



Measurement System Analysis SigmaXL[®] Version 6.1

MSA: Overview

Gage R&R Template

Gage R&R (Crossed) Worksheet

Analyze Gage R&R (Crossed)

Analyze Gage R&R With Confidence Intervals

Analyze Gage R&R – X-Bar & R Charts

Analyze Gage R&R – Multi-Vari Charts

Attribute MSA (Binary)



Measurement Systems Analysis

- Basic MSA Templates
- Create Gage R&R (Crossed) Worksheet
 - Generate worksheet with user specified number of parts, operators, replicates
- Analyze Gage R&R (Crossed)
- Attribute MSA (Binary)



Measurement Systems Analysis: Gage R&R Template

Gage Name: _____
 Date of Study: _____
 Performed By: _____
 Notes: _____

Process Tolerance _____
 USL: 0.05
 LSL: 0.03
 StDev Multiplier: 5.15

Gage R&R Metrics	Variance Component	% Contribution of Variance Component	StDev	StDev * Multiplier	% Total Variation (TV)	% Tolerance
Gage R&R:	1.19363E-05	100.00	0.003454892	0.017792692	100.00	88.96
Operator (AV Appraiser Variation):	2.30532E-06	19.31	0.001518329	0.007819394	43.95	39.10
Operator * Part (INT Interaction):	0	0.00	0	0	0.00	0.00
Reproducibility (SQRT(AV^2 + INT^2)):	2.30532E-06	19.31	0.001518329	0.007819394	43.95	39.10
Repeatability (EV Equipment Variation):	9.63095E-06	80.69	0.003103378	0.015982395	89.83	79.91
Part Variation (PV):	0	0.00	0	0	0.00	0.00
Total Variation (TV):	1.19363E-05	100.00	0.003454892	0.017792692	100.00	88.96

Operator A	Part 1	Part 2	Part 3
Reading 1	0.023723336	0.02656742	0.027773566
Reading 2	0.025024153	0.020252222	0.026572347
Reading 3	0.028028842	0.024040015	0.022373752

Operator B	Part 1	Part 2	Part 3
Reading 1	0.026501719	0.028590101	0.029095317
Reading 2	0.025416103	0.02138348	0.02487379
Reading 3	0.025671465	0.031645323	0.02822113

Operator C	Part 1	Part 2	Part 3
Reading 1	0.022481503	0.01937289	0.021863448
Reading 2	0.02731664	0.026095291	0.022165166
Reading 3	0.021774387	0.024457899	0.027268289

Create Stacked Column Format for "Analyze Gage R&R" >>

Measurement Systems Analysis: Create Gage R&R (Crossed) Worksheet

Create Gage R&R (Crossed) Worksheet

Number of Parts/Samples: 10

Number of Operators/Appraisers: 3

Number of Replicates/Trials: 3

Randomize Parts/Samples

Randomize Operators/Appraisers

Part/Sample Names:

1: Part 1

2: Part 2

3: Part 3

4: Part 4

Operator/Appraiser Names::

1: Operator A

2: Operator B

3: Operator C

Buttons: OK>>, Cancel, Help, Reset

Gage R&R Study (Crossed) Worksheet

Gage Name:	Calipers
Date of Study:	26-Apr-06
Performed By:	John Noguera
Notes:	

Run Order	Std. Order	Parts	Operators	Measurement
1	12	Part 4	Operator A	0.676
2	2	Part 1	Operator A	0.898
3	20	Part 7	Operator A	0.398
4	24	Part 8	Operator A	0.948
5	17	Part 6	Operator A	0.932
6	6	Part 2	Operator A	0.934
7	27	Part 9	Operator A	0.689
8	15	Part 5	Operator A	0.538
9	29	Part 10	Operator A	0.704

Measurement Systems Analysis: Analyze Gage R&R (Crossed)

- ANOVA, %Total, %Tolerance (2-Sided or 1-Sided), %Process, Variance Components, Number of Distinct Categories
- Gage R&R Multi-Vari and X-bar R Charts
- Confidence Intervals on %Total, %Tolerance, %Process and Standard Deviations
- Handles unbalanced data (confidence intervals not reported in this case)

