STATISTICAL PROCESS CONTROL DESIGN OF EXPERIMENTS MEASUREMENT SYSTEMS ANALYSIS ADVANCED STATISTICS EXCEL PRIMER

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STATISTICAL PROCESS CONTROL

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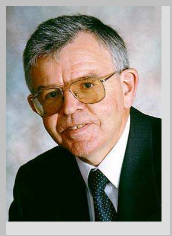
STATISTICAL PROCESS CONTROL



This publication belongs to a series of **Course Reference** booklets that accompany our online courses. This booklet summarizes material covered in our online course in **Statistical Process Control**. For more information please visit www.micquality.com

Glen Netherwood, **MiC Quality**

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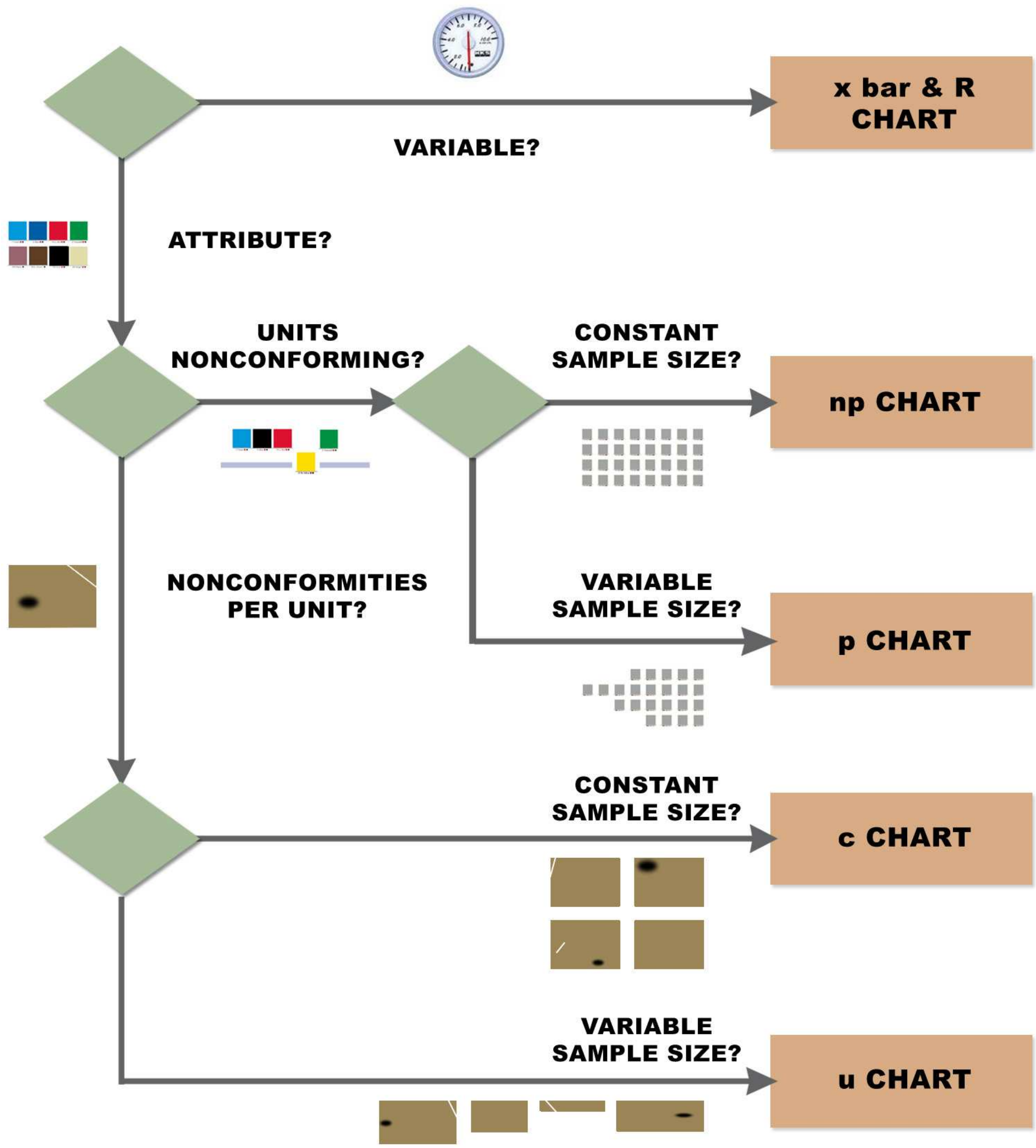
Selecting a Control Chart



Carrying Out A Capability Study

Measurement System

The characteristics to be measured, and the characteristics to be controlled must be defined.

