Expected QI Macros® Results & Comparison to Minitab 17 or other Resources

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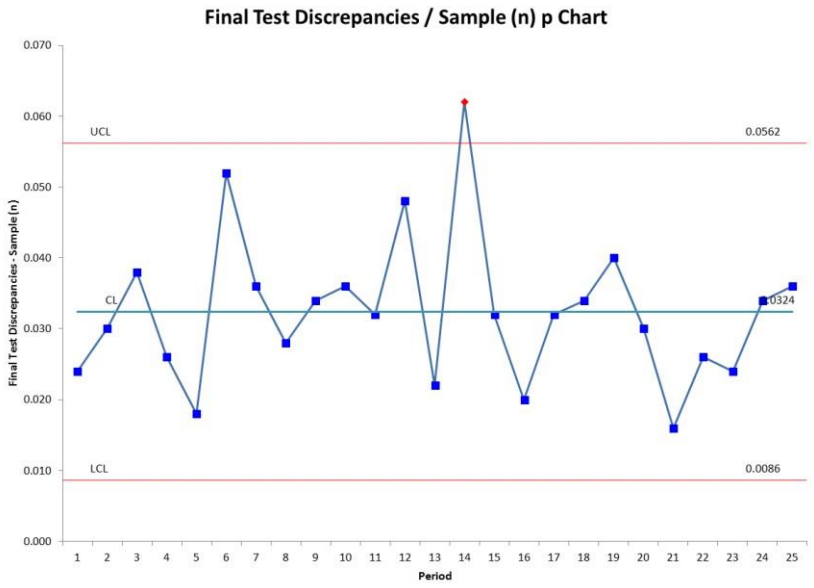
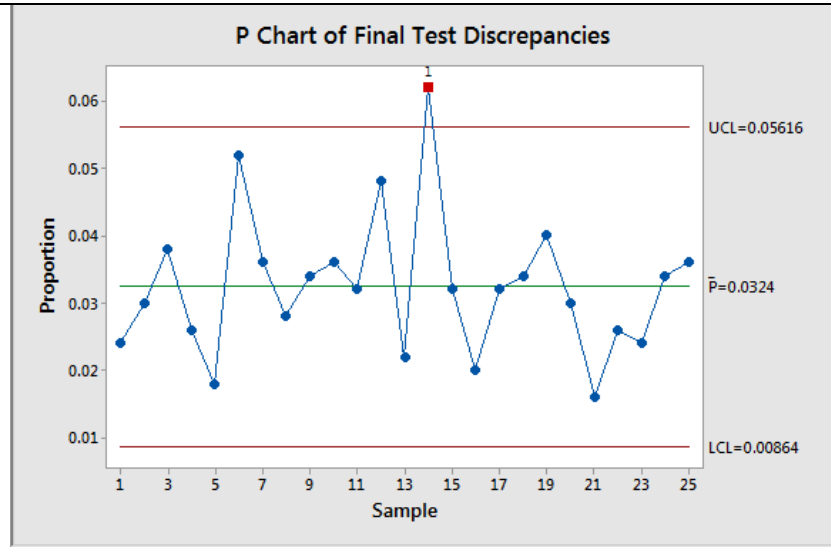
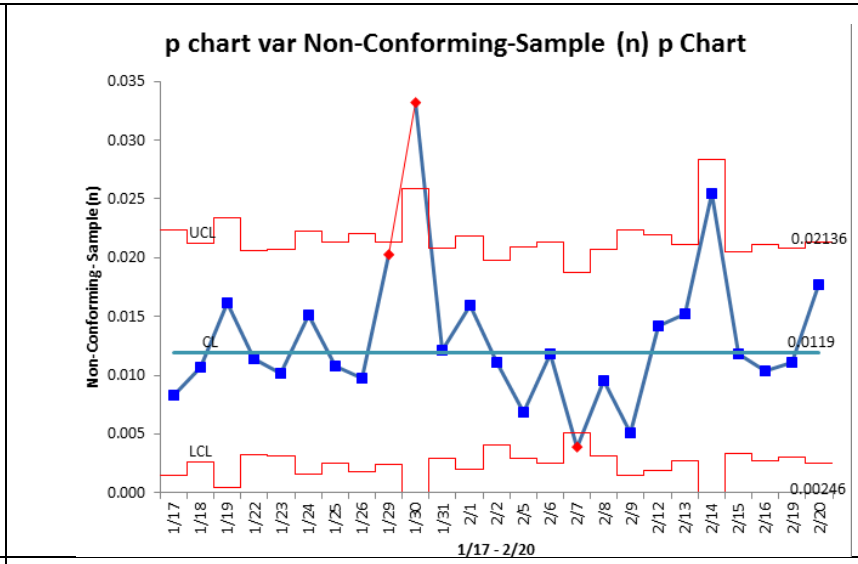
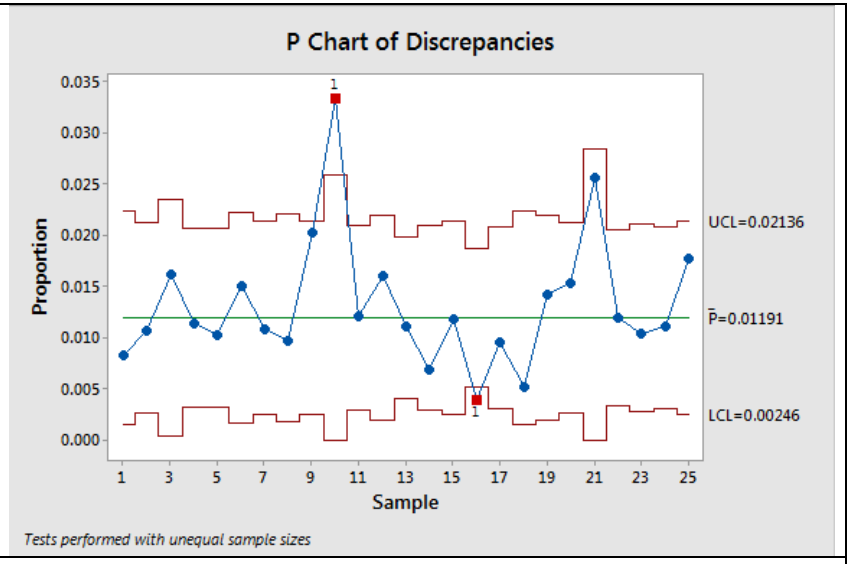
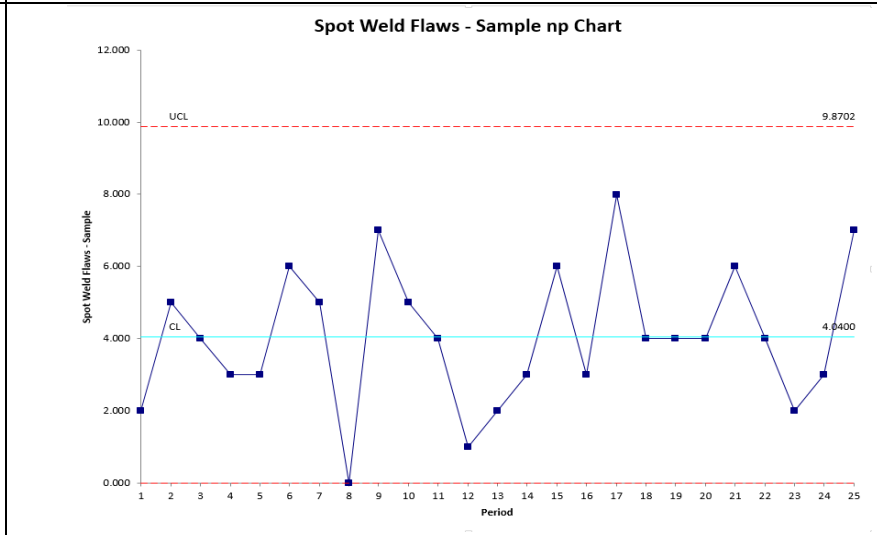
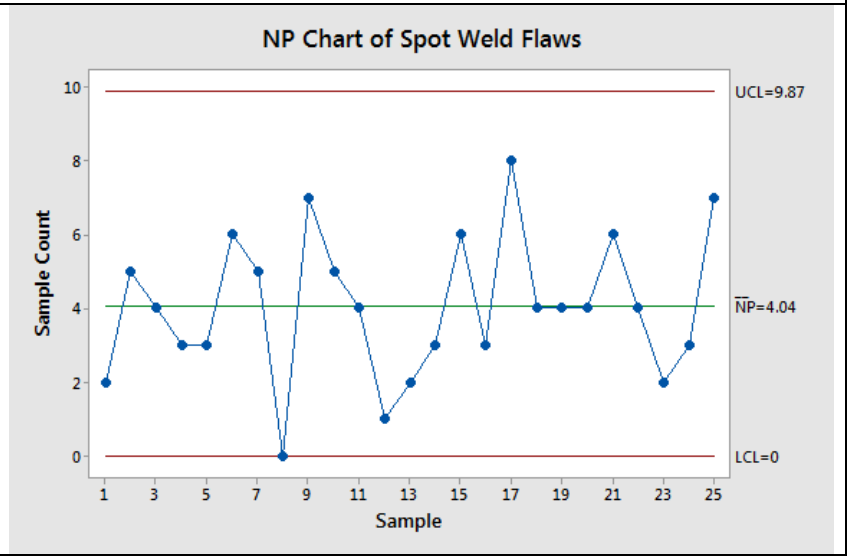
P Chart AIAG SPC 2nd Edition page 88		