Measurement Systems Analysis: Analyze Gage R&R (Crossed)

Analyze Gage R&R (Crossed)

Run Order Std. Order	Part >>	Parts	OK >>
	Operator >>	Operators	Cancel
	Measurement >>	Measurement	Help
	<< Remove		

Standard Deviation Multiplier: 6

Alpha to Remove Interaction: 0.1

Confidence Level: 90 %

Display Multi-Vari & X-Bar R Charts

Report Information (Optional)

Tolerance/Historical StDev (Optional)

Gage Name:

Performed By:

Date:

Notes:

Upper-Lower Spec:

Upper Spec:

Lower Spec:

Historical Process Standard Deviation:



Measurement Systems Analysis: Analyze Gage R&R with Confidence Intervals

Analysis of Variance with Part * Operator Interaction:

Source	DF	SS	MS	F	P
Part:	9	0.553693	0.061521481	37.103	0.0000
Operator:	2	0.013653333	0.006826667	4.1170	0.0337
Part * Operator:	18	0.029846667	0.001658148	4.1111	0.0003
Repeatability:	30	0.0121	4.033E-04		
Total:	59	0.609293	0.010327006		

Gage R&R Metrics	StDev	StDev Lower 90% CI	StDev Upper 90% CI	6 * StDev	% Total Variation (TV)	% TV Lower 90% CI	% TV Upper 90% CI
Gage R&R:	0.035904967	0.030367917	0.087410367	0.215430	33.83	20.16	68.36
Operator (AV Appraiser Variation):	0.016075631	0.004168708	0.081026508	0.096453789	15.15		
Part * Operator (INT Interaction):	0.025048102	0.017095374	0.037247076	0.150289	23.60		
Reproducibility (SQRT(AV^2 + INT^2)):	0.029762952	0.021365632	0.085000016	0.178578	28.04		
Repeatability (EV Equipment Variation):	0.02008316	0.016626072	0.025579555	0.120499	18.92		
Part Variation (PV):	0.099886046	0.071946598	0.165736	0.599316	94.10		
Total Variation (TV):	0.106143247	0.080362383	0.172845	0.636859	100.00		

Confidence Intervals are calculated for Gage R&R Metrics!