A gage R&R study should have been completed and the measuring equipment calibrated. The precision of the measuring equipment must be sufficient to give at least 7, and preferably 10 measurement steps in the range of process variation.

Gather Data

At least 30 consecutive items, preferably more should be measured. For a short term 'machine capability study' this may be 30 consecutive pieces. A longer term 'process capability study' may be carried out over several days or weeks. Machine capability studies are often required to demonstrate a higher value of Cp as to allow leeway for time-related factors.

Check for Stability

Create trial control limits and plot the study data. Look for points outside the control limits and other patterns that indicate special causes. Check for normality, using a normal probability plot. If necessary fix problems with the process before proceeding.

Check for Process Capability

After all special causes are removed and the process is stable calculate the process capability. If the process capability is not adequate fix problems with the process before proceeding. If that is not practical, proceed temporally with tightened inspection criteria whilst working to fix the process.

Using Control Charts

Introducing Control Charts

When the process has been brought under control and a satisfactory capability study has been completed the process is monitored using control charts. The control limits can be based on the data gathered for the process capability study.

Subgroup Size and Frequency

Large subgroup sizes make it easy to spot small shifts in the process mean. Decide on the magnitude of the mean shift that you want to identify, and then select the subgroup size that gives you a reasonably small probability of a Type II Error for a mean shift of that size. For further information investigate OC Curves.

The frequency of subgroups will depend on the likely speed at which 'special causes' might arise, and the economic loss associated with delays in identifying special causes. This may be every few minutes, hourly, once a shift or some other frequency.

The Average Run Length (ARL) may give some guidance.

Process In Control (average points plotted before a Type I error):

$$\text{ARL} = \frac{1}{\alpha}$$

Process Out of Control (average points plotted before the ‘special cause’ is identified):

$$\text{ARL} = \frac{1}{1-\beta}$$

α and β refer to the Type I and Type II error probabilities.

Rational Subgroups

Subgroups should be chosen so that the opportunities for variation within subgroups are as small as possible, and due only to common cause process variation. This is known as a ‘rational subgroup’. Items in a subgroup may be consecutive items taken from the process. A subgroup should not be taken across a shift change, or any other event that might affect the process.

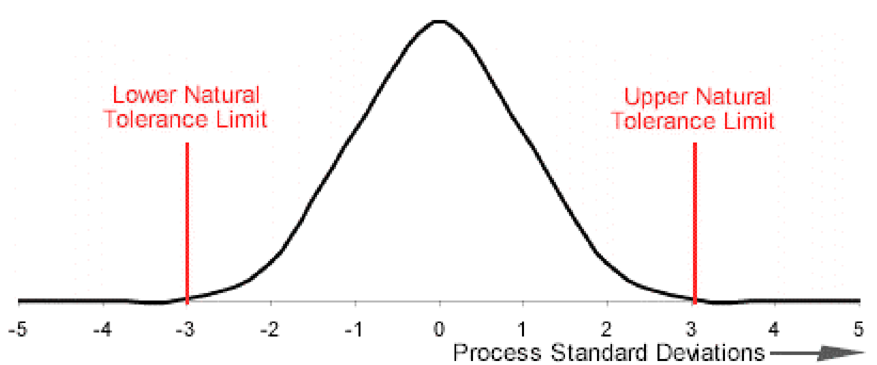
Special care should be taken if the process has several streams, for example a machine with multiple heads. Each subgroup could consist of product from each stream, or a single stream. Results are likely to be different in each case.

Note that under some conditions, for example when there is 100% inspection, the rational subgroup size is one unit. See the MiC Quality Advanced SPC Course for applicable charts.