Pchart AIAG SPC 2nd Edition page 92		
np Chart		

C Chart

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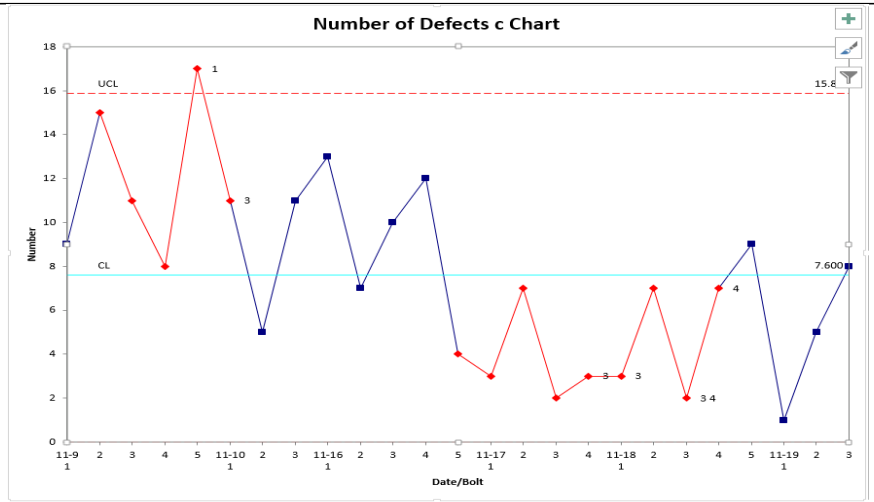
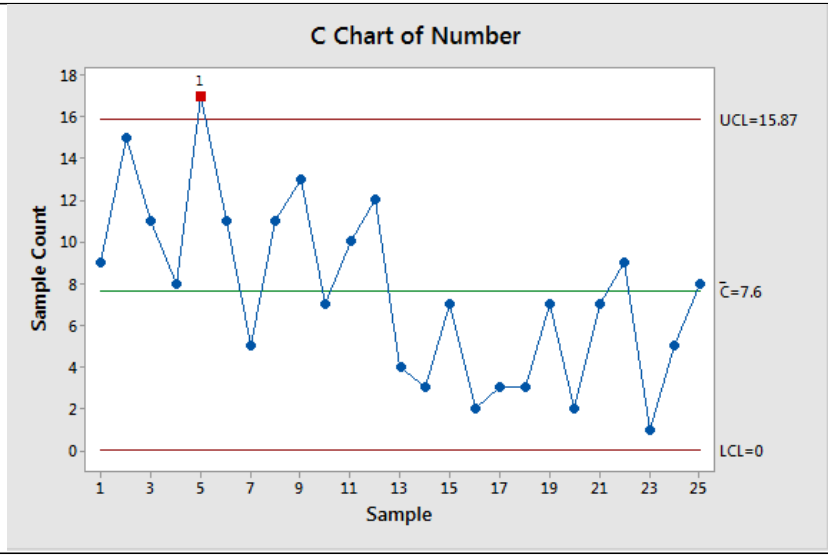
(This example displays the "show rule numbers" option.)





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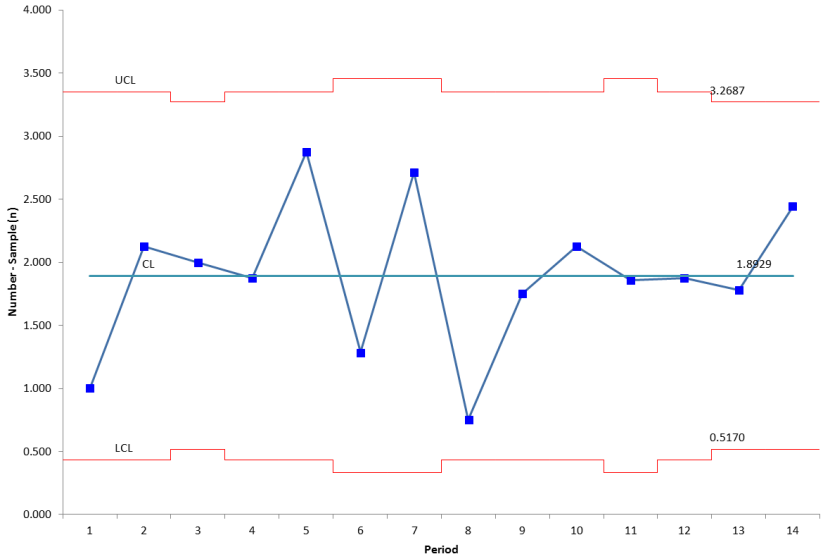