Measurement Systems Analysis: Analyze Gage R&R with Confidence Intervals

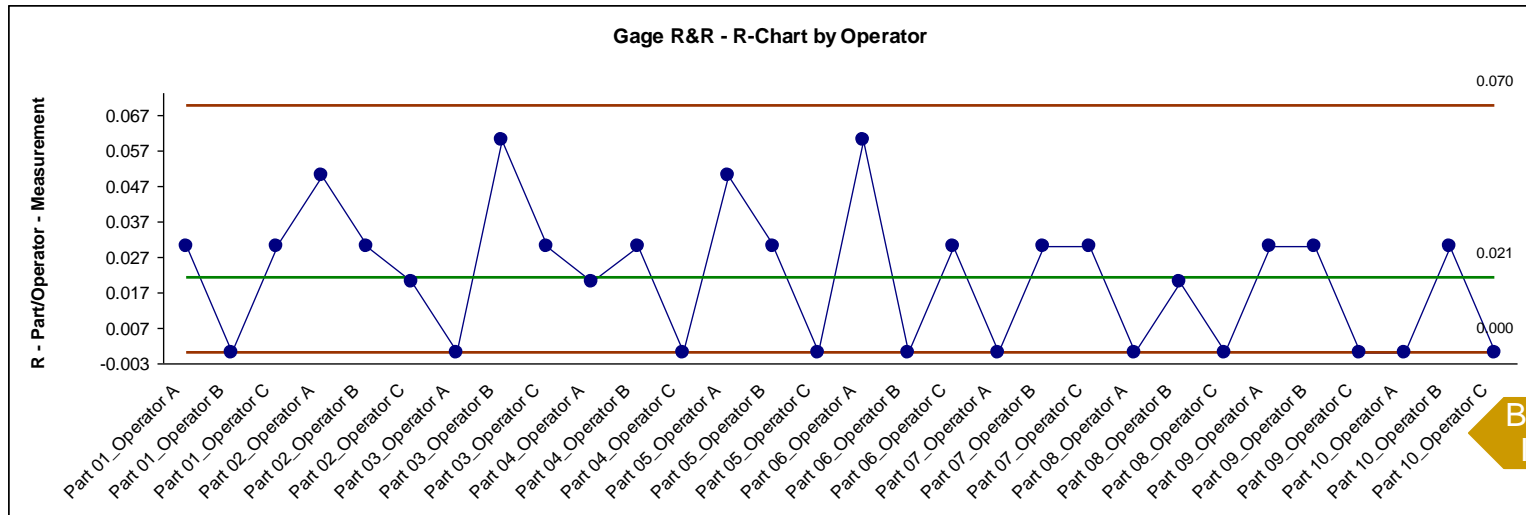
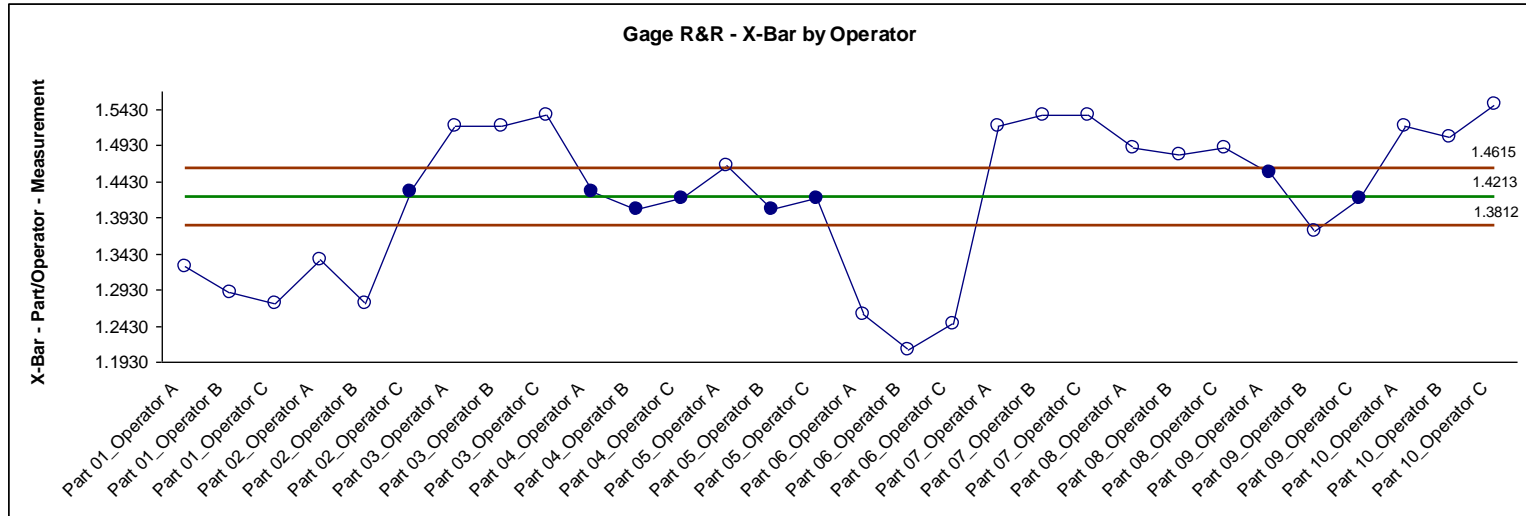
Gage R&R Metrics	% Tolerance	% Tolerance Lower 90% CI	% Tolerance Upper 90% CI
Gage R&R:	21.54	18.22	52.45
Operator (AV Appraiser Variation):	9.65	2.50	48.62
Part * Operator (INT Interaction):	15.03	10.26	22.35
Reproducibility (SQRT(AV ² + INT ²)):	17.86	12.82	51.00
Repeatability (EV Equipment Variation):	12.05	9.98	15.35
Part Variation (PV):	59.93	43.17	99.44
Total Variation (TV):	63.69	48.22	103.71

