

## GR&amp;R Study (Average &amp; Range) Report For Gage ID: Demo\_01

Gage ID	Demo_01	Parts	10	Part No./Name	-	Tolerance	-	Study Date	19/02/2016
Gage Type	Micrometer	Appraiser(s)	3	Characteristic	-	Pro. Std. Dev. (1 Sigma)	1.8	Target Pp / Ppk	2
Resolution	0.001	Trials	3	Study By	-	Confidence	95 %	Coverage	99.73% (6 * Sigma)
Lower Specification	-	Upper Specification		GR&R Method	Average & Range				

## Average &amp; Range Data

GR&R - Range & Average Report	
Measurement Systems Analysis	% Total Variation (TV)
Repeatability - Equipment Variation (EV)	
$EV = R\bar{D}bar * K1$ $= 0.341667 * 0.590818$ $= 0.201863$	$\% EV = 100[EV/TV]$ $= 100[ 0.201863 / 1.146001 ]$ $= 17.61$
Reproducibility - Appraiser Variation (AV)	
$AV = \sqrt{[ ( X\bar{B}ar Diff * K2 )^2 - ( EV^2 / nr ) ]}$ $= \sqrt{[(0.444667 * 0.523136)^2 - ( 0.201863^2 / 30 )]}$ $= 0.229683$	$\% AV = 100[AV/TV]$ $= 100[ 0.229683/1.146001]$ $= 20.04$
Repeatability & Reproducibility (RR)	
$RR = \sqrt{[ (EV^2 + AV^2) ]}$ $= \sqrt{[(0.201863^2 + 0.229683^2 )]}$ $= 0.305782$	$\% RR = 100[RR/TV]$ $= 100[ 0.305782/1.146001]$ $= 26.68$
Part Variation (PV)	
$PV = R_p * K3$ $= 3.511111 * 0.314559$ $= 1.104453$	$\% PV = 100[PV/TV]$ $= 100[ 1.104453/1.146001]$ $= 96.37$
Total Variation (TV)	
$TV = \sqrt{[ R\&R^2 + PV^2 ]}$ $= \sqrt{[ 0.305782^2 + 1.104453^2 ]}$ $= 1.146001$	$nDC = 1.41 (PV/RR)$ $= 1.41 (1.104453/0.305782)$ $= 5.129 \sim 5$

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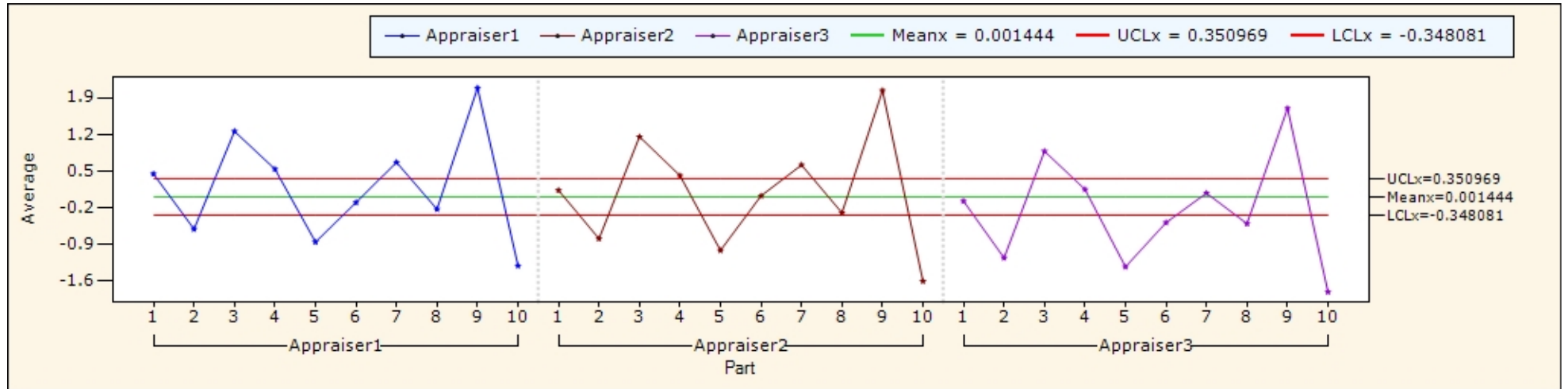
Statistic	St.Dev	6.* St.Dev	% Study	% Contrib	% Tol	% Proc	Pp/Ppk
Based On Study Variation							
EV	0.201863	1.211176	17.61	3.10	-	11.21	-
AV	0.229683	1.378098	20.04	4.02	-	12.76	-
RR	0.305782	1.834693	26.68	7.12	-	16.99	-
PV	1.104453	6.626718	96.37	92.88	-	61.36	-
TV	1.146001	6.876008	100.00	100.00	-	63.67	-
nDC	5.093[ ~5]		S/N Ratio	3.61			