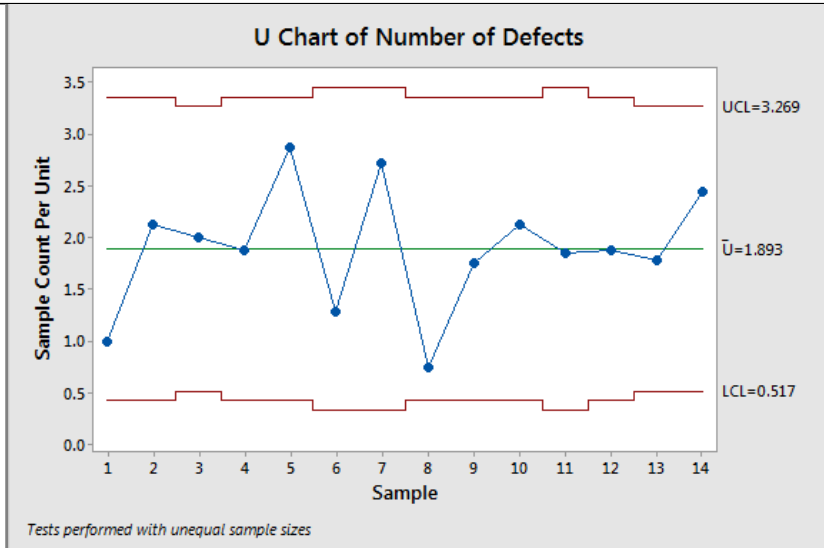

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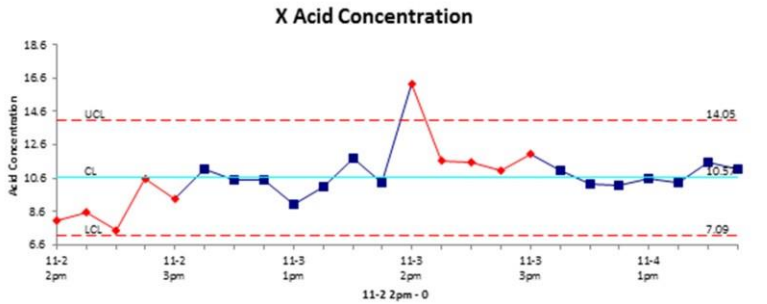
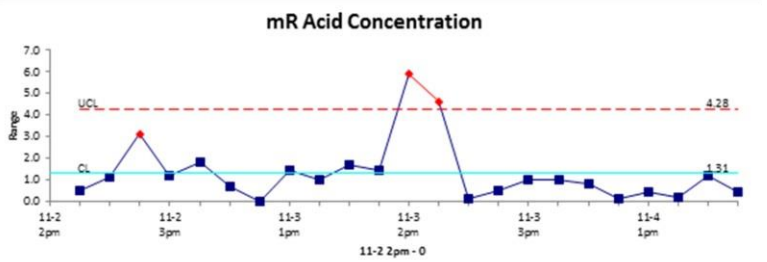
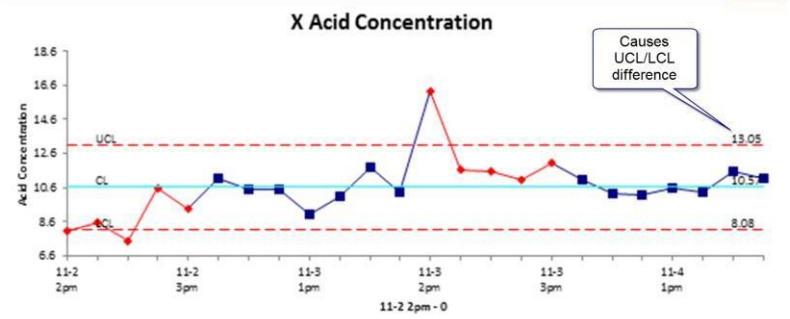
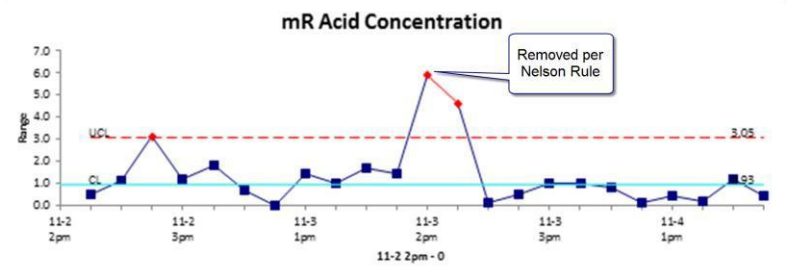
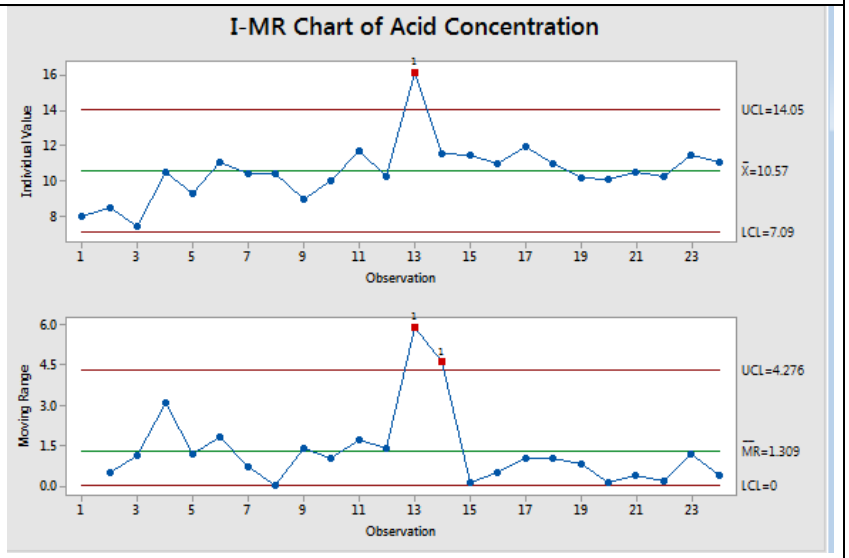
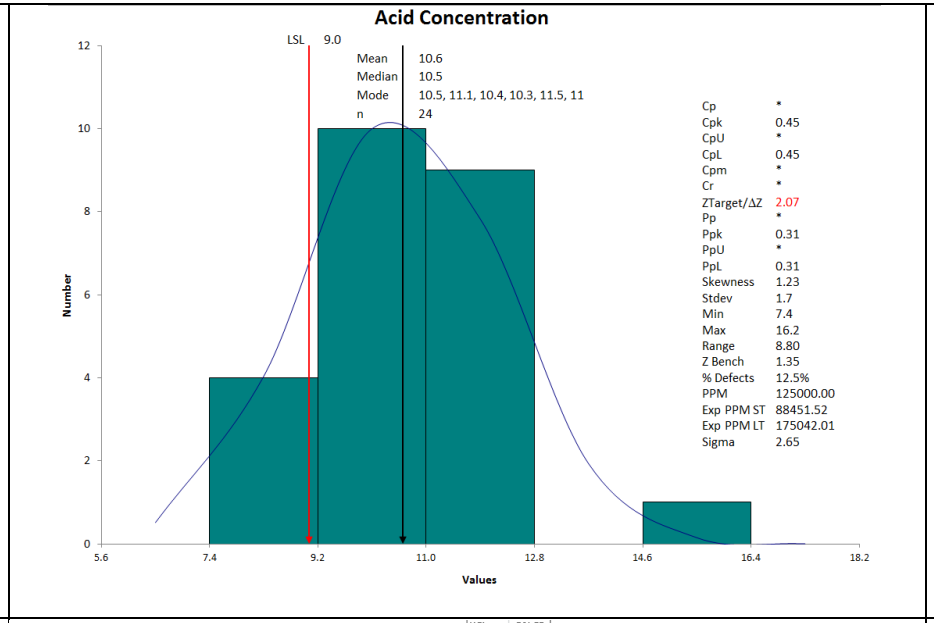
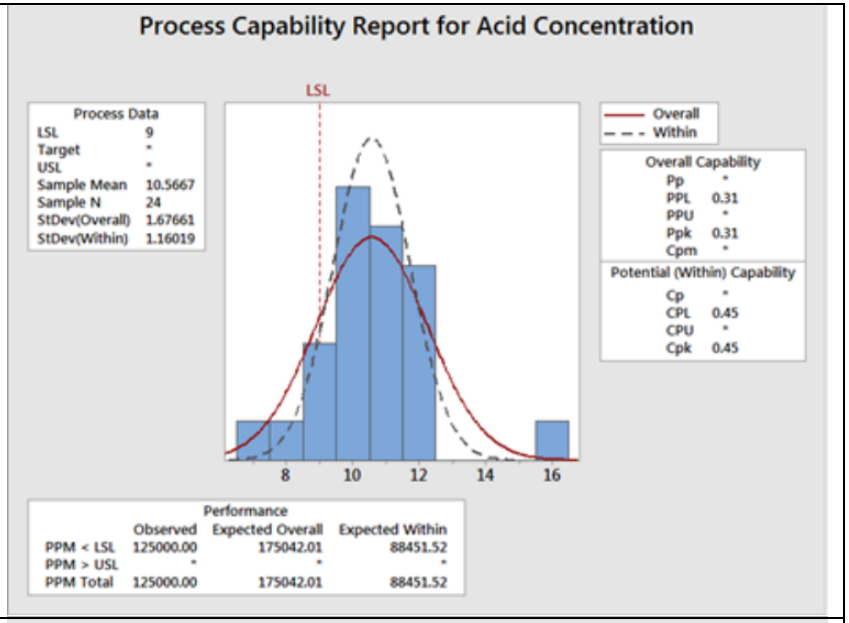
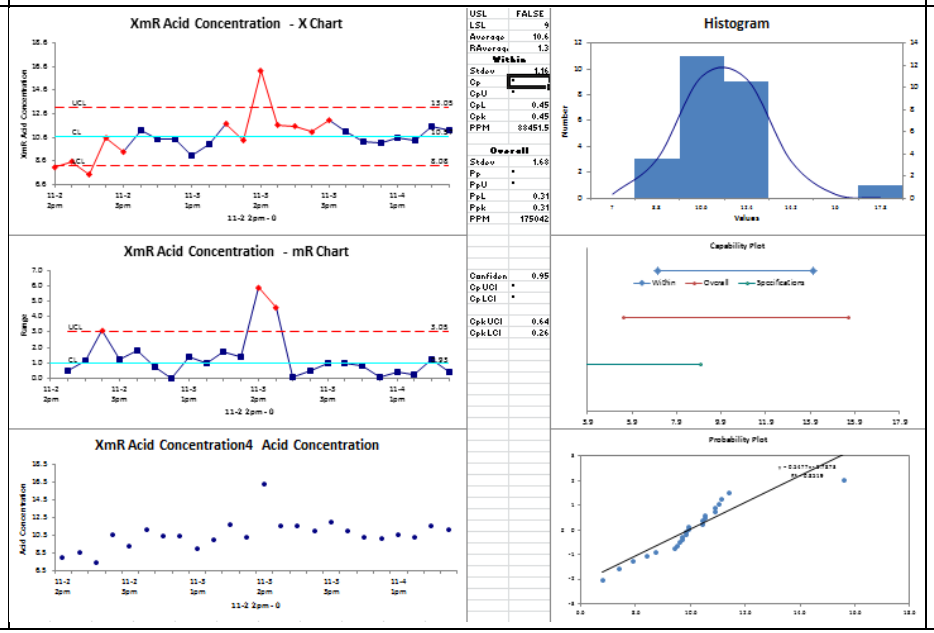
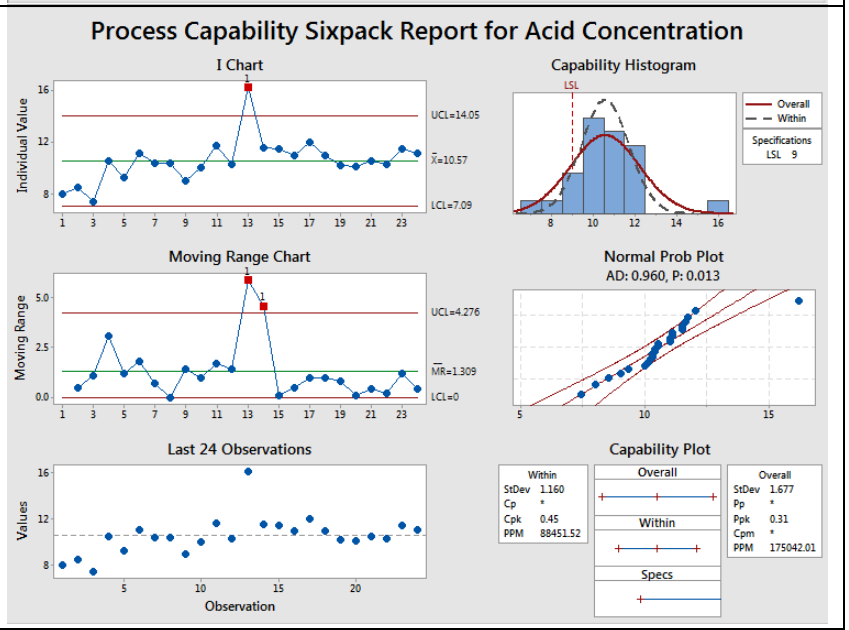
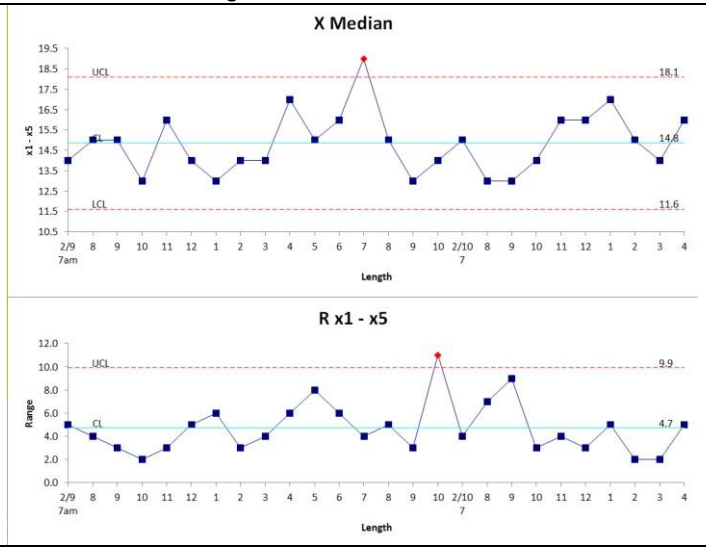
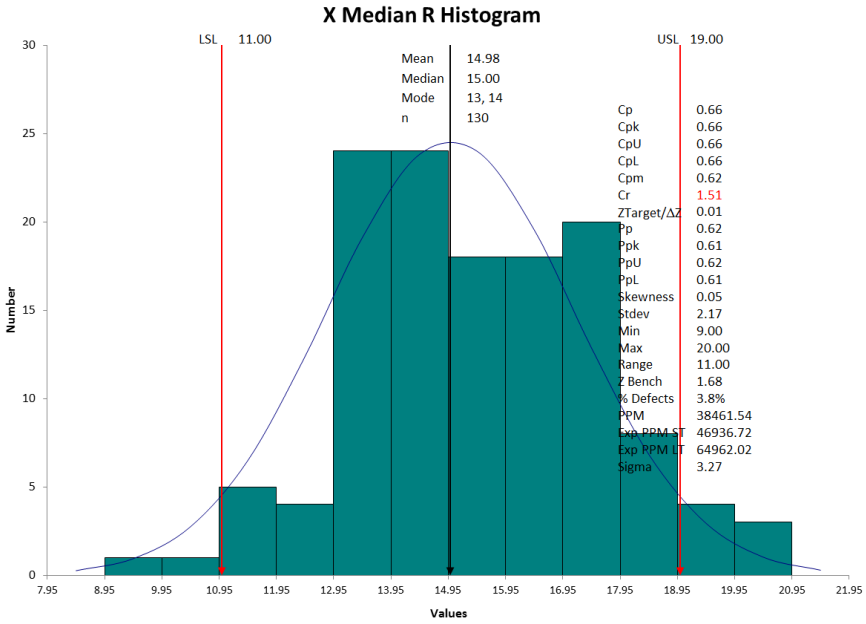
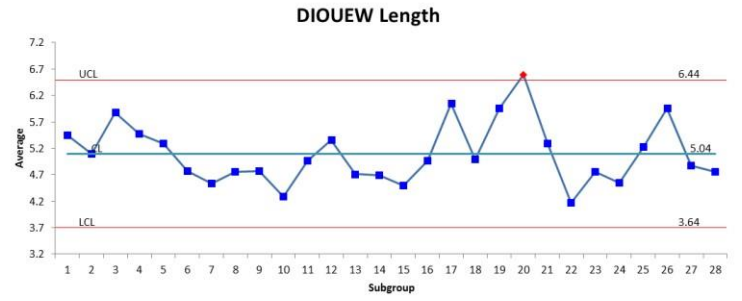
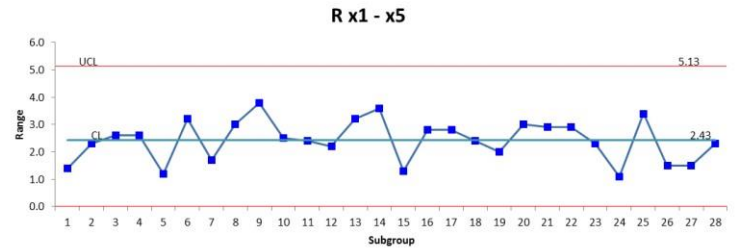
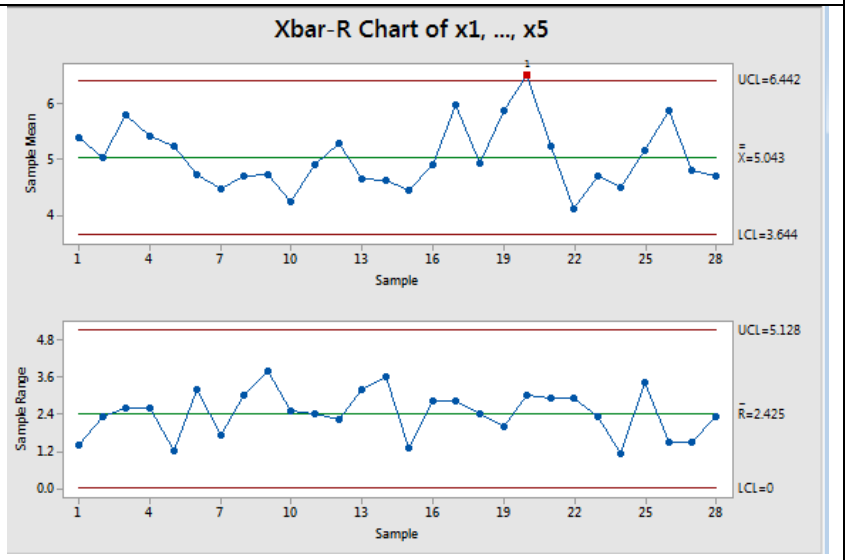
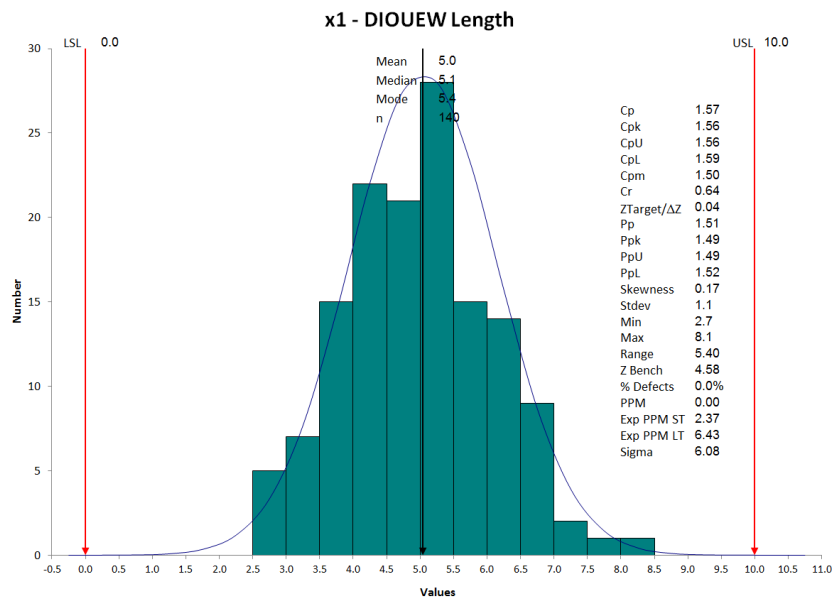
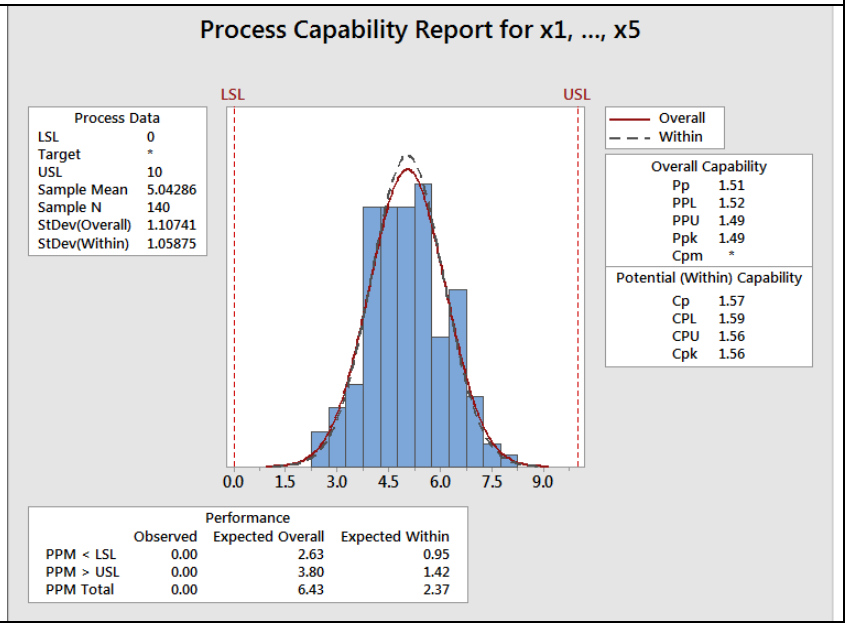
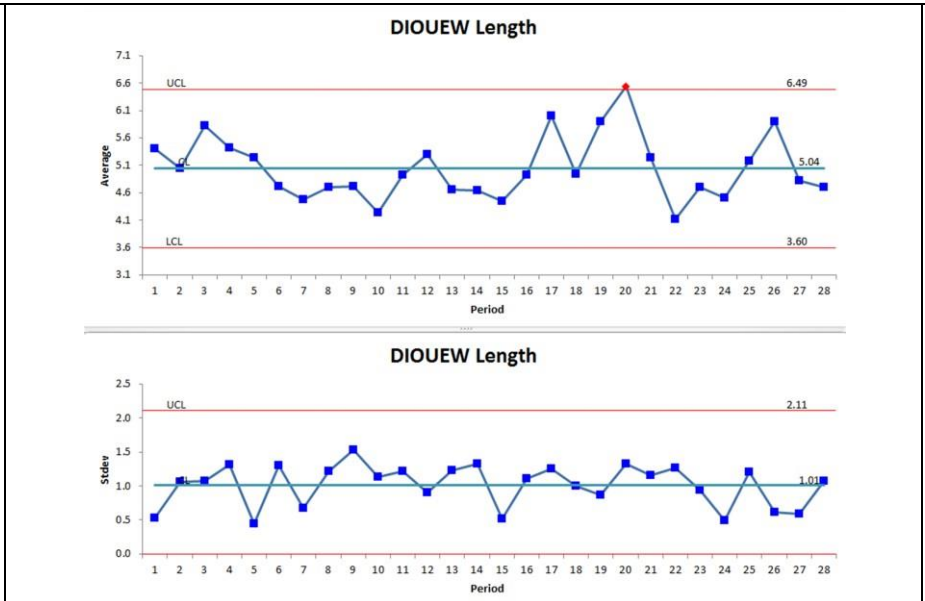
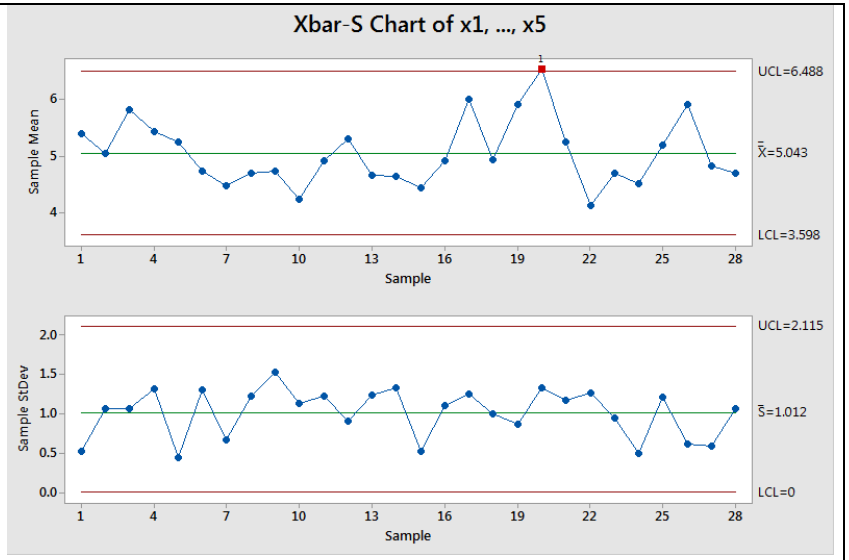
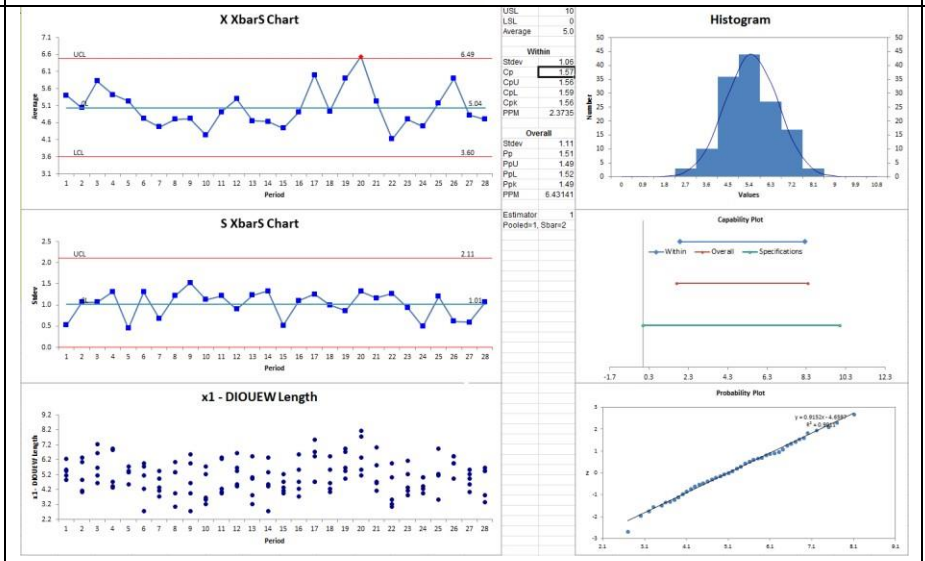
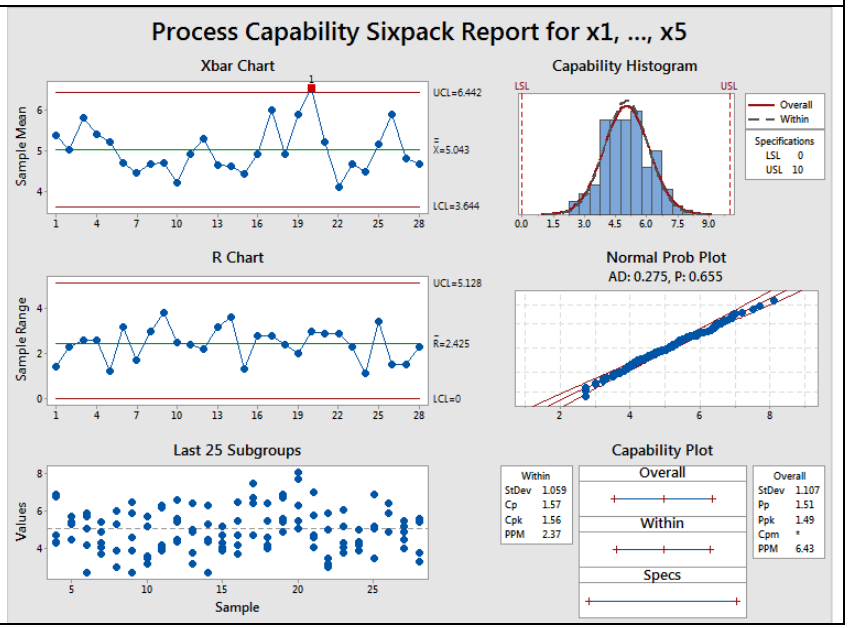
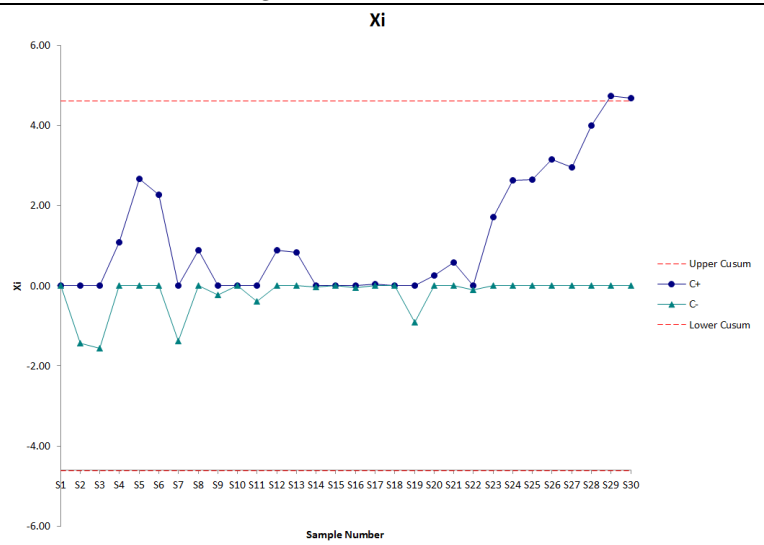
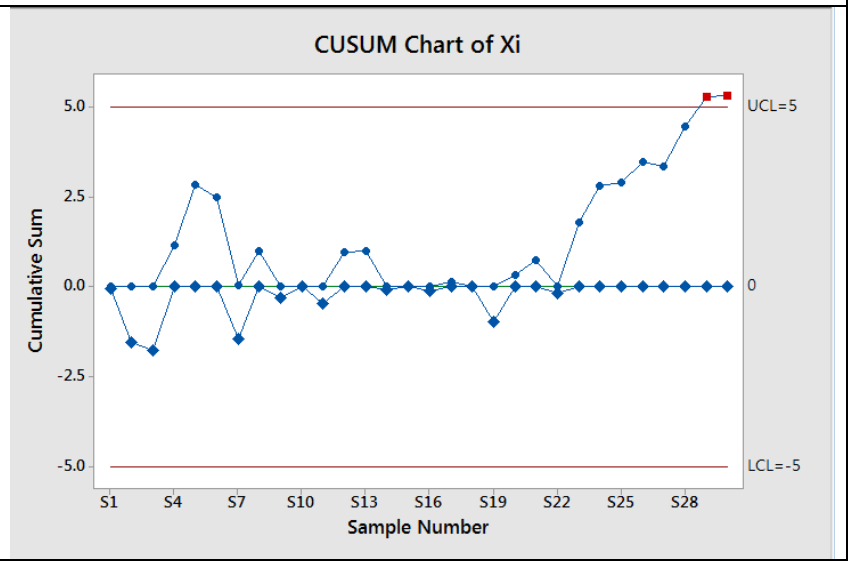
XmR AIAG SPC 2nd Edition page 86	   	

Histogram AIAG SPC 2nd Edition page 86		
Capability Suite AIAG SPC 2nd Edition page 86		

Chart/data	QI Macros for Excel	Minitab
XMedianR AIAG SPC 2nd Edition page 84		Doesn't have an XMedianR
Histogram		

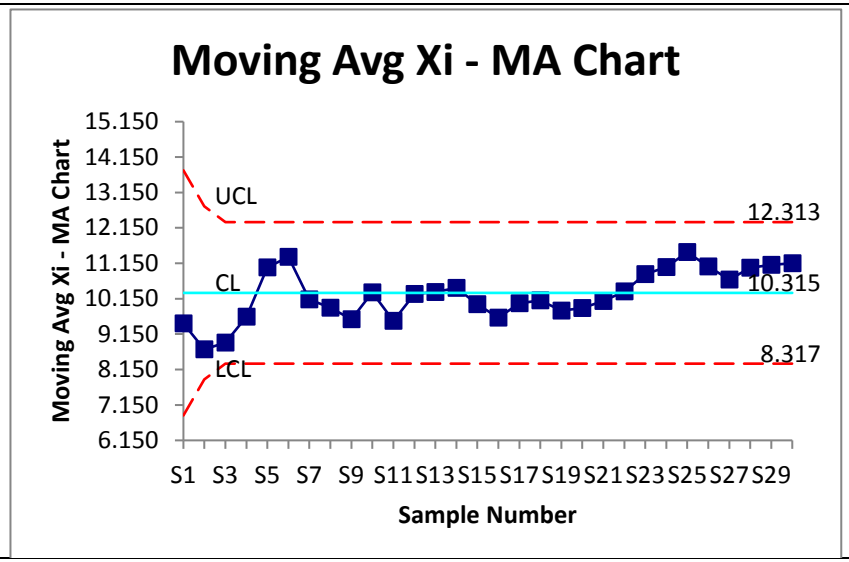
Chart/data	QI Macros for Excel	Minitab
XbarR AIAG SPC 2nd Edition page 78	 	
Histogram		

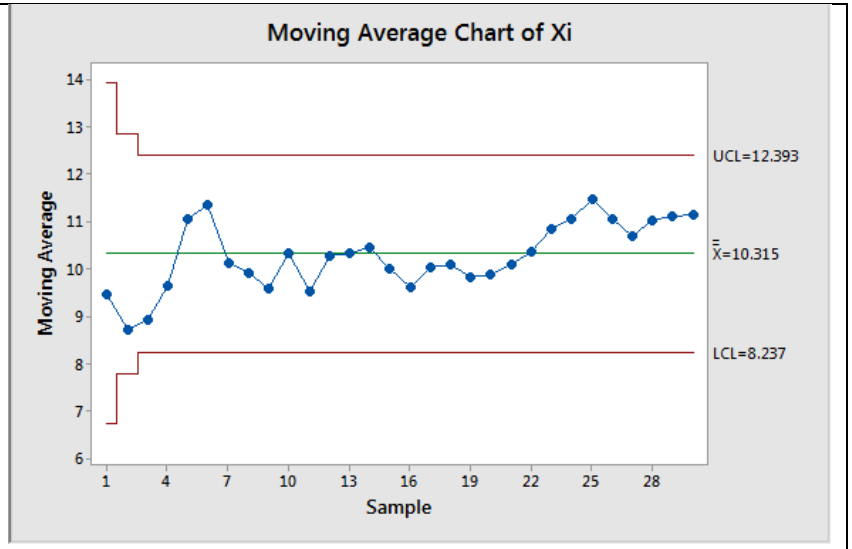
XbarS AIAG SPC 2nd Edition page 78		
Capability Suite AIAG SPC 2nd Edition page 78		

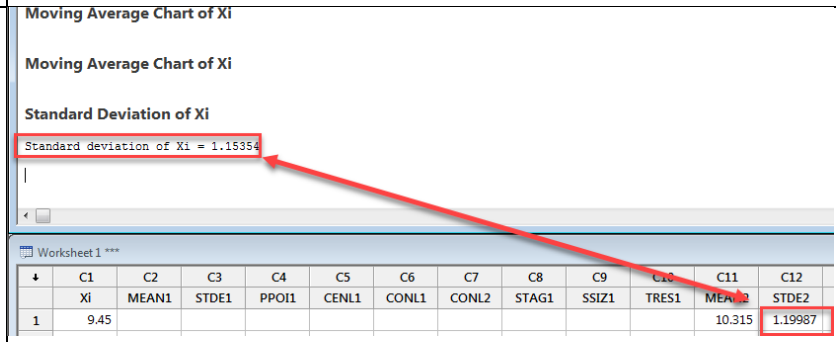
Chart/data	QI Macros for Excel	Minitab
Cusum Montgomery Intro to SPC 5th Edition, page 393		

Moving Average

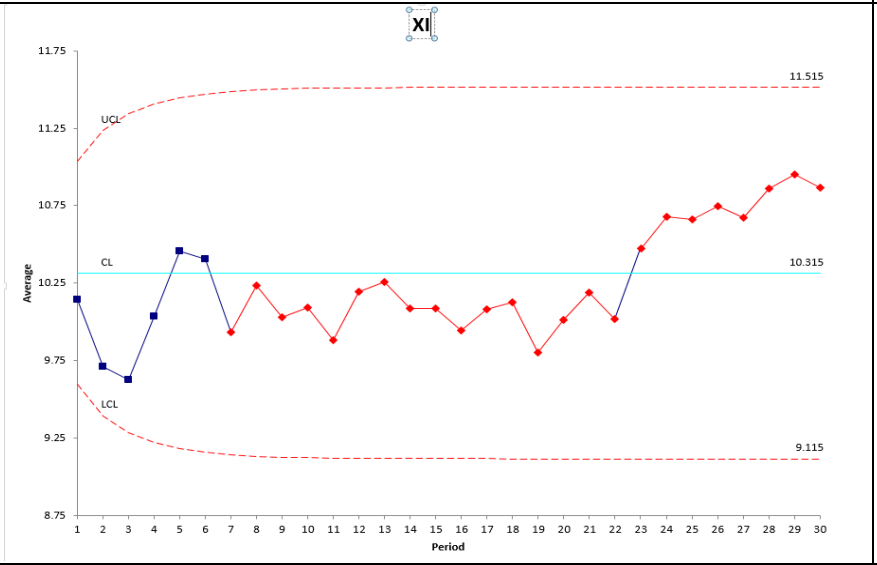
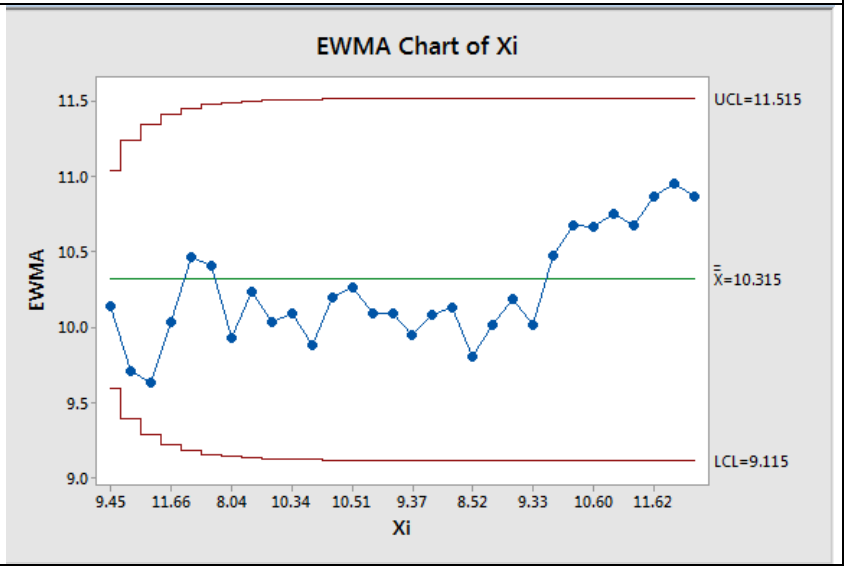
Montgomery
Intro to SPC 4th Edition, page 438-439

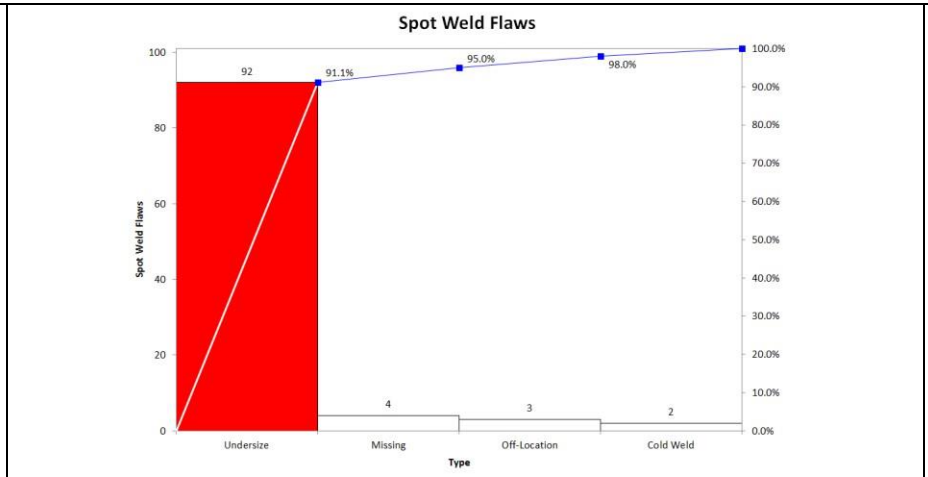
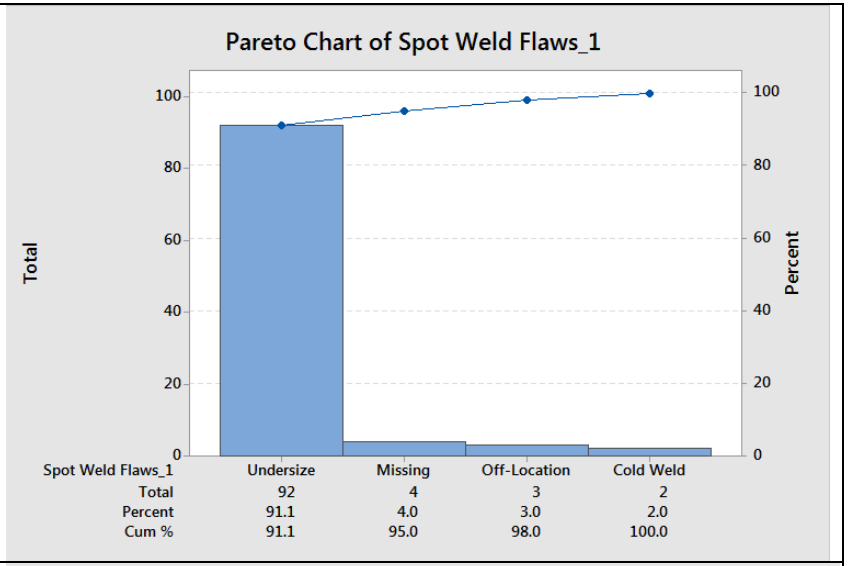
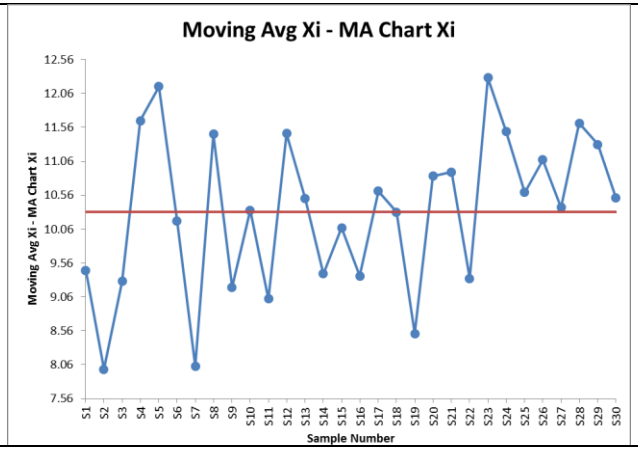
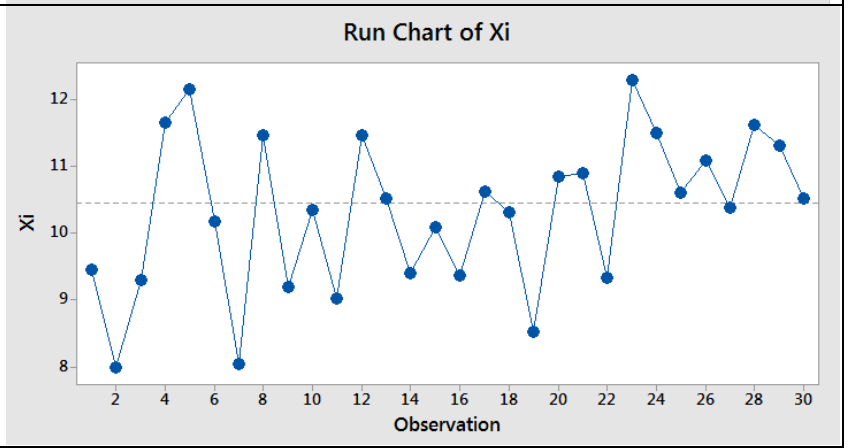


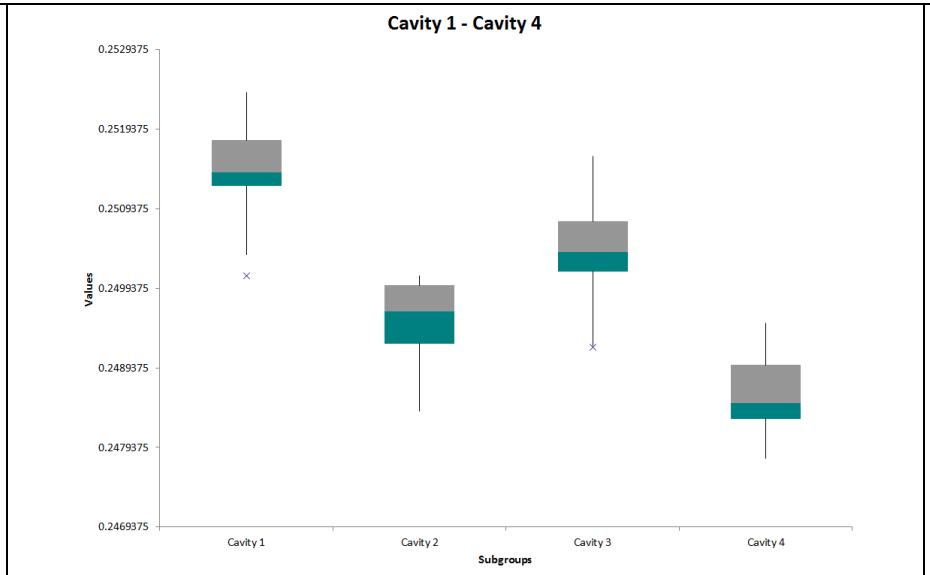
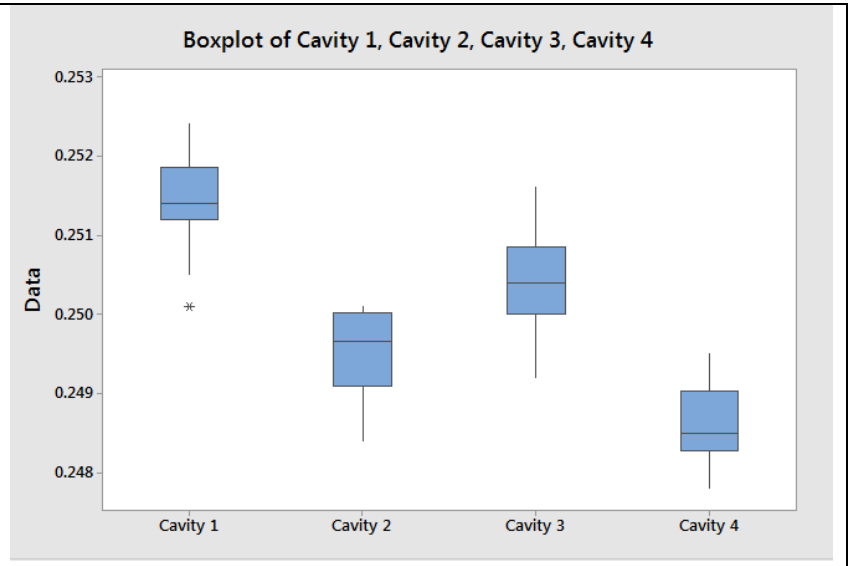
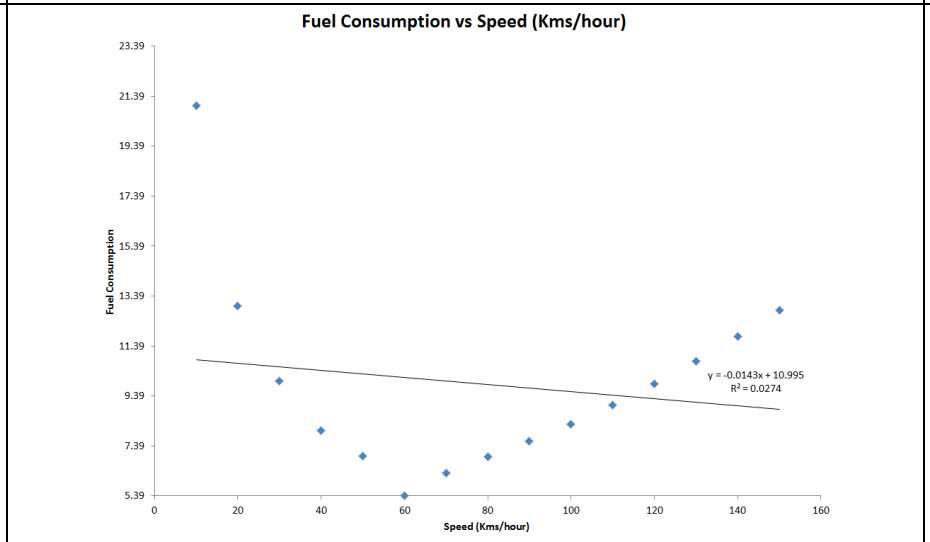
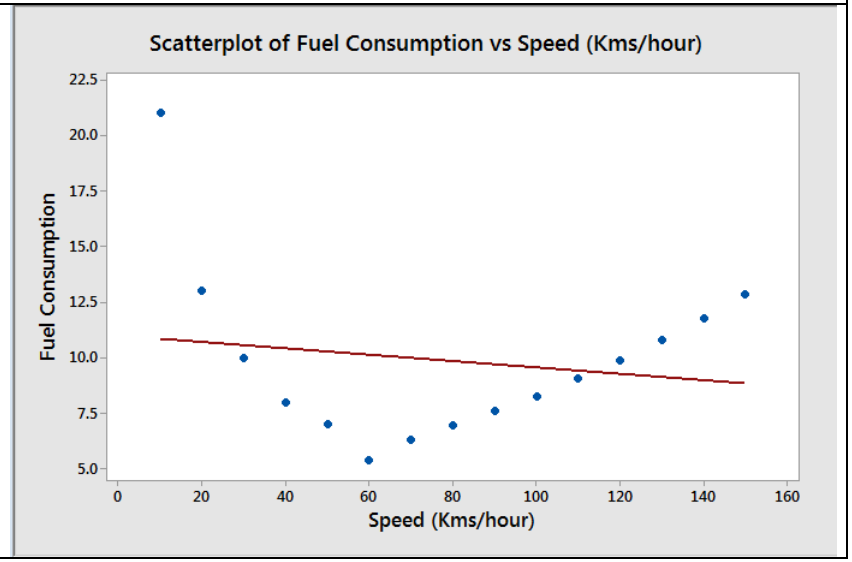




Minitab seems to calculate Stdev differently for MA Chart which results in different control limits.