Gage R&R Metrics	Variance Component	% Contribution of Variance Component
Gage R&R:	0.001289167	11.44
Operator:	2.584E-04	2.29
Part * Operator:	6.274E-04	5.57
Reproducibility:	8.858E-04	7.86
Repeatability:	4.033E-04	3.58
Part Variation:	0.009977222	88.56
Total Variation:	0.011266389	100.00

Gage R&R Metrics	NDC	NDC Lower 90% CI	NDC Upper 90% CI
Number of Distinct Categories (Signal-to-Noise Ratio: 1.41 * PV/R&R):	3.9	1.5	6.9

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Measurement Systems Analysis: Analyze Gage R&R – X-bar & R Charts

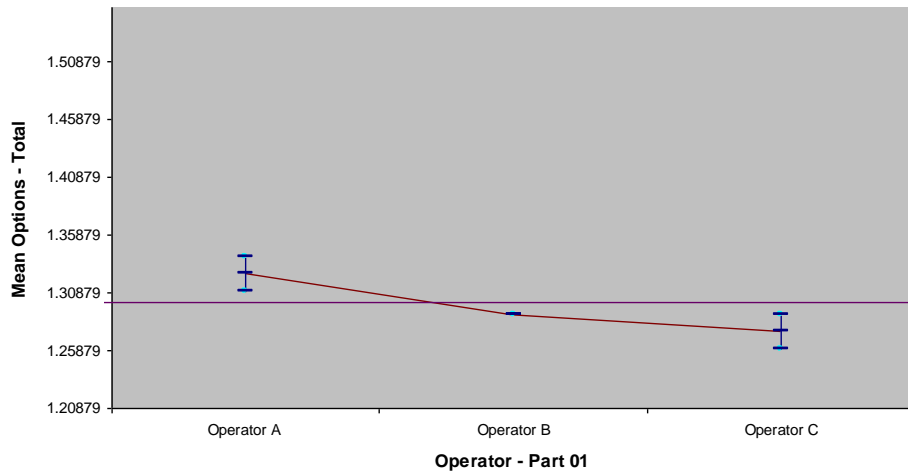


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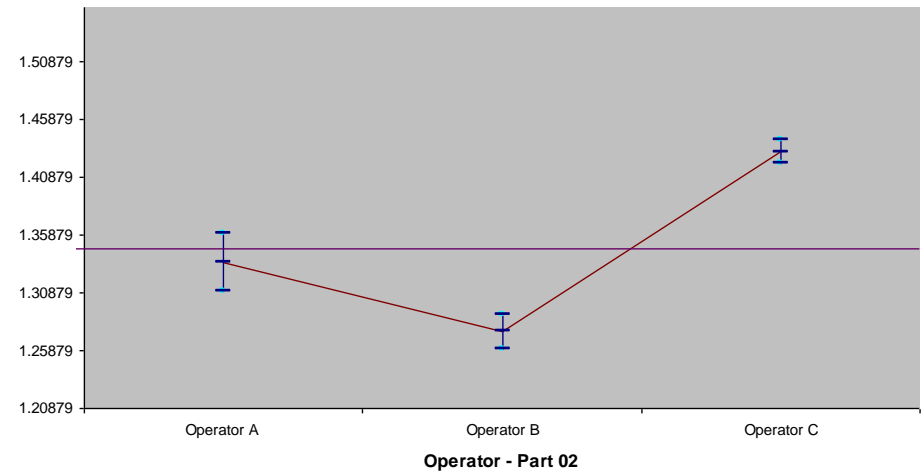


Measurement Systems Analysis: Analyze Gage R&R – Multi-Vari Charts

Gage R&R Multi-Vari



Gage R&R Multi-Vari



Measurement Systems Analysis: Attribute MSA (Binary)

- Any number of samples, appraisers and replicates
- Within Appraiser Agreement, Each Appraiser vs Standard Agreement, Each Appraiser vs Standard Disagreement, Between Appraiser Agreement, All Appraisers vs Standard Agreement
- Fleiss' kappa