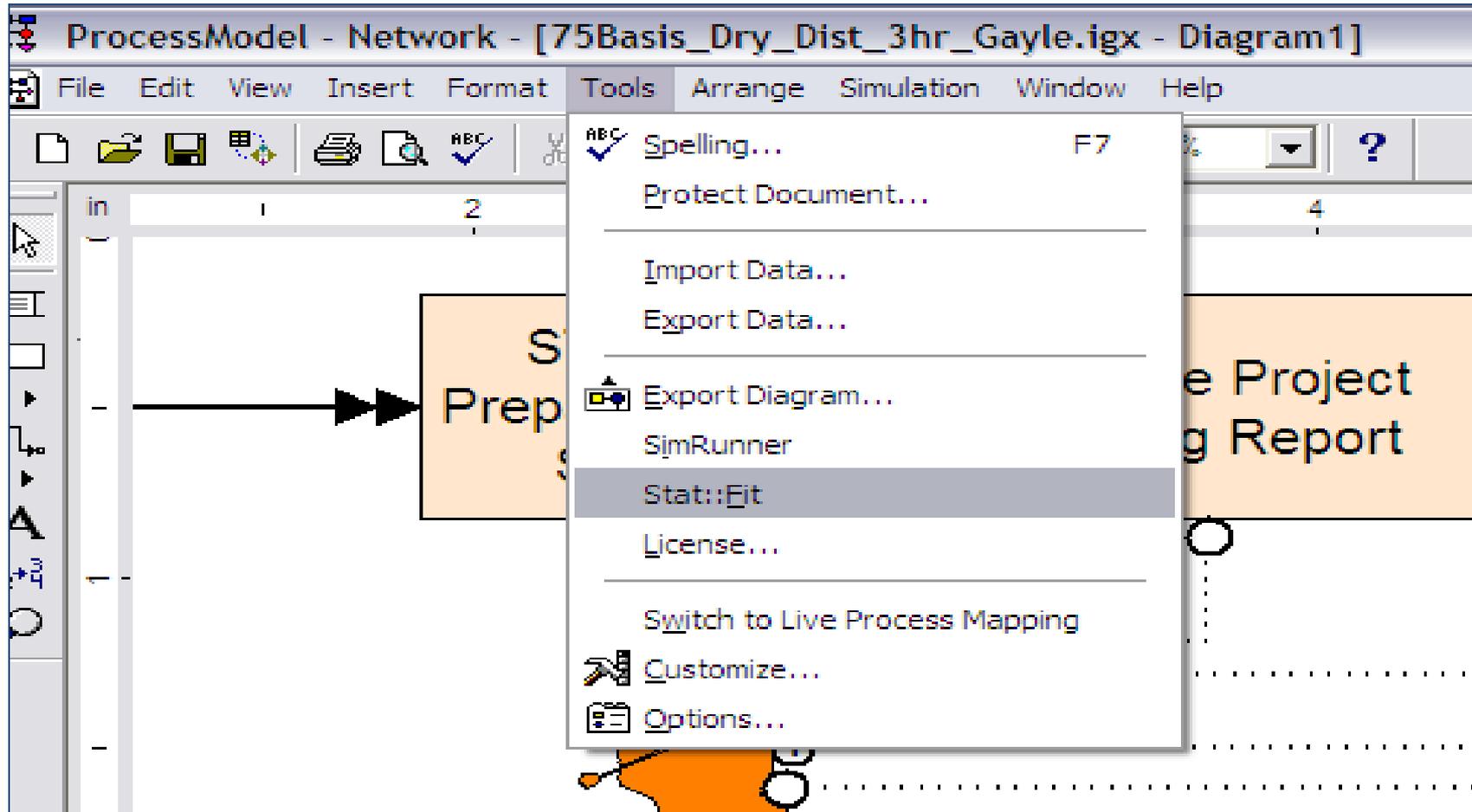
CoverSheet

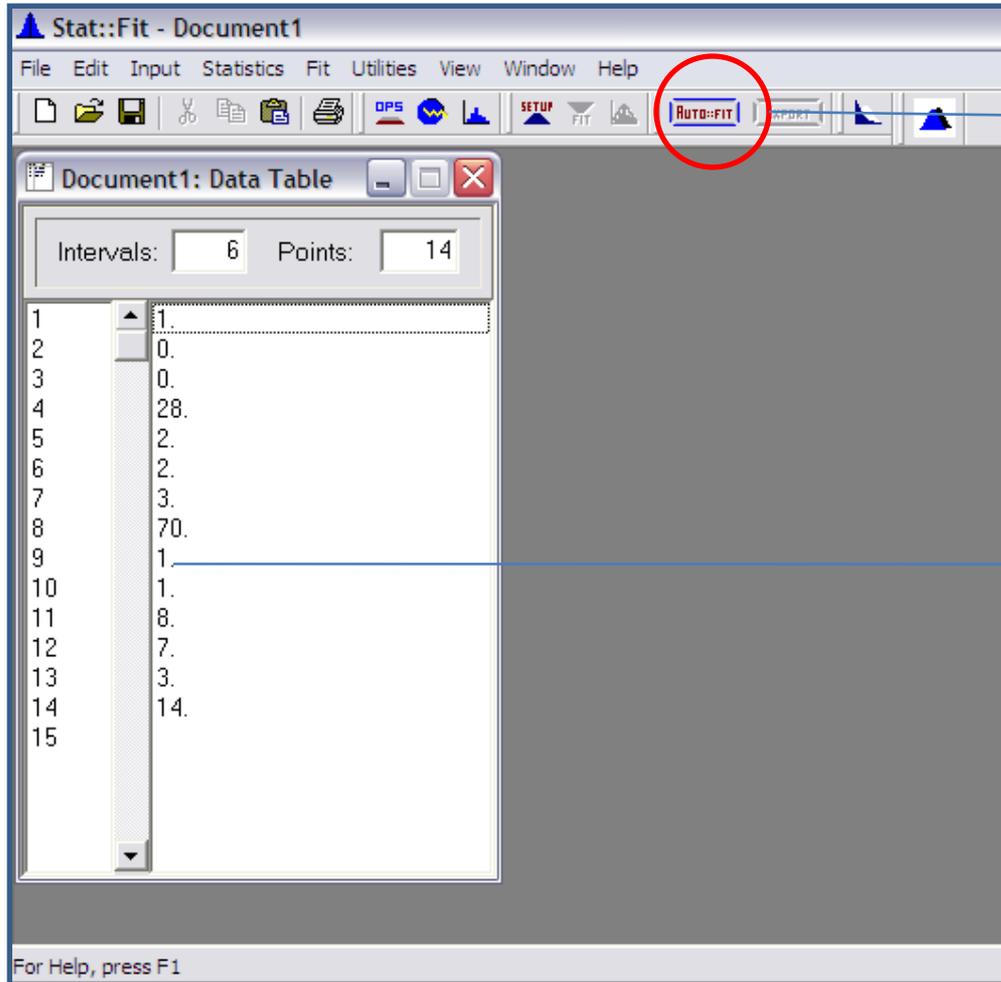
Select Variables to plot I-MR chart



Outliers







Auto Fit

Data points from Minitab

Stat::Fit - [Document1: Automatic Fitting]

File Edit Input Statistics Fit Utilities View Window Help

Auto::Fit of Distributions

distribution	rank	acceptance
LogLogistic(0., 1.29, 3.91)	94.7	do not reject
Inverse Gaussian(0., 3.11, 10.)	66.8	do not reject
Pearson 6(0., 9.25e-002, 25.1, 0.95)	65.1	do not reject
Pearson 5(0., 0.936, 2.22)	62.3	do not reject
Inverse Weibull(0., 0.984, 0.419)	59.	do not reject
Lognormal(0., 1.49, 1.33)	58.8	do not reject
Weibull(0., 0.712, 8.9)	36.3	do not reject
Beta(0., 1.58e+006, 0.627, 8.42e+004)	14.1	do not reject
Gamma(0., 0.735, 13.6)	12.1	do not reject
Power Function(0., 70., 0.362)	1.19	do not reject
Exponential(0., 10.)	1.08	reject
Erlang(0., 1., 13.6)	7.e-002	reject
Chi Squared(0., 5.38)	2.83e-003	reject
Triangular(-1., 75.7, -1.)	0.	reject
Uniform(0., 70.)	0.	reject
Rayleigh(0., 15.8)	0.	reject
Pareto	no fit	reject
Johnson SB	no fit	reject

For Help, press F1

Select do not reject variables to get time interval

# Distribution Graph

Stat::Fit - [Document1: Automatic Fitting]

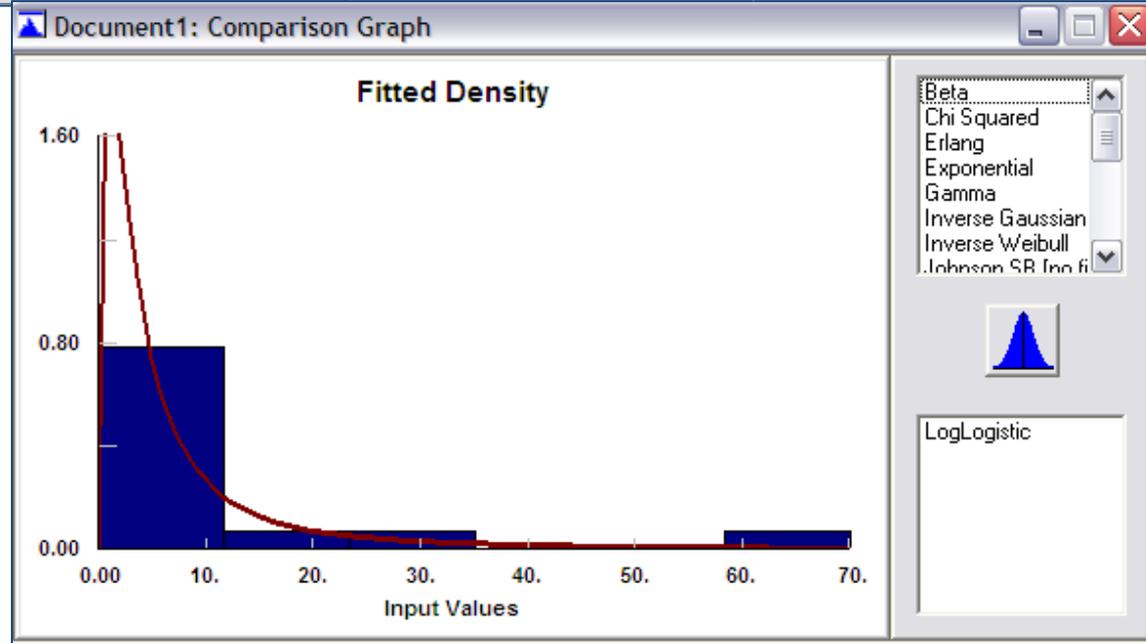
File Edit Input Statistics Fit Utilities View Window Help