nDC Calculation			
	Based On Process Tolerance	Based On Process Variation	Based On Target Pp/Ppk
TV	-	1.800000	-
PV	-	1.773837	-
nDC	-	8.179383[ ~8 ]	-
S/N Ratio	-	5.800981	-

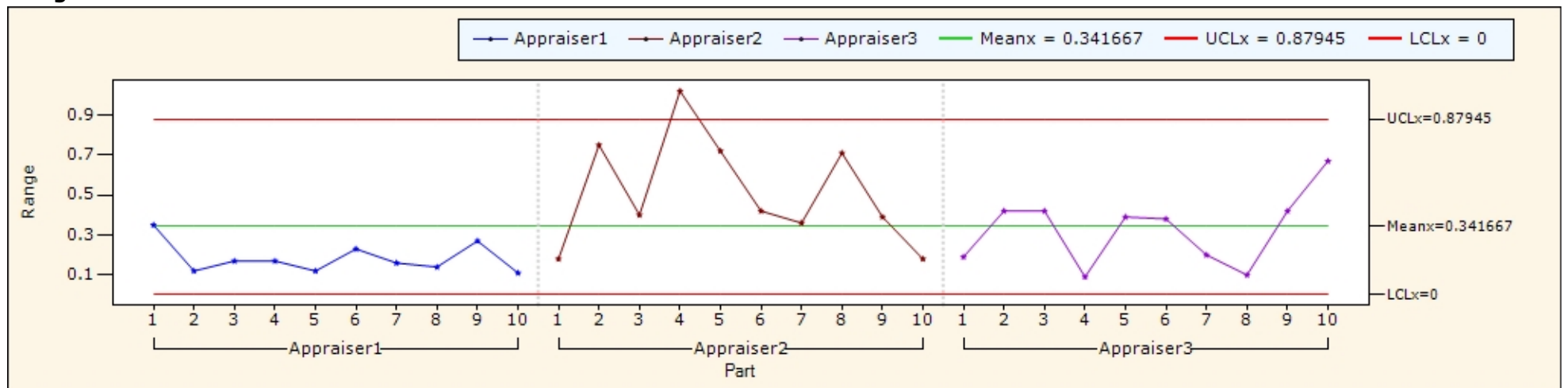
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## XBar Chart