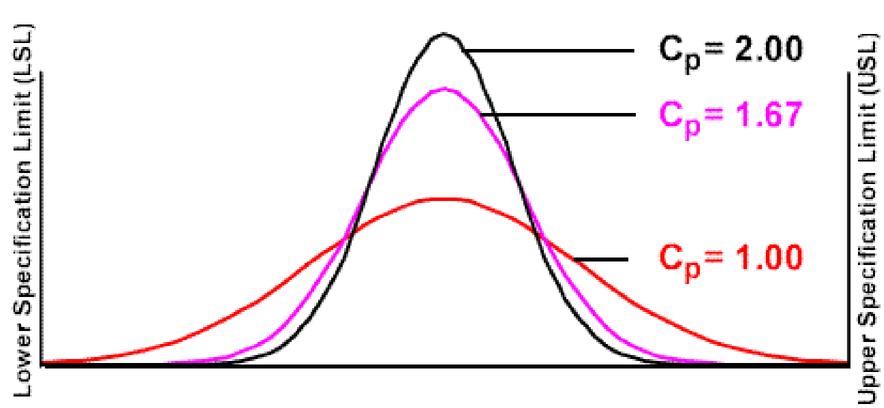
STATISTICAL PROCESS CONTROL

Process Capability

Natural Tolerance Limits

DESCRIPTION	Hypothetical tolerance limits positioned at three standard deviations either side of the process mean
CHART	

Process Capability Cp

CHART	

Process Capability Measures

MEASURE	DESCRIPTION	FORMULA
Process Capability Index Cp	A measure used to predict long-term potential process performance. Often used in supplier accreditation systems e.g. a requirement for: $C_p > 1.67$	$C_p = \frac{USL - LSL}{6\hat{\sigma}_R}$ USL, LSL are the Upper and Lower Specification Limits.
Process Capability Index C_{pk}	A measure used to predict actual process performance.	$C_{pk} = \min\left\{\frac{USL-\mu}{3\hat{\sigma}_R}, \frac{\mu - LSL}{3\hat{\sigma}_R}\right\}$
Process Capability Index CPU (C_{pu})	A variation on C_p used where there is only an upper specification limit (e.g. impurities).	$CPU = \frac{USL-\mu}{3\hat{\sigma}_R}$
Process Capability Index CPL (C_{pl})	A variation on C_p where there is only a lower specification limit (e.g. strength).	$CPL = \frac{\mu - LSL}{3\hat{\sigma}_R}$
Capability Ratio	The reciprocal of C_p	$\frac{6\hat{\sigma}_R}{USL - LSL}$

Note: The process standard deviation $\hat{\sigma}_R$ is estimated using the **range method**

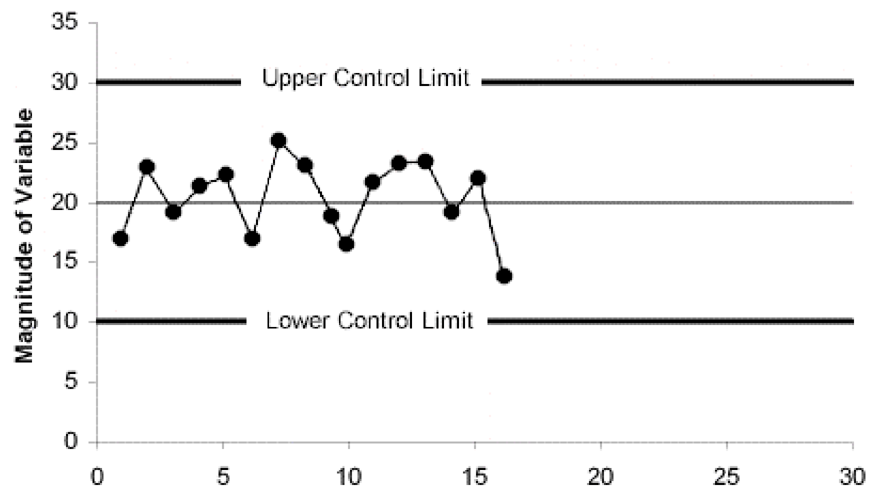
Process Performance Measures

MEASURE	DESCRIPTION	FORMULA
Process Performance Index P_p	Similar to Cp but is affected by long-term shifts in the process mean. Used for **Process Improvement**, not recommended for predicting future performance.	$P_p = \frac{USL - LSL}{6\hat{\sigma}_s}$
Process Performance Index P_{pk}	Similar to Cpk but is affected by long term trends in the process mean.	$P_{pk} = \min\left\{\frac{USL-\mu}{3\hat{\sigma}_S}, \frac{\mu - LSL}{3\hat{\sigma}_S}\right\}$
Performance Ratio	The reciprocal of P_p	$\frac{6\hat{\sigma}_s}{USL - LSL}$

Note: The process standard deviation $\hat{\sigma}_S$ is estimated using the **RMSE** (**Root Mean Square Error**) method.