Auto::Fit of Distributions

distribution	rank	acceptance
<b>LogLogistic(0., 1.29, 3.91)</b>	<b>94.7</b>	<b>do not reject</b>
Inverse Gaussian(0., 3.11, 10.)	66.8	do not reject
Pearson 6(0., 9.25e-002, 25.1, 0.95)	65.1	do not reject
Pearson 5(0., 0.936, 2.22)	62.3	do not reject
Inverse Weibull(0., 0.984, 0.419)	59.	do not reject
Lognormal(0., 1.49, 1.33)	58.8	do not reject
Weibull(0., 0.712, 8.9)	36.3	do not reject
Beta(0., 1.58e+006, 0.627, 8.42e+004)	14.1	do not reject
Gamma(0., 0.735, 13.6)	12.1	do not reject
Power Function(0., 70., 0.362)	1.19	do not reject
Exponential(0., 10.)	1.08	reject
Erlang(0., 1., 13.6)	7.e-002	reject
Chi Squared(0., 5.38)	2.83e-003	reject
Triangular(-1., 75.7, -1.)	0.	reject
Uniform(0., 70.)	0.	reject
Rayleigh(0., 15.8)	0.	reject
Pareto	no fit	reject
Johnson SB	no fit	reject

For Help, press F1

Double Click it  
will produce  
Following graph



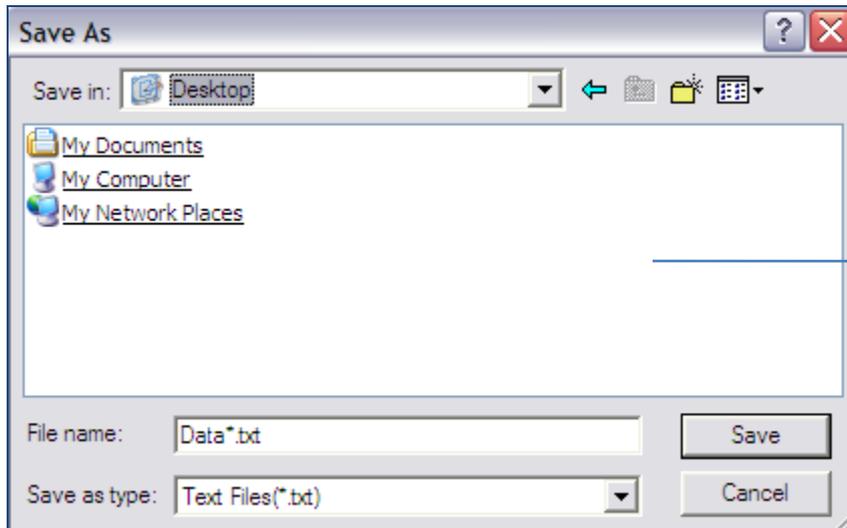
# Export data to text file

The screenshot shows the Stat::Fit software interface. The 'File' menu is open, and the 'Export' option is selected, which has opened a sub-menu with 'Export Fit' and 'Export Empirical' options. A blue arrow points from 'Export Fit' to the 'EXPORT FIT' dialog box. The 'Auto::Fit of Distributions' window is also visible, showing a list of fitted distributions with their respective ranks and parameters.

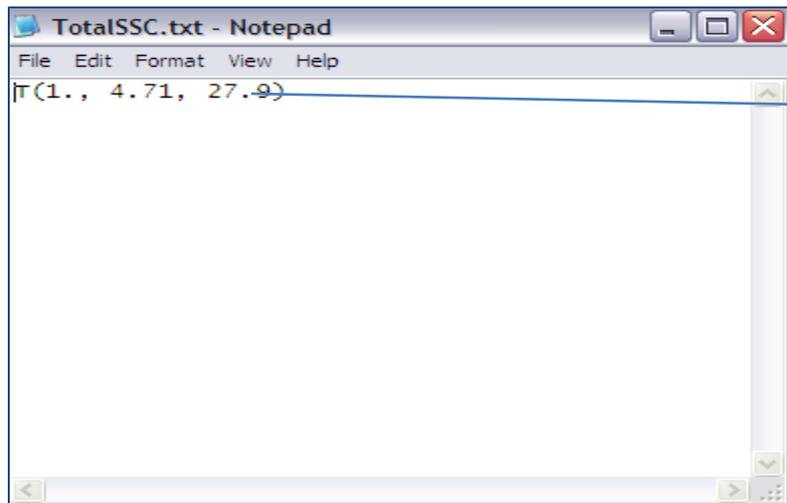
distribution	rank	a
LogLogistic(0., 1.29, 3.91)	94.7	d
Inverse Gaussian(0., 3.11, 10.)	66.8	d
Pearson 6(0., 9.25e-002, 25.1, 0.95)	65.1	d
Pearson 5(0., 0.936, 2.22)	62.3	d
Inverse Weibull(0., 0.984, 0.419)	59.	d
Lognormal(0., 1.49, 1.33)	58.8	d
Weibull(0., 0.712, 8.9)	36.3	d
Beta(0., 1.58e+006, 0.627, 8.42e+004)	14.1	d

The 'EXPORT FIT' dialog box is shown. It has two main sections: 'Application' and 'Fitted Distribution'. The 'Application' dropdown is set to 'ProcessModel'. The 'Fitted Distribution' dropdown is set to 'LogLogistic'. There is a 'Precision' field set to '3'. Under the 'Output' section, there are three radio buttons: 'Clipboard', 'File' (which is selected), and 'Direct'. A text box at the bottom contains the mathematical formula:  $3.91 * (1. / ((1. / U(0.5, 0.5)) - 1.))^{1. / 1.29}$ . At the bottom of the dialog are 'OK', 'Cancel', and 'Help' buttons. A blue arrow points from the 'File' radio button to a blue button labeled 'Click file'.