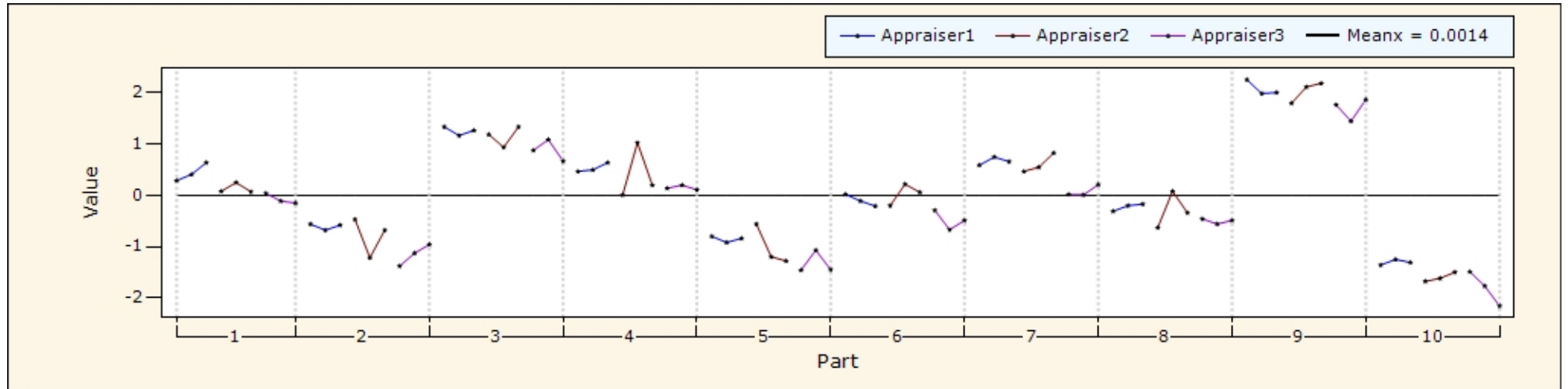
## Range Chart



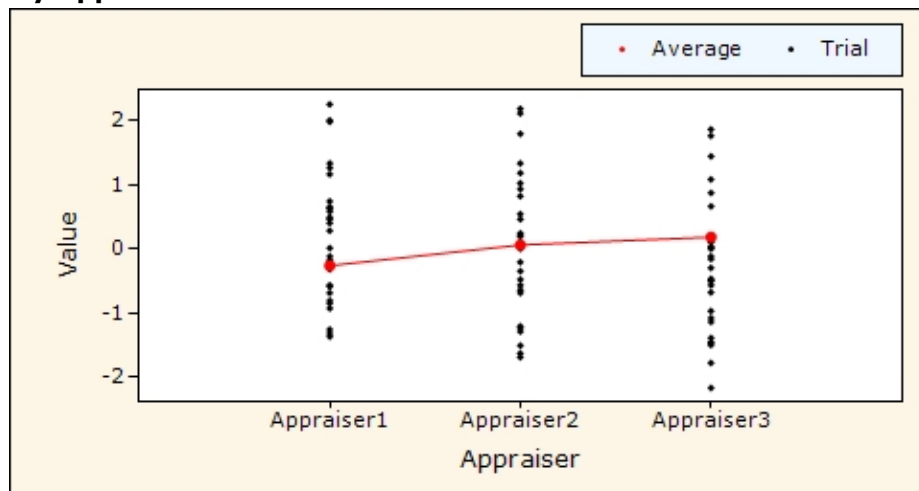
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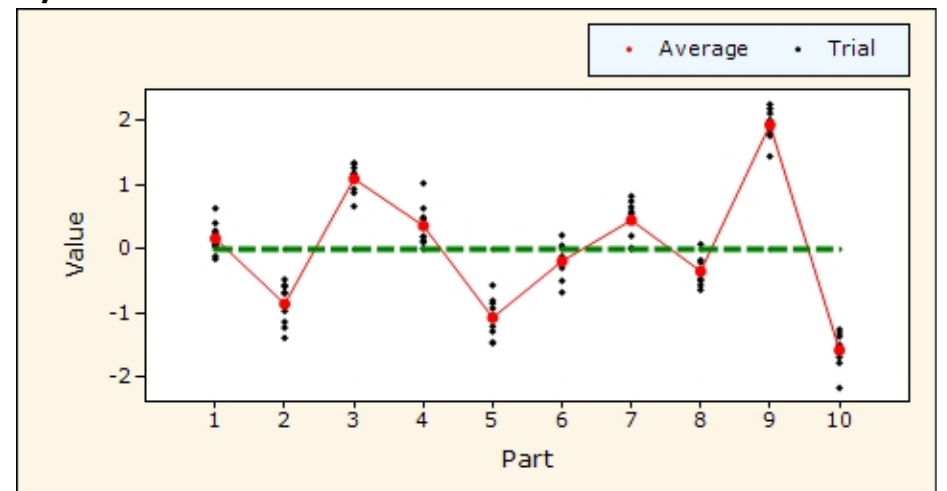
## Scatter Chart