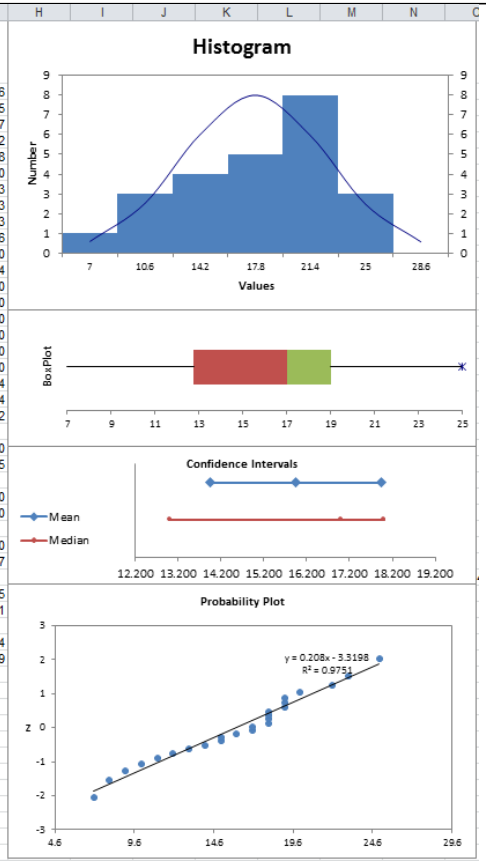
Chart/data	QI Macros for Excel	Minitab
EWMA		

Pareto AIAG Spot Weld Flaws		
Run Chart		

Box and Whisker		
Scatter		

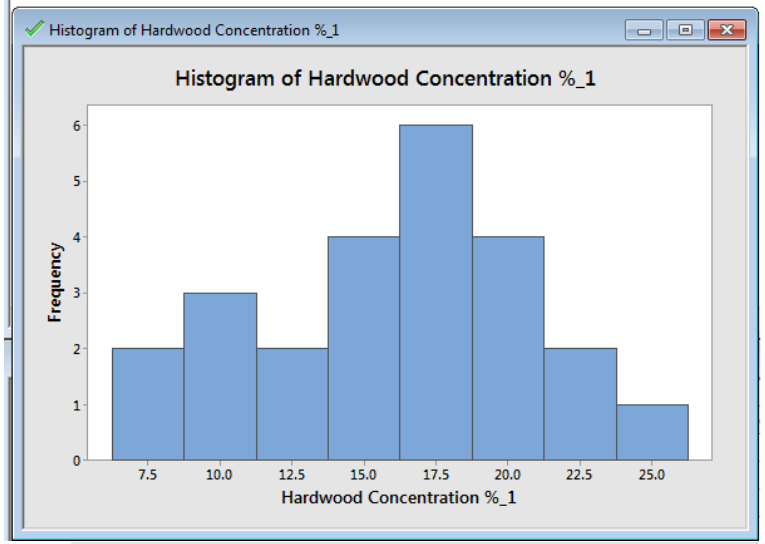
Descriptive Statistics and Normality

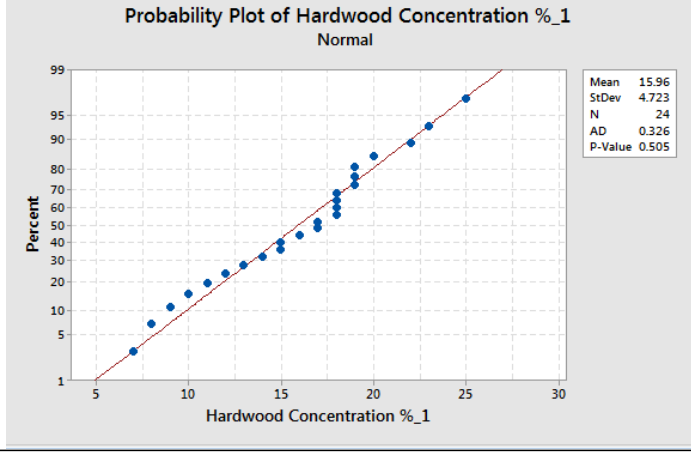
	A	B	C	D	E	F	G
1	Hardwood Concentration %	5%	10%	15%	20%	Anderson-Darling	Data is Normal
2	Obs1	7	12	14	19	A-Squared	0.326
3	Obs2	8	17	18	25	*p*	0.505
4	Obs3	15	13	19	22	95% Critical Value	0.787
5	Obs4	11	18	17	23	99% Critical Value	1.092
6	Obs5	9	19	16	18	Mean	15.958
7	Obs6	10	15	18	20	Mode	18.000
8						Standard Deviation	4.723
9						Variance	22.303
10						Skewedness	-0.223
11						Kurtosis	-0.476
12						n	24.000
13						Std Err	0.964
14						Minimum	7.000
15						1st Quartile	12.750
16						Median	17.000
17						3rd Quartile	19.000
18						Maximum	25.000
19						Range	18.000
20						Confidence Interval	1.994
21						for Mean (Mu)	13.964
22						0.95	17.952
23							
24						For Stdev (sigma)	3.670
25							6.625
26							
27						for Median	13.000
28							18.000
29							
30						k-Factor Two-sided	1.770
31						0.99	30.147
32							
33						k-Factor One-sided	3.305
34							28.611
35							
36						k Two-sided	3.004
37						k One-sided	2.679



Descriptive Statistics: Hardwood Concentration %_1

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Hardwood Concentration %	24	0	15.958	0.964	4.723	7.000	12.250	17.000	19.000	25.000





ANOVA

Anova: Single Factor		α	0.05							
							LSD	3.072423		
SUMMARY							HSD	4.122257		
Groups	*Count*	*Sum*	*Average*	*Variance*			Scheffe	5.797322		
5%	6	60	10	8			Post Hoc	5%	10%	15%
10%	6	94	15.66667	7.866667			10%	5.666667		
15%	6	102	17	3.2			15%	7	1.333333	
20%	6	127	21.16667	6.966667			20%	11.16667	5.5	4.166667
							Colored cells have signficant mean differences			

ANOVA			Reject Null Hypothesis because p < 0.05 (Means are Different)			
Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	382.7917	3	127.5972	19.60521	0.000	3.098391
Within Groups	130.1667	20	6.508333			
Total	512.9583	23				

```
Analysis of Variance

Source  DF  Adj SS   Adj MS  F-Value  P-Value
Factor   3   382.8  127.597    19.61    0.000
Error   20   130.2    6.508
Total   23   513.0


Model Summary

      S    R-sq  R-sq(adj)  R-sq(pred)
2.55114  74.62%     70.82%      63.46%


Means

Factor  N    Mean  StDev       95% CI
5%      6   10.00   2.83  (  7.83,  12.17)
10%     6   15.67   2.80  ( 13.49,  17.84)
15%     6  17.000  1.789  (14.827, 19.173)
20%     6   21.17   2.64  ( 18.99,  23.34)
```

t Test 2-sample Equal Variances

Catalyst 1	Catalyst2	t-Test: Two-Sample Assuming Equal Variances		α	0.05					
91.5	89.19	Equal Sample Sizes								
94.18	90.95		*Catalyst 1*	*Catalyst2*	diff	95% Confidence Interval				
92.18	90.46	Mean	92.255	92.7325	-0.477	-3.374	2.419			
95.39	93.21	Variance	5.688314	8.900993						
91.79	97.19	Observations	8	8						
89.07	97.04	Pooled Variance	7.294654							
94.72	91.07	Hypothesized Mean Difference	0							
89.21	92.75	df	14							
		t Stat	-0.354							
		P(T<=t) one-tail	0.364		Cannot Reject Null Hypothesis because p > 0.05 (Means are the same)					
		T Critical one-tail	1.761							
		P(T<=t) two-tail	0.729		Cannot Reject Null Hypothesis because p > 0.05 (Means are the same)					
		T Critical Two-tail	2.145							

Two-Sample T-Test and CI: Catalyst 1, Catalyst2

```
Two-sample T for Catalyst 1 vs Catalyst2

            N   Mean  StDev  SE Mean
Catalyst 1  8  92.26   2.39     0.84
Catalyst2   8  92.73   2.98      1.1


Difference = μ (Catalyst 1) - μ (Catalyst2)
Estimate for difference:  -0.48
95% CI for difference:  (-3.39, 2.44)
T-Test of difference = 0 (vs ≠): T-Value = -0.35  P-Value = 0.729  DF = 13
```

Appendix
Expected Differences

Stability Analysis
Both QI Macros and Minitab let you define what stability rules you want to use. QI Macros defaults to Montgomery's rules but lets you select from Juran, AIAG, Westgard, Healthcare (IHI) and Western Electric rules. You can also further customize rules in QI Macros. See https://www.qimacros.com/control-chart/stability-analysis-control-chart-rules/ .

Minitab requires you to define the rules you want to use each time you run a chart. QI Macros offer additional tests that Minitab does not. Minitab also treats trends differently than QI Macros. For example, one common set of rules is 6 points in a row increasing or decreasing. Once you have 6 points in a row that meet these criteria, QI Macros will turn all 6 points red. Minitab will not turn any points red until the 7th point and then will only turn the 7th point.

Upper and Lower control limits on u, p, and XbarS charts – since the sample size on these charts vary, the upper and lower control limits vary (from point to point). Minitab displays the UCL and LCL for the last point. QI Macros displays the UCL and LCL for the 3rd to the last point. Note the control limit lines are the same, only the value displayed is different. Also, the center lines are both the same since these do not vary.

Histogram - Standard Deviation calculation
QI Macros uses the standard deviation calculation of Microsoft Excel. Minitab uses a different calculation which returns slightly different results. The standard deviation difference will cause slight differences in the following calculations: **Pp, Ppk, Z score and Expected PPM.**

Histogram Cp, Cpk calculation when subgroup size is 3
The difference in the two calculations is the constant used in the sigma estimator calculation. This effects Cp and Cpk but not Pp and Ppk. See formulas: https://www.qimacros.com/process-capability-analysis/cp-cpk-formula/

Per Juran and Montgomery, QI Macros uses a constant of 1.693 when there are 3 subgroups. It looks like Minitab is using something like 1.093.

Cusum and Moving Average Chart Control Limits
Control limits are slightly different because QI Macros uses standard deviation while Minitab uses sigma estimator.