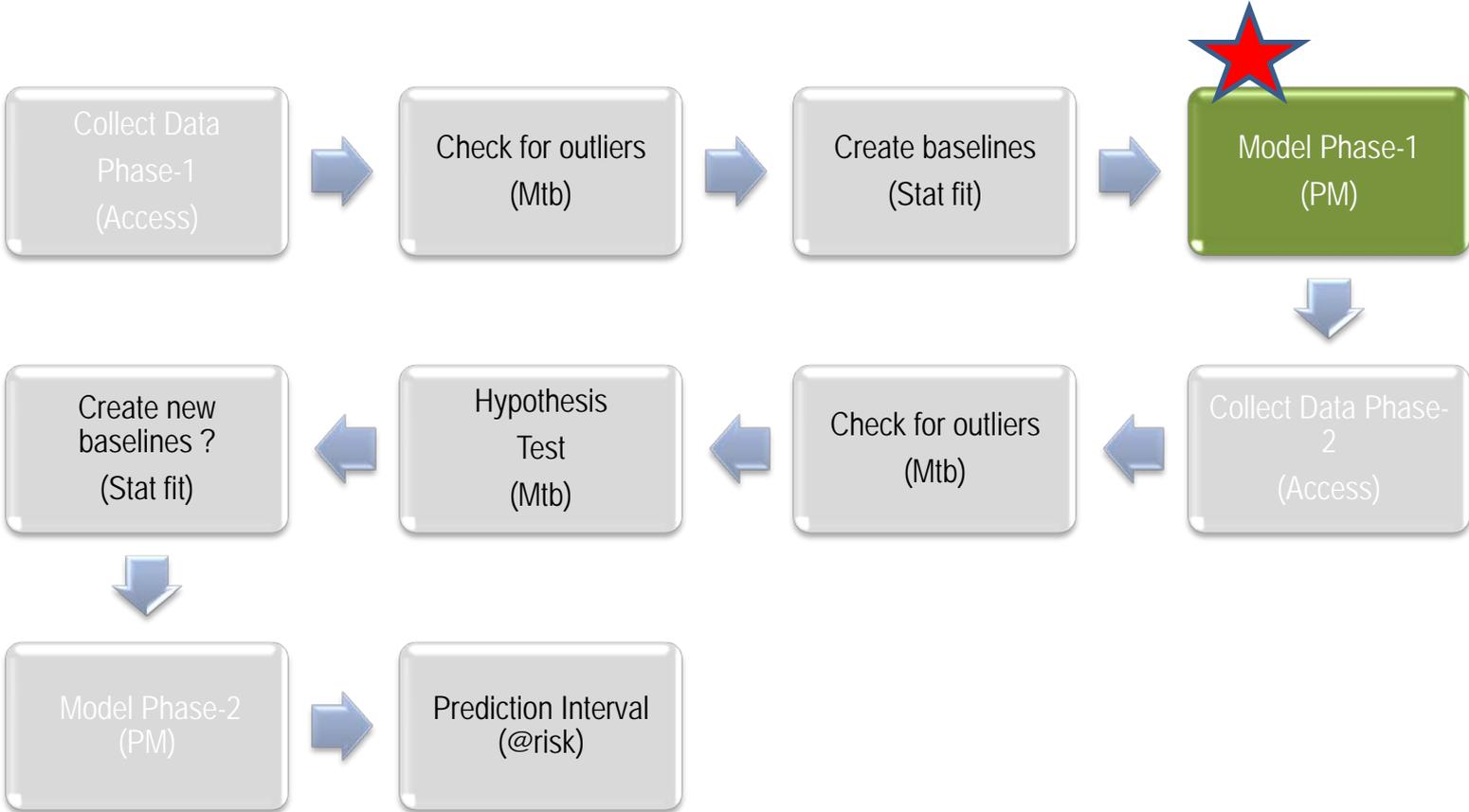
Click file

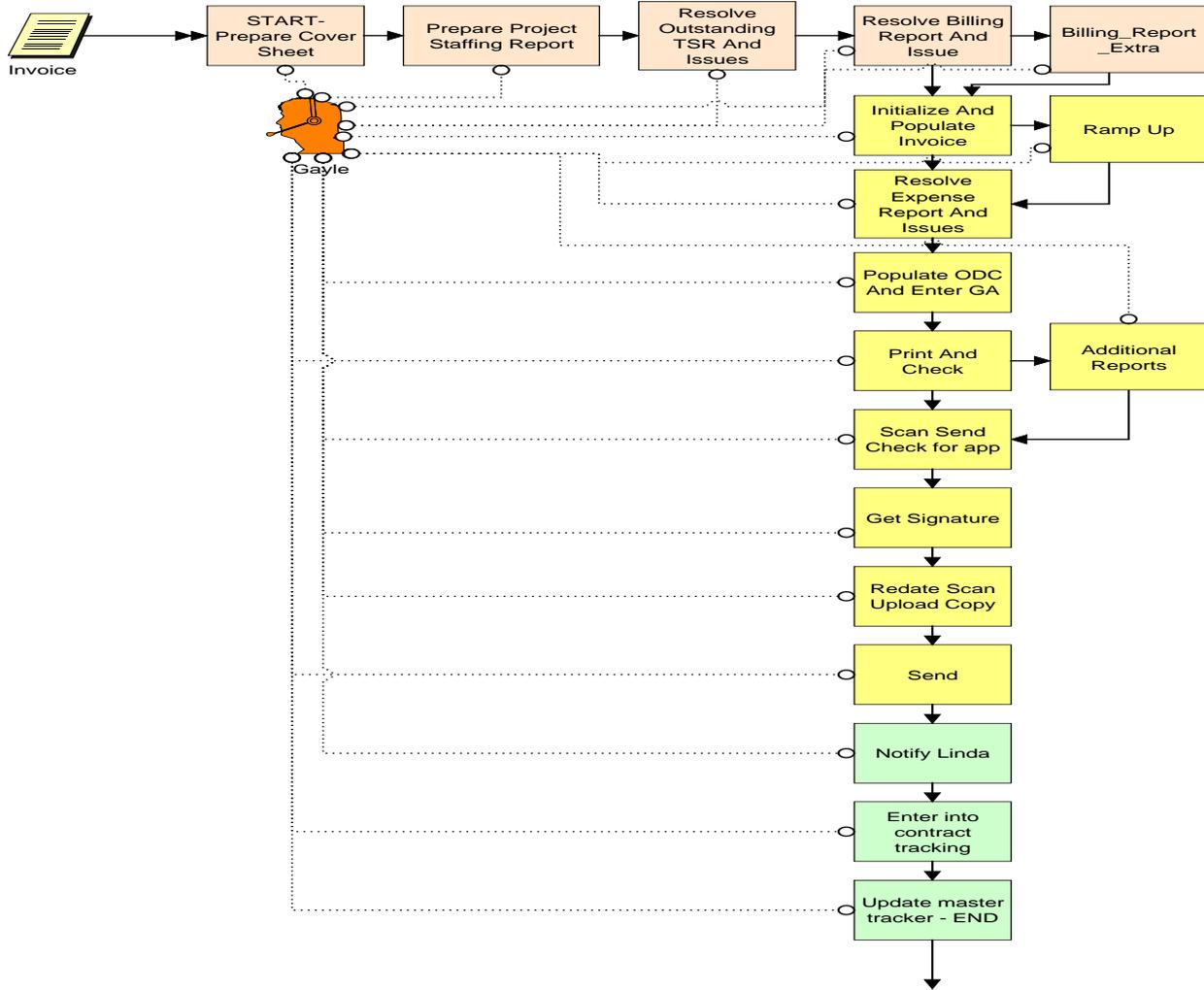


Save as  
Text file

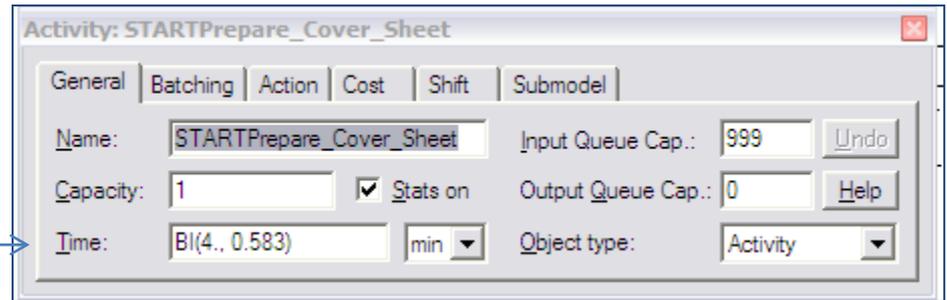
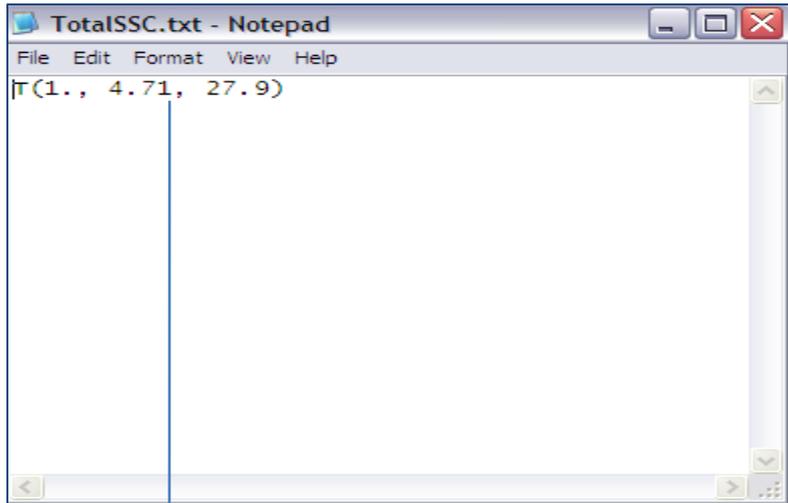


Copy this value  
and paste it in  
Process Model





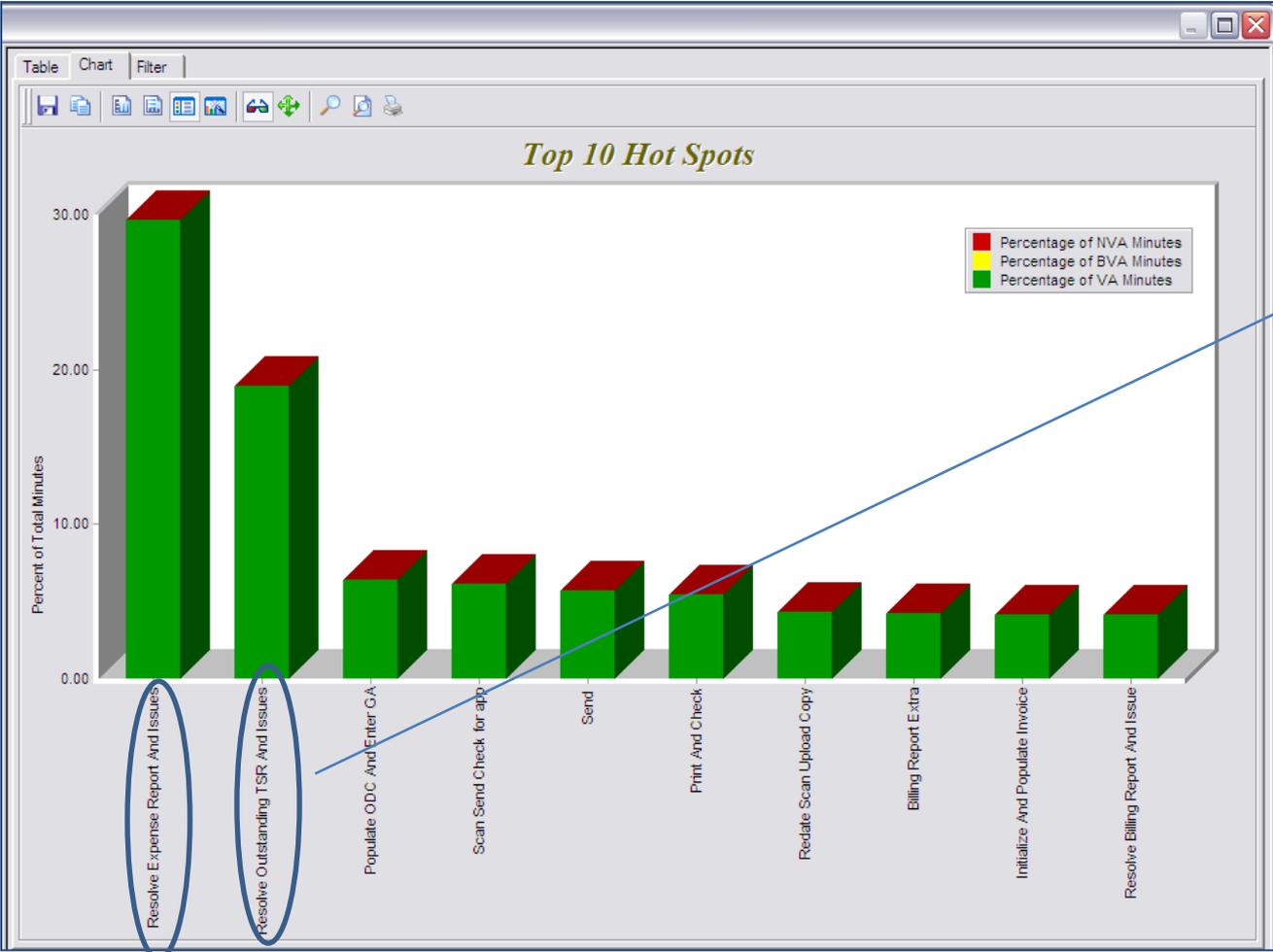
# Update time interval in to particular Process