## By Appraiser Chart



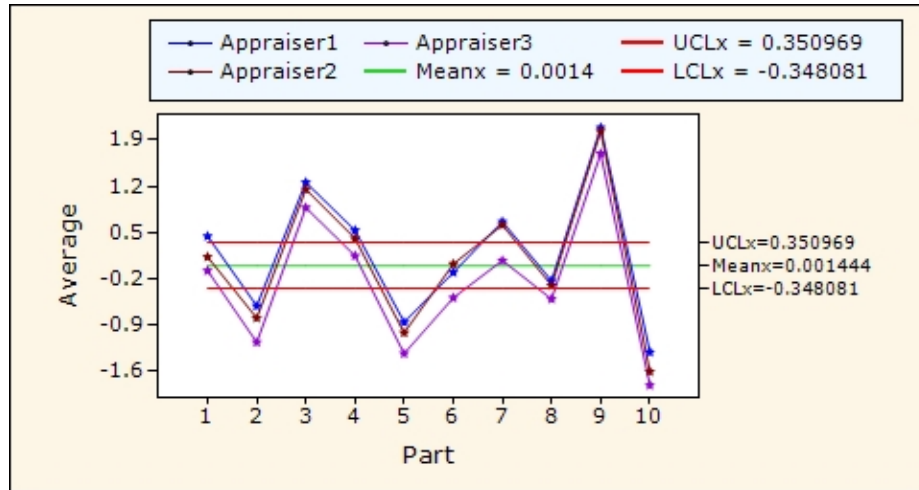
## By Part Chart



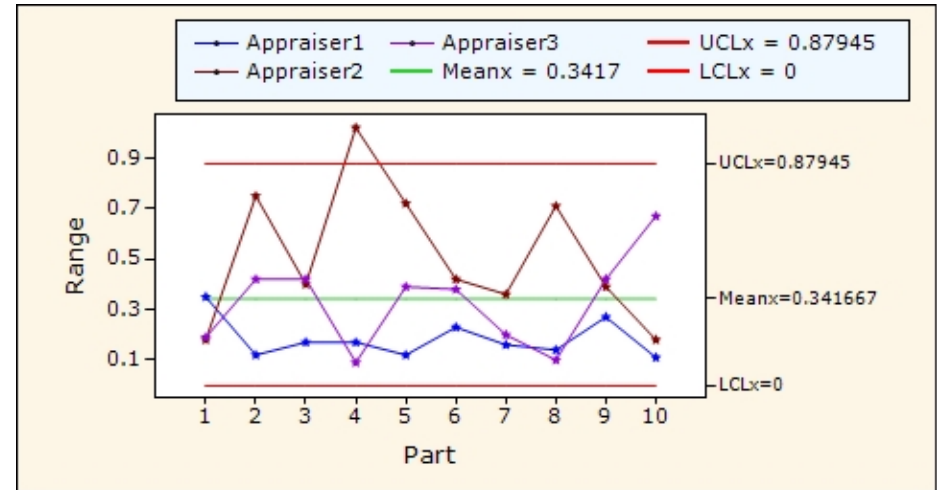
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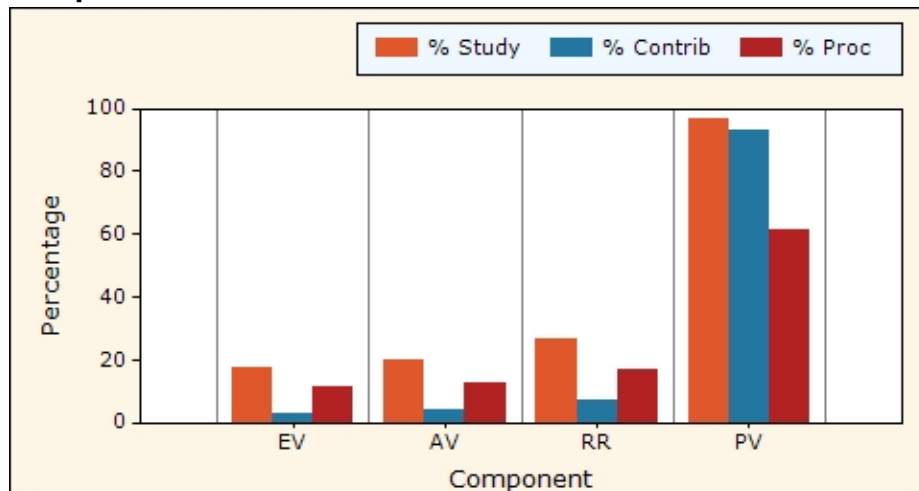
## Xbar Stacked Chart