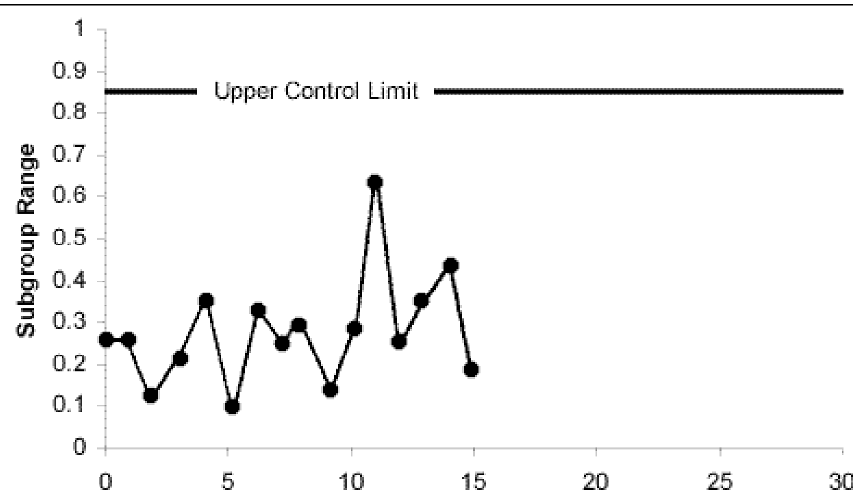
Control Charts For Variables

CONTROL CHARTS FOR THE MEAN

CHART TYPE	**Control Charts for the Mean**
CONTROL LIMITS	$LCL_{\bar{X}} = \bar{\bar{X}} - A_2\bar{R}$ $UCL_{\bar{X}} = \bar{\bar{X}} + A_2\bar{R}$
EXAMPLE	

Note: the values of A_2 are tabulated in **Appendix 3**

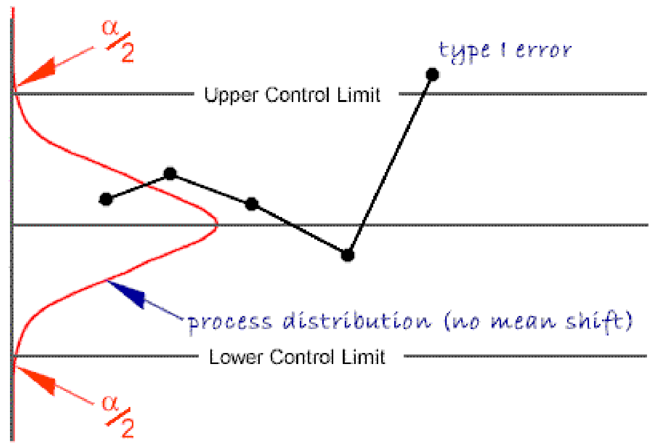
CONTROL CHARTS FOR THE RANGE

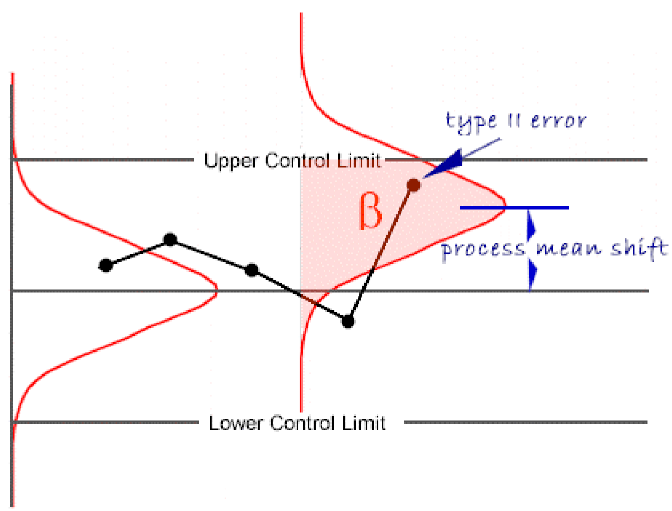
CHART TYPE	**Control Charts for the Range**
CONTROL LIMITS	$LCL_{\bar{X}} = D_3\bar{R}$ $UCL_R = D_4\bar{R}$
EXAMPLE	