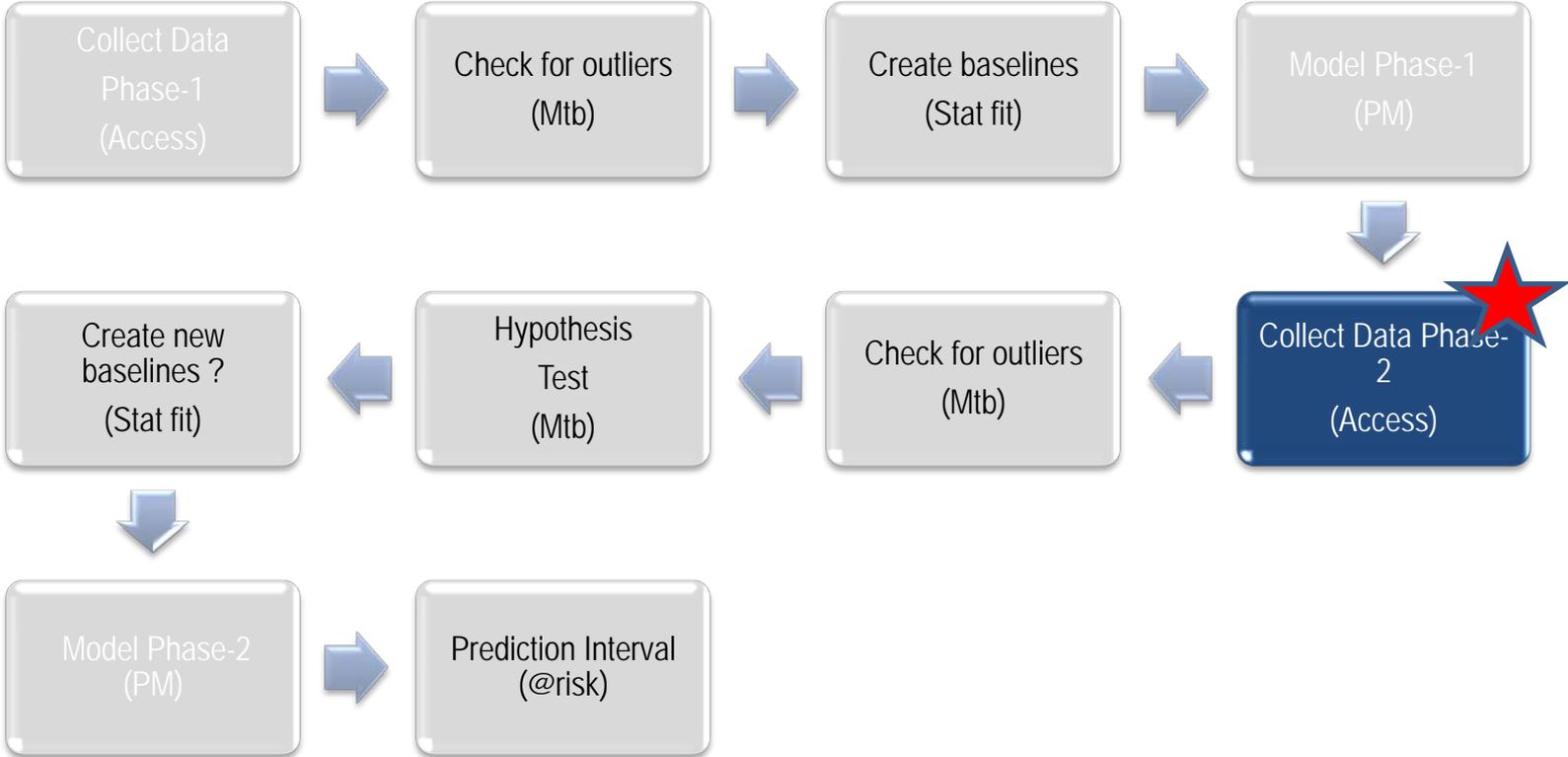
ENTITY SUMMARY (Times in Scoreboard time units)

Entity Name	Qty Processed	Average Cycle Time (Minutes)	Average VA Time (Minutes)	Average Cost	
Invoice	63.66	19467.3	149.66	249.43	(Average)
Invoice	3.82	1236	10.53	17.56	(Std. Dev.)
Invoice	56	17259.7	126.04	210.07	(Min)
Invoice	72	22512.6	174.34	290.57	(Max)
Invoice	62.23	19005.8	145.72	242.88	(95% C.I. Low)
Invoice	65.09	19928.8	153.59	255.99	(95% C.I. High)
HardInvoice	16.33	20359.8	178.11	296.86	(Average)
HardInvoice	3.82	1441.94	12.29	20.49	(Std. Dev.)
HardInvoice	8	18085.7	152.53	254.23	(Min)
HardInvoice	24	23480.9	203.04	338.41	(Max)
HardInvoice	14.90	19821.4	173.52	289.20	(95% C.I. Low)
HardInvoice	17.76	20898.2	182.70	304.51	(95% C.I. High)

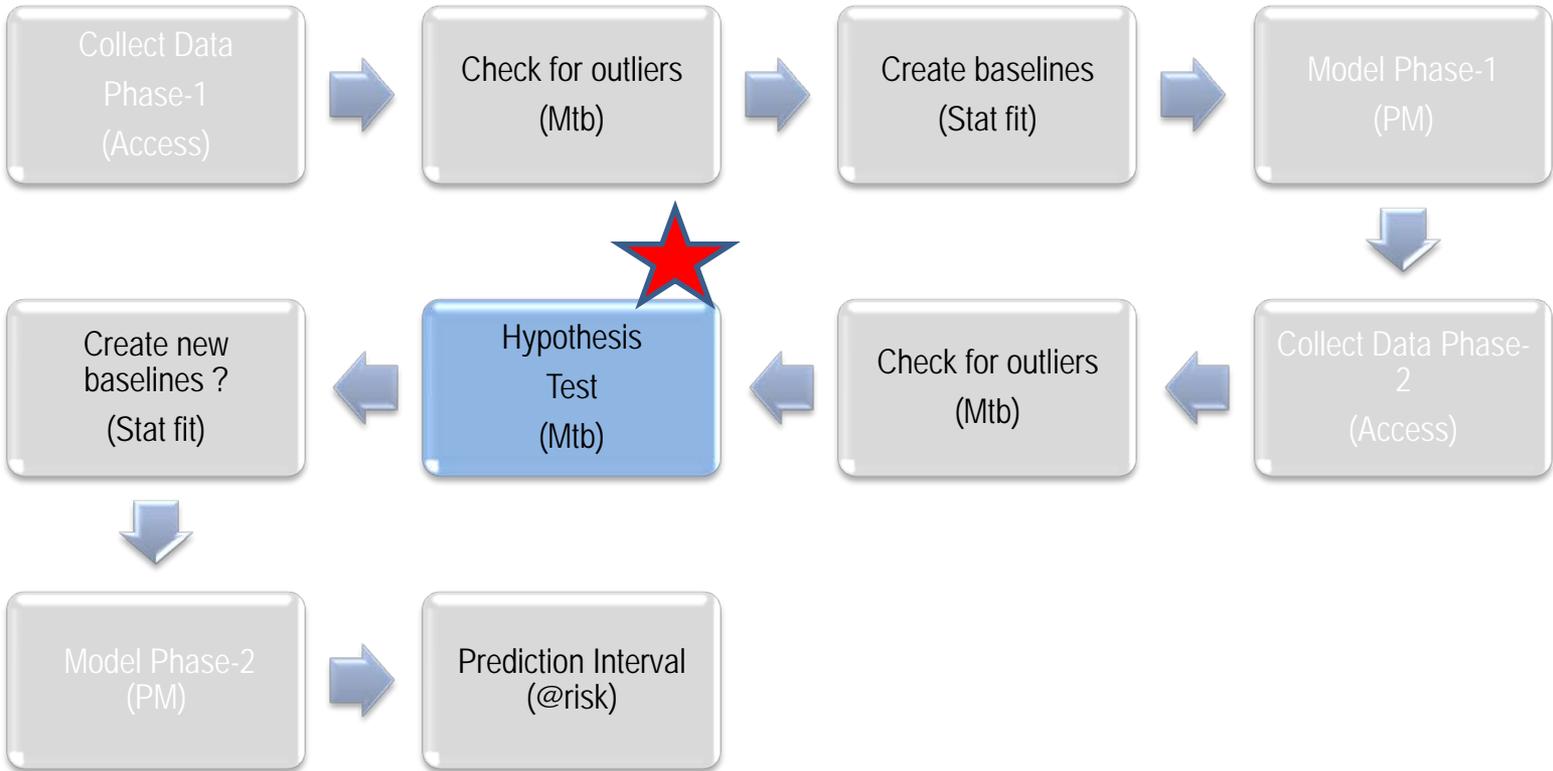
Average time for Phase-1



Hot Spot



◀ Repeat as in Phase 1



- ◀ Retrieving data from Access database
- ◀ Plotting charts such as

I-MR charts

Summary Charts

Individual Charts (For difference in phases)

- ◀ These Charts are plotted to check for P-value for further analysis to check for Normality and Equal-Variance

- ▶ The P-value is the probability of obtaining a test statistic at least as extreme as the one that was actually observed, assuming that the null hypothesis is true.
- ▶ All tests are run at 95% confidence limit.
- ▶ 2 independent samples



◀ As per SEI's Job Aid

# Appropriate Analysis: Types of Hypothesis Tests

Data Type # Samples (Data groups)	Interval or Ratio (Parametric Tests)		Ordinal (Non-Parametric Tests)		Nominal	Proportion
	Mean	Variance	Median	Variance / Fit	Similarity	Similarity
1 Sample	1-sample t test	1-sample Chi-Square test	1 sample Wilcoxon Signed Ranks test	Kolmogorov-Smirnov Goodness of Fit test	>2 cells Chi-Square Binomial Sign Test =2 cells	1 Proportions test
2 Samples	Independent 2-sample t test Paired t test	Normal F test Levene test Not Normal	Independent Mann Whitney U test Wilcoxon matched Paired	= Medians Siegel-Tukey test Moses test ≠ Medians	Fisher Exact test (1-way ANOVA); Chi-Square test	2 Proportions test
3+ Samples	ANOVA (1 & 2 way ANOVA; Balanced ANOVA; GLM) MANOVA (General & Balanced)	Normal Bartlett test Levene test Not Normal	Independent Kruskal-Wallis 1-way ANOVA Friedman 2-way ANOVA Paired	Van der Waerden Normal scores test	Chi-Square test	ANOM (Analysis of Means)

Current sample data



# Normality Test – Summary chart Minitab Tool

Minitab - 35 & 75 Merge MINITAB.MPJ - [Worksheet 1 \*\*\*]

File Edit Data Calc Stat Graph Editor Tools Window Help

Basic Statistics  
Regression  
ANOVA  
DOE  
Control Charts  
Quality Tools  
Reliability/Survival  
Multivariate  
Time Series  
Tables  
Nonparametrics  
EDA  
Power and Sample Size

Display Descriptive Statistics...  
Store Descriptive Statistics...  
Graphical Summary...  
1-Z 1-Sample Z...  
1-t 1-Sample t...  
2-t 2-Sample t...  
t-t Paired t...  
1-P 1 Proportion...  
2-P 2 Proportions...  
1-P 1-Sample Poisson Rate...  
2-P 2-Sample Poisson Rate...  
1-σ 1 Variance...  
2-σ 2 Variances...  
COR Correlation...  
COV Covariance...  
TEST Normality Test...  
χ² Goodness-of-Fit Test for Poisson...