## Range Stacked Chart



## Components of Variation



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## Average &amp; Range Data

Appraisers	Trials	Part										Average	
		1	2	3	4	5	6	7	8	9	10		
Appraiser1	Trial 1	0.29	-0.56	1.34	0.47	-0.8	0.02	0.59	-0.31	2.26	-1.36		0.194000
	Trial 2	0.41	-0.68	1.17	0.5	-0.92	-0.11	0.75	-0.2	1.99	-1.25		0.166000
	Trial 3	0.64	-0.58	1.27	0.64	-0.84	-0.21	0.66	-0.17	2.01	-1.31		0.211000
	Average	0.446667	-0.606667	1.260000	0.536667	-0.853333	-0.100000	0.666667	-0.226667	2.086667	-1.306667	Xa-Bar	0.190333
	Range	0.35	0.12	0.17	0.17	0.12	0.23	0.16	0.14	0.27	0.11	Ra-Bar	0.184000
Appraiser2	Trial 1	0.08	-0.47	1.19	0.01	-0.56	-0.2	0.47	-0.63	1.8	-1.68		0.001000
	Trial 2	0.25	-1.22	0.94	1.03	-1.2	0.22	0.55	0.08	2.12	-1.62		0.115000
	Trial 3	0.07	-0.68	1.34	0.2	-1.28	0.06	0.83	-0.34	2.19	-1.5		0.089000
	Average	0.133333	-0.790000	1.156667	0.413333	-1.013333	0.026667	0.616667	-0.296667	2.036667	-1.600000	Xb-Bar	0.068333
	Range	0.18	0.75	0.4	1.02	0.72	0.42	0.36	0.71	0.39	0.18	Rb-Bar	0.513000
Appraiser3	Trial 1	0.04	-1.38	0.88	0.14	-1.46	-0.29	0.02	-0.46	1.77	-1.49		-0.223000
	Trial 2	-0.11	-1.13	1.09	0.2	-1.07	-0.67	0.01	-0.56	1.45	-1.77		-0.256000
	Trial 3	-0.15	-0.96	0.67	0.11	-1.45	-0.49	0.21	-0.49	1.87	-2.16		-0.284000
	Average	-0.073333	-1.156667	0.880000	0.150000	-1.326667	-0.483333	0.080000	-0.503333	1.696667	-1.806667	Xc-Bar	-0.254333
	Range	0.19	0.42	0.42	0.09	0.39	0.38	0.2	0.1	0.42	0.67	Rc-Bar	0.328000
Part Average		0.168889	-0.851111	1.098889	0.366667	-1.064444	-0.185556	0.454444	-0.342222	1.940000	-1.571111	Rp	3.511111

[[Ra-Bar = 0.184000] + [Rb-Bar = 0.513000] + [Rc-Bar = 0.328000] / [# of Operators = 3] ]= RD-Bar =0.341667

[Max XBar =-0.254333] - [Min XBar =-0.254333] =XBar Diff = 0.444667

[RD-Bar = 0.341667] X [D4 = 2.574 ]=UCLr = 0.879450