Note: the values of D_3 and D_4 are tabulated in **Appendix 3**

TYPE I AND TYPE II ERRORS

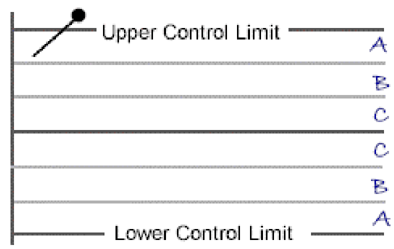
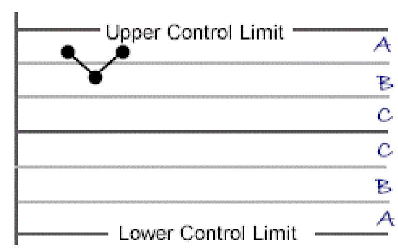
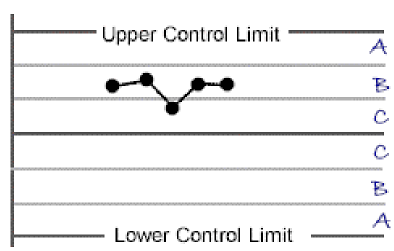
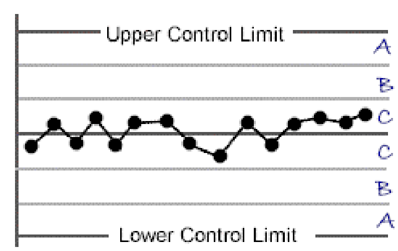
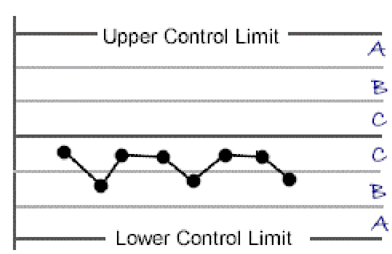
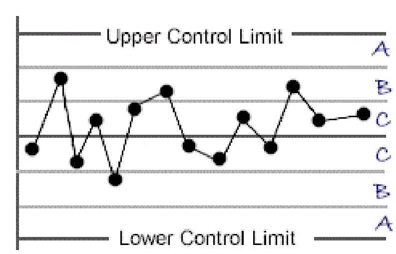
In **Hypothesis Testing** we distinguish between two types of error:

ERROR TYPE	**Type I Error**
DESCRIPTION	The statistical analysis leads us to believe, incorrectly that the process has changed when it has not e.g. a point outside the control limits.
EXAMPLE	The probability of a Type I error is represented by α 

ERROR TYPE	**Type II Error**
DESCRIPTION	The process has changed although this is not evident from the position of the points on the control chart.
EXAMPLE	The probability of a Type II error is represented by β 

PATTERNS INDICATING A SPECIAL CAUSE

Various patterns are used to indicate that a process is out of control. Different authorities suggest different patterns. One widely used classification is the **Western Electric Rules**:

RULE NUMBER	**Rule 1**	**Rule 2**
DESCRIPTION	A single point falls outside the control limits	Two out of three successive points lie in zone 'A' on one side of the mean
EXAMPLE		
RULE NUMBER	**Rule 3**	**Rule 4**
DESCRIPTION	Four out of five successive points fall in or beyond zone 'B' on one side of the mean,	Fifteen points in a row fall in zone 'C' on either side of the mean:
EXAMPLE		
RULE NUMBER	**Rule 5**	**Distribution**
DESCRIPTION	Eight points is a row fall on one side of the mean:	Roughly two-thirds of points in zones 'C' combined. About one point in 40 in zones 'A' combined
EXAMPLE		

Note:
Not all of these rules should be used, or the probability of a Type II error becomes excessive. Select rules that are likely to identify the type of problems that are likely to occur with the process concerned. Other rules e.g. cyclical patterns may also be worth considering.

Control Charts For Attributes