	C1-T	C2-D		
	Location	Date		
1	In office	5/11/2009		
2	In office	5/12/2009		
3	In office	5/13/2009		
4	In office	5/14/2009		
5	In office	5/18/2009		
6	In office	5/19/2009		
7	In office	5/20/2009		
8	In office	5/18/2009		
9	In office	5/21/2009		
10	In office	5/26/2009	BITS-IRS	Jan
11	In office	5/28/2009	FAA-ATOHR	Apr
12	In office	5/28/2009	CSC-Crown	Apr
13	In office	5/28/2009	CSC-Crown	Mar
14	In office	6/1/2009	HUD-FHA2	May
15	In office	6/2/2009	HUD-EIV3	Apr
16	In office	6/2/2009	DHS-S&T	May
17	In office	6/2/2009	FAA-SEAS	May

Summary Graph

# Summary Graph



Minitab - 35 &75 Merge MINITAB.MPJ - [Worksheet 1 \*\*\*]

File Edit Data Calc Stat Graph Editor Tools Window Help

	C1-T	C2-D	C3-T	C4-T	C5	C6	C7	C8		
	Location	Date	Client	Mo					ing	Check Outst
1	In office	5/11/2009	HUD-eGrants	Apr						1
2	In office	5/12/2009	DCLB	Apr					*	
3	In office	5/13/2009	FEMAIT	Apr					*	
4	In office	5/14/2009	HUD-FHA2	Apr					*	
5	In office	5/18/2009	FAA-IASDEX	Apr					2	
6	In office	5/19/2009	FAA-ATOHR	Mar					1	
7	In office	5/20/2009	HUD-SAGIS2	Apr					1	
8	In office	5/18/2009	HUD-SAGIS2	Mar					1	
9	In office	5/21/2009	FAA-UCS	Apr					1	
10	In office	5/26/2009	BITS-IRS	Jan					*	
11	In office	5/28/2009	FAA-ATOHR	Apr					2	
12	In office	5/28/2009	CSC-Crown	Apr					1	
13	In office	5/28/2009	CSC-Crown	Mar					2	
14	In office	6/1/2009	HUD-FHA2	May					3	
15	In office	6/2/2009	HUD-EIV3	Apr					1	
16	In office	6/2/2009	DHS-S&T	May					3	
17	In office	6/2/2009	FAA-SEAS	May			*		1	
18	In office	6/2/2009	HUD-EIV3	May			2		1	

**Graphical Summary**

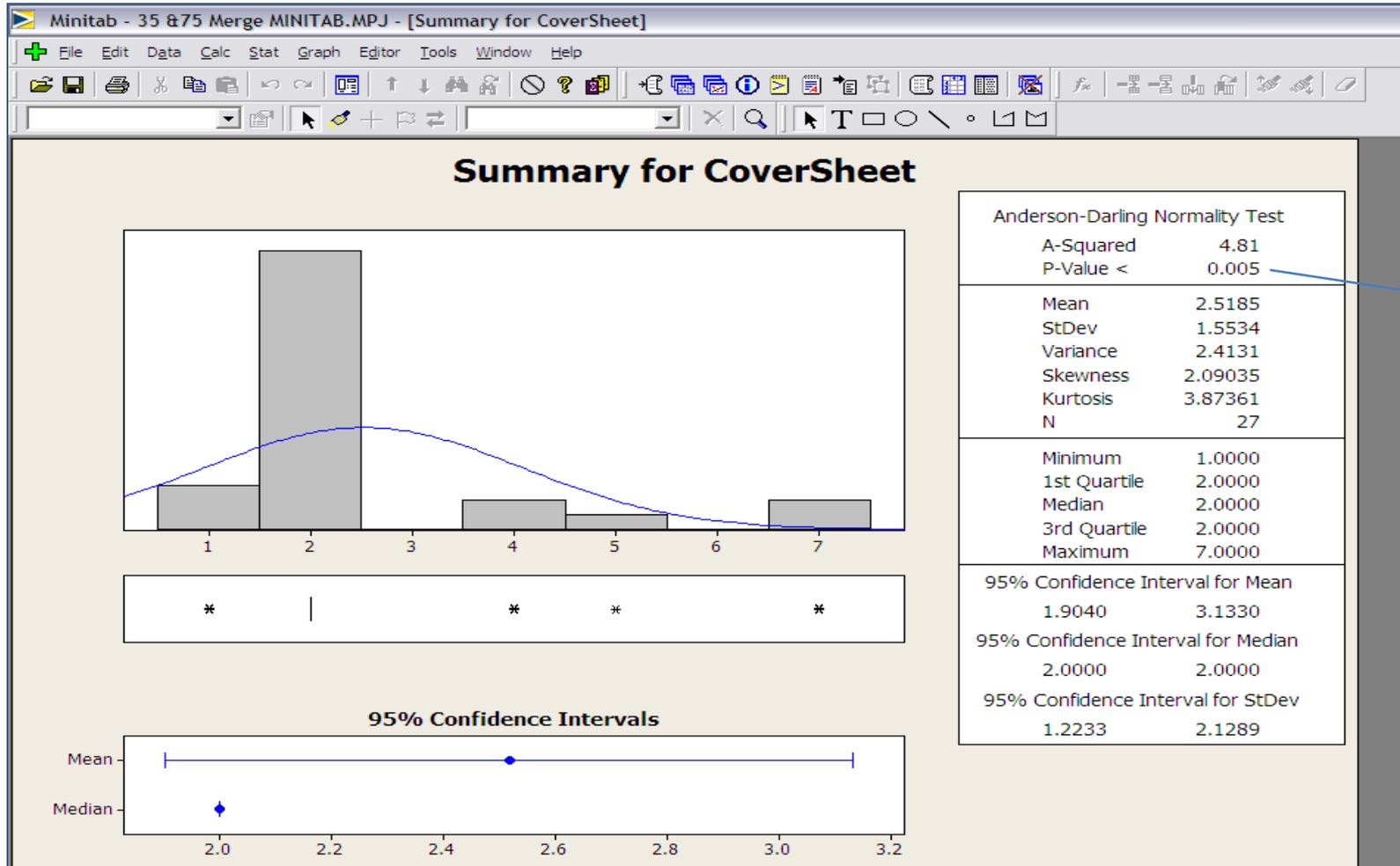
Variables: CoverSheet

By variables (optional):

Confidence level: 95.0

Select Help OK Cancel

Select variable to plot summary graph



Check for P Value

# Variance Test – 2 Variance Test



The screenshot shows the Minitab software interface. The 'Stat' menu is open, and '2 Variances...' is selected. The background data table is as follows:

	C1-T	C2-D
	Location	Date
1	In office	5/11/2009
2	In office	5/12/2009
3	In office	5/13/2009
4	In office	5/14/2009
5	In office	5/18/2009
6	In office	5/19/2009
7	In office	5/20/2009
8	In office	5/18/2009
9	In office	5/21/2009
10	In office	5/26/2009
11	In office	5/28/2009
12	In office	5/28/2009
13	In office	5/28/2009
14	In office	6/1/2009
15	In office	6/2/2009
16	In office	6/2/2009
17	In office	6/2/2009
18	In office	6/2/2009

Variance Test

**2 Variances**

- Samples in one column
  - Samples:
  - Subscripts:
- Samples in different columns
  - First:
  - Second:
- Summarized data
  - Sample size:  Variance:
  - First:  Second:

Buttons: Select, Options..., Storage..., Help, OK, Cancel

	C1-T	C2-D	C3-T	C4-T	C5	C6
	Location	Date	Client	Month	Year	CoverSheet
1	In					
2	In					
3	In					
4	In					
5	In					
6	In					
7	In					
8	In					
9	In					
10	In					
11	In					
12	In					
13	In					
14	In					
15	In					
16	In					
17	In office	6/2/2009	FAA-SEAS	May		
18	In office	6/2/2009	HUD-EIV3	May		
19	In office	6/4/2009	FAA-ESVMS	Apr		

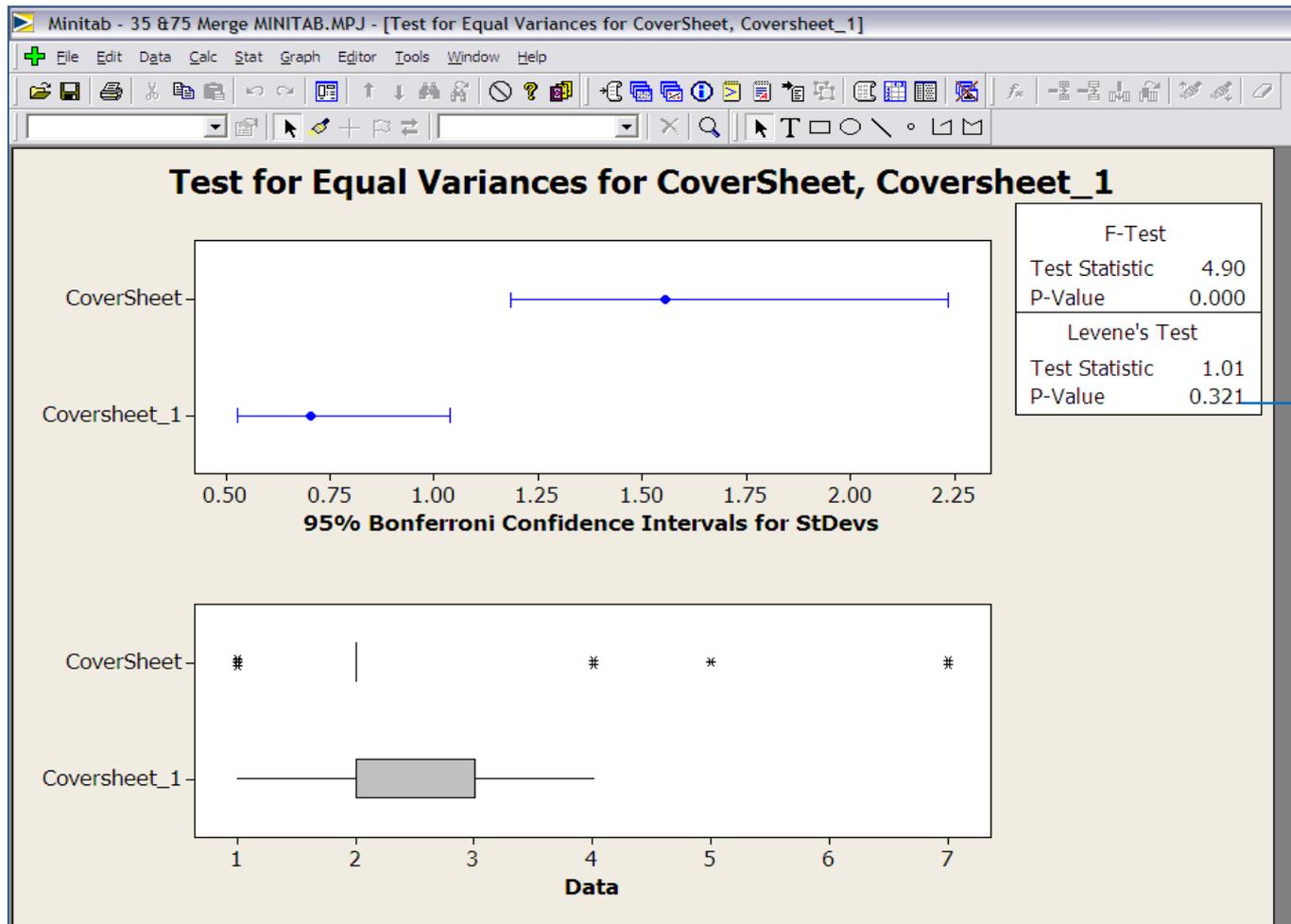
**2 Variances**

- Samples in one column
  - Samples:
  - Subscripts:
- Samples in different columns
  - First:
  - Second:
- Summarized data
  - Sample size:  Variance:
  - First:  Second:

Buttons: Select, Options..., Storage..., Help, OK, Cancel

	C1-T	C2-D	C3-T	C4-T	C5	C6
	Location	Date	Client	Month	Year	CoverSheet
1	In					
2	In					
3	In					
4	In					
5	In					
6	In					
7	In					
8	In					
9	In					
10	In					
11	In					
12	In					
13	In					
14	In					
15	In					
16	In					
17	In office	6/2/2009	FAA-SEAS	May		
18	In office	6/2/2009	HUD-EIV3	May		
19	In office	6/4/2009	FAA-ESVMS	Apr		

Select two columns to be sampled for Variance



Check for P Value

# Non-Parametric Test for Median



	C1-T	C2-D		C5	C6	C7
	Location	Date		Year	CoverSheet	BurnRate
1	In office	5/11/2009				
2	In office	5/12/2009				
3	In office	5/13/2009				
4	In office	5/14/2009				
5	In office	5/18/2009				
6	In office	5/19/2009				
7	In office	5/20/2009				
8	In office	5/18/2009				
9	In office	5/21/2009				
10	In office	5/26/2009	BITS-IRS	Jan		
11	In office	5/28/2009	FAA-ATOHR	Apr		
12	In office	5/28/2009	CSC-Crown	Apr		
13	In office	5/28/2009	CSC-Crown	Mar		
14	In office	6/1/2009	HUD-FHA2	May		
15	In office	6/2/2009	HUD-EIV3	Apr		
16	In office	6/2/2009	DHS-S&T	May		
17	In office	6/2/2009	FAA-SEAS	May		
18	In office	6/2/2009	HUD-EIV3	May		
19	In office	6/4/2009	FAA-ESVMS	Apr		7
20	In office	6/5/2009	DC Lottery	May		2

Nonparametric test

Mann-Whitney test

# Select particular data sample to be tested

Minitab - 35 &75 Merge MINITAB.MPJ - [Worksheet 1 \*\*\*]

File Edit Data Calc Stat Graph Editor Tools Window Help

	C1-T	C2-D	C3-T	C4-T	C5
	Location	Date	Client	Month	Year
1	Mann-Whitney				
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16	In office	6/2/2009	DHS-S&T	May	

Select Samples to be tested

## Test for Equal Variances for CoverSheet, Coversheet\_1

## Mann-Whitney Test and CI: CoverSheet, Coversheet\_1

	N	Median
CoverSheet	27	2.000
Coversheet_1	24	2.000

Point estimate for ETA1-ETA2 is -0.000

95.1 Percent CI for ETA1-ETA2 is (-0.001,0.000)

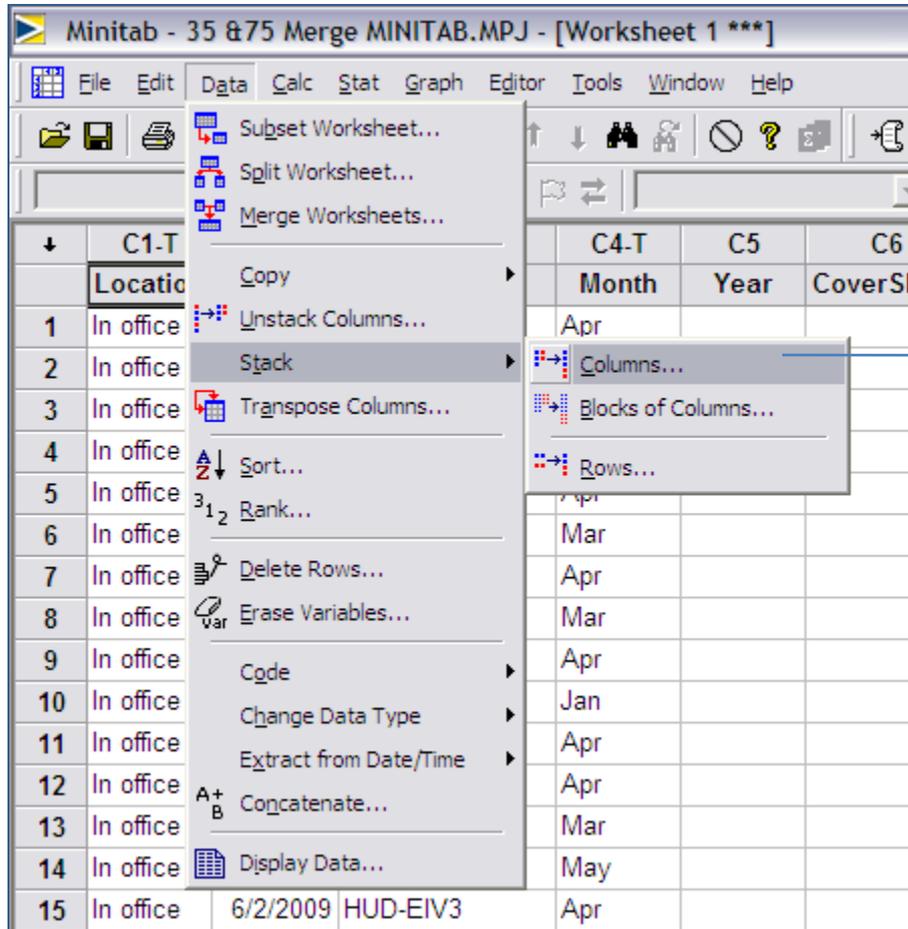
W = 668.5

Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.5334

The test is significant at 0.4485 (adjusted for ties)



Check for p  
value



Stacking Columns

# Select columns to be stacked

Minitab - 35 & 75 Merge MINITAB.MPJ - [Worksheet 1 \*\*\*]

File Edit Data Calc Stat Graph Editor Tools Window Help

	C1-T	C2-D	C3-T	C4-T	C5	C6	C7
	Location	Date	Client	Month	Year	CoverSheet	BurnRat
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17	In office	6/2/2009	FAA-SEAS	May			*
18	In office	6/2/2009	HUD-EIV3	May			2

Stack Columns

Stack the following columns:

Store stacked data in:

New worksheet

Name: \_\_\_\_\_ (Optional)

Column of current worksheet: \_\_\_\_\_

Store subscripts in: \_\_\_\_\_ (Optional)

Use variable names in subscript column

Select Help OK Cancel

17 In office 6/2/2009 FAA-SEAS May \*  
18 In office 6/2/2009 HUD-EIV3 May 2

We can select required column to be stacked

Stack Columns

Stack the following columns:

CoverSheet 'Coversheet\_1'

Store stacked data in:

New worksheet

Name: \_\_\_\_\_ (Optional)

Column of current worksheet: \_\_\_\_\_

Store subscripts in: \_\_\_\_\_ (Optional)

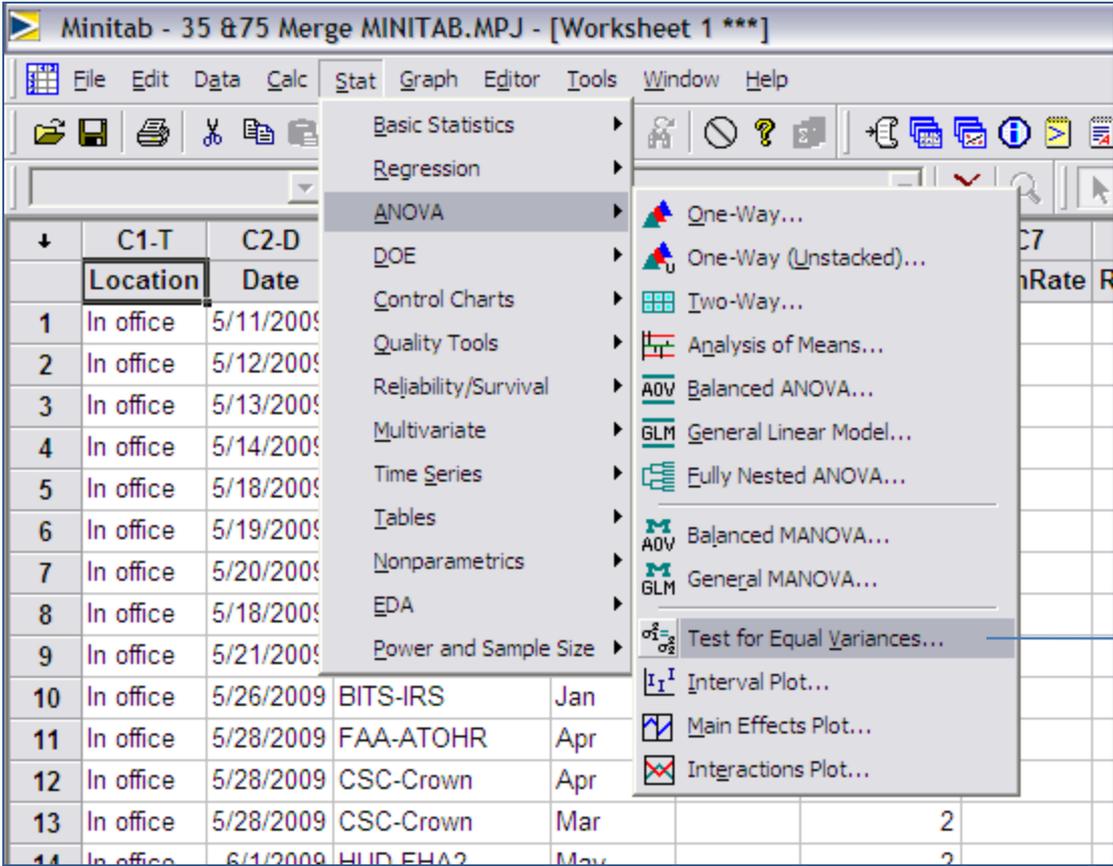
Use variable names in subscript column

Select Help OK Cancel

Selection of column

ComboCoversheet	SubComboCoversheet
2	CoverSheet Phase_2
2	CoverSheet Phase_2
*	CoverSheet Phase_2
2	CoverSheet Phase_2
*	CoverSheet Phase_2
5	CoverSheet Phase_2
2	CoverSheet Phase_2
1	CoverSheet Phase_2
2	CoverSheet Phase_2
2	CoverSheet Phase_2
2	CoverSheet Phase_2
7	CoverSheet Phase_2

# Non-Parametric Test for Variance



Equal Variance Test

# Select particular data point for Variance test



The screenshot shows the Minitab interface with a 'Test for Equal Variances' dialog box open. The dialog box is configured with the following settings:

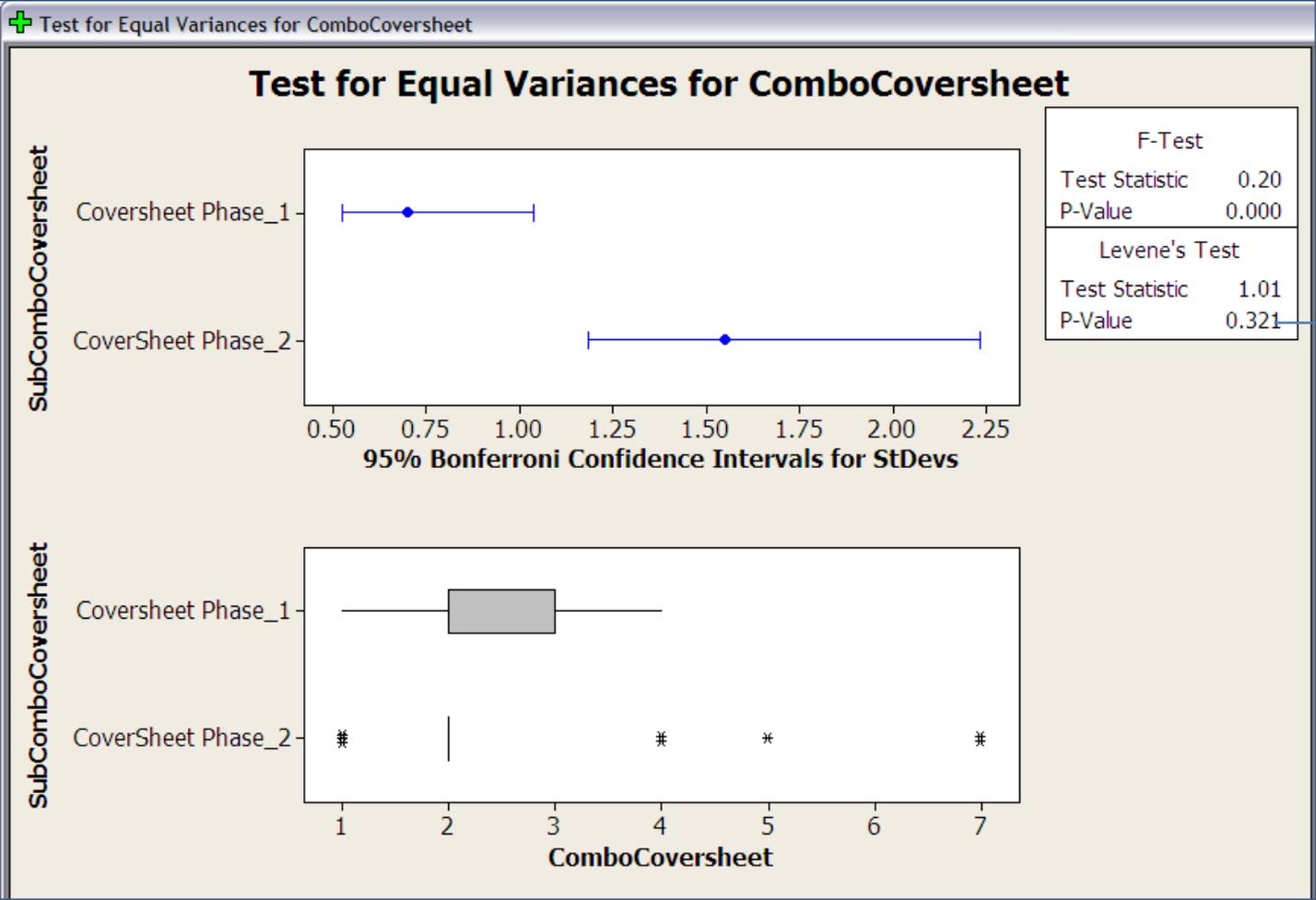
- Response: ComboCoversheet
- Factors: SubComboCoversheet
- Confidence level: 95.0
- Title: (empty)

The background data table is as follows:

	C1-T	C2-D	C3-T	C4-T	C5	C6	C7
	Location	Date	Client	Month	Year	CoverSheet	BurnRate
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17	In office	6/2/2009	FAA-SEAS	May			*
18	In office	6/2/2009	HUD-EIV3	May			2
19	In office	6/4/2009	FAA-ESVMS	Apr			7

Phase-1

Phase-2



Check for P Value

# Test for Individuals Graphs



Minitab - 35 & 75 Merge MINITAB.MPJ - [Worksheet 1 \*\*\*]

File Edit Data Calc Stat Graph Editor Tools Window Help

Basic Statistics  
Regression  
ANOVA  
DOE  
Control Charts  
Quality Tools  
Reliability/Survival  
Multivariate  
Time Series  
Tables  
Nonparametrics  
EDA  
Power and Sample Size

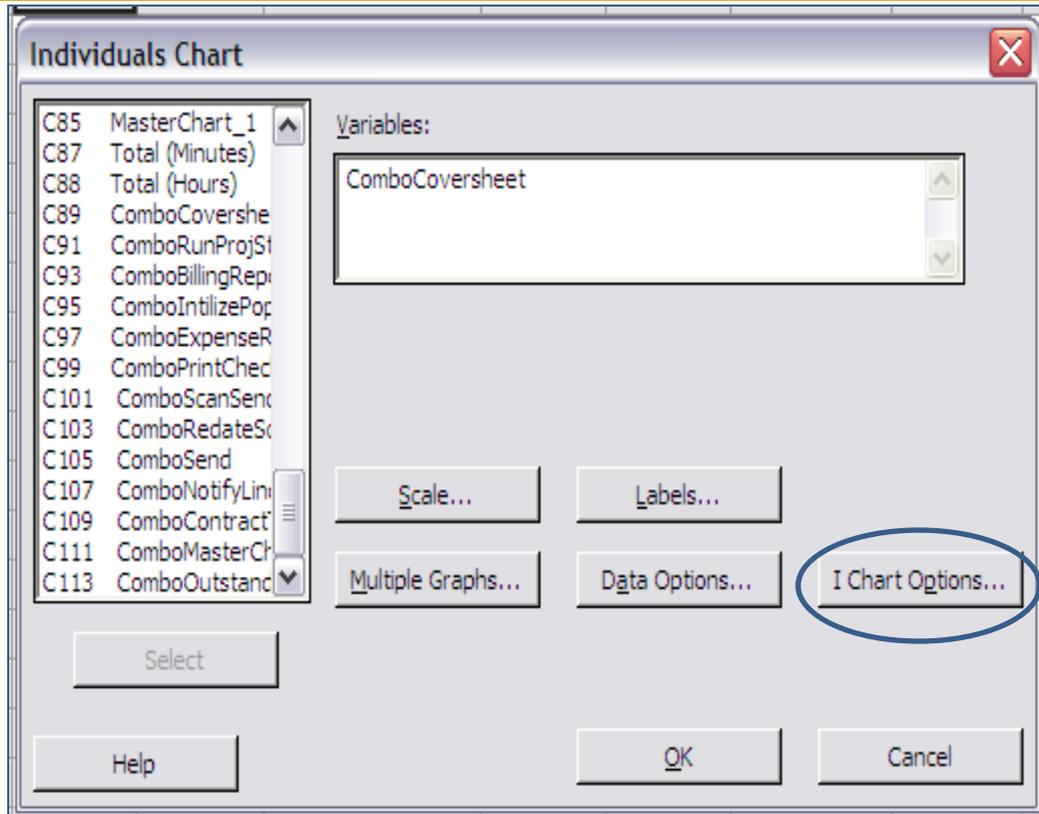
Box-Cox Transformation...  
Variables Charts for Subgroups  
Variables Charts for Individuals  
Attributes Charts  
Time-Weighted Charts  
Multivariate Charts

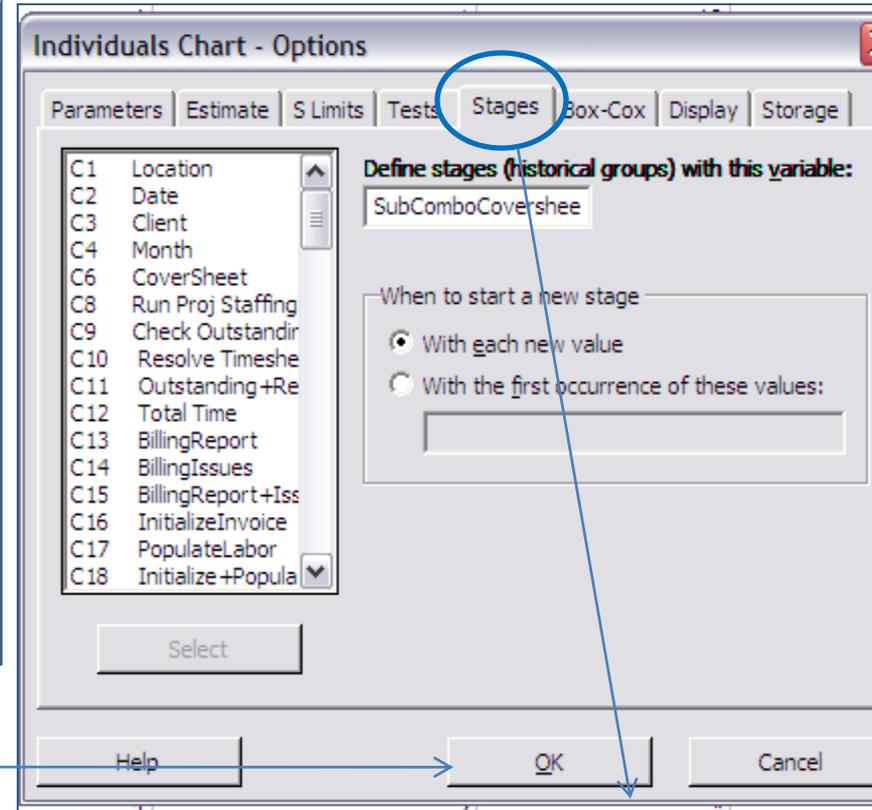
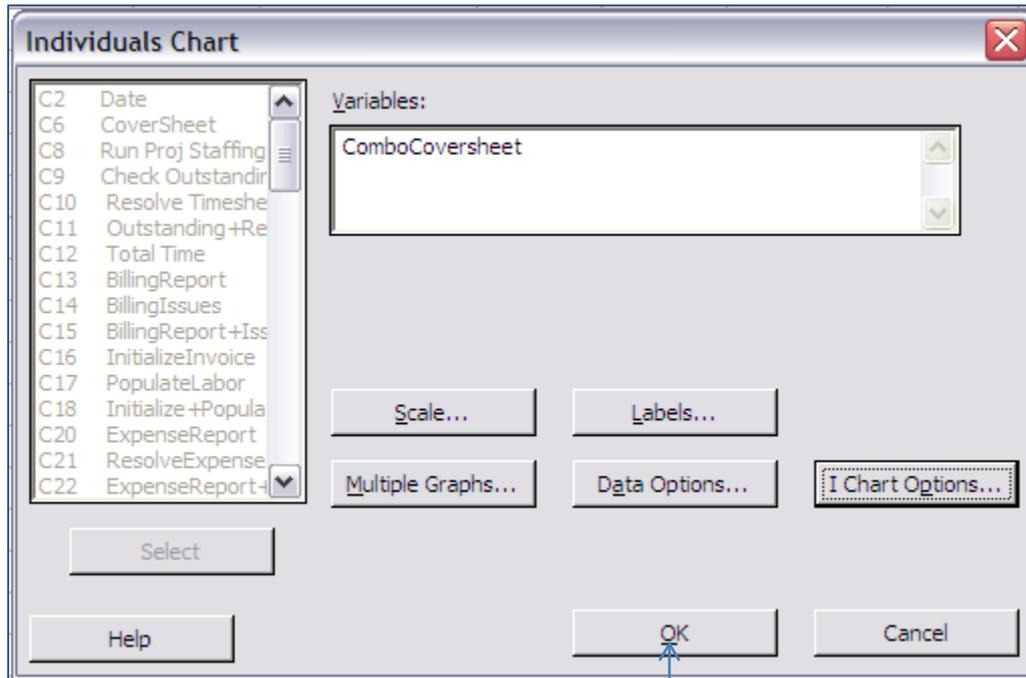
I-MR...  
Z-MR...  
Individuals...  
Moving Range...

	C1-T	C2-D	C5	C6	C7	C8	
	Location	Date			Rate	Run Proj Staffing	Check
1	In office	5/11/2009					1
2	In office	5/12/2009					*
3	In office	5/13/2009					
4	In office	5/14/2009					
5	In office	5/18/2009					
6	In office	5/19/2009					
7	In office	5/20/2009					
8	In office	5/18/2009					1
9	In office	5/21/2009					1
10	In office	5/26/2009	BITS-IRS	Jan			*
11	In office	5/28/2009	FAA-ATOHR	Apr			2
12	In office	5/28/2009	CSC-Crown	Apr			1

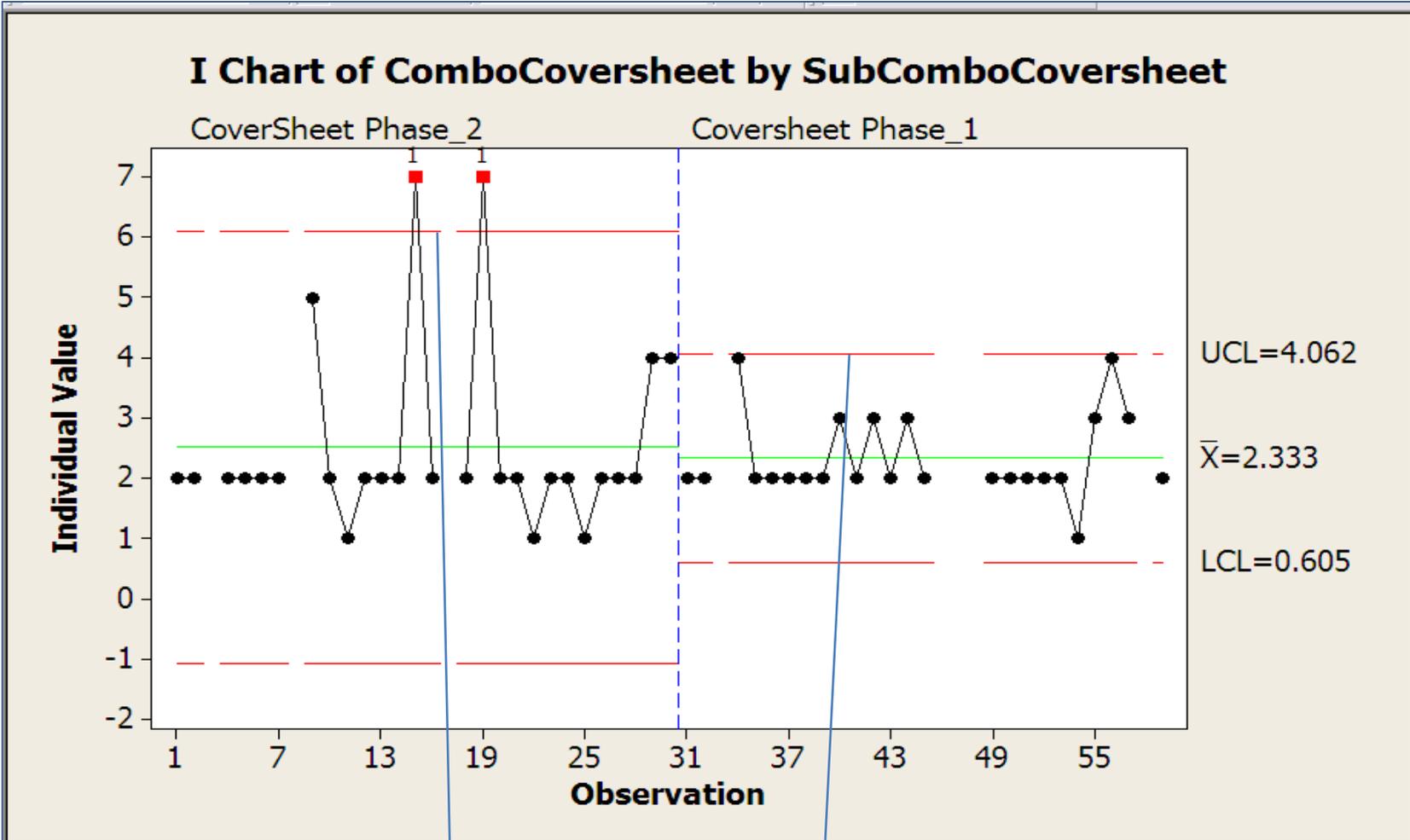
Select Individual to Plot charts

# Select data point for Individual Chart





Stages gives the option to select sub stage of data point



Difference between Phase-1 & Phase-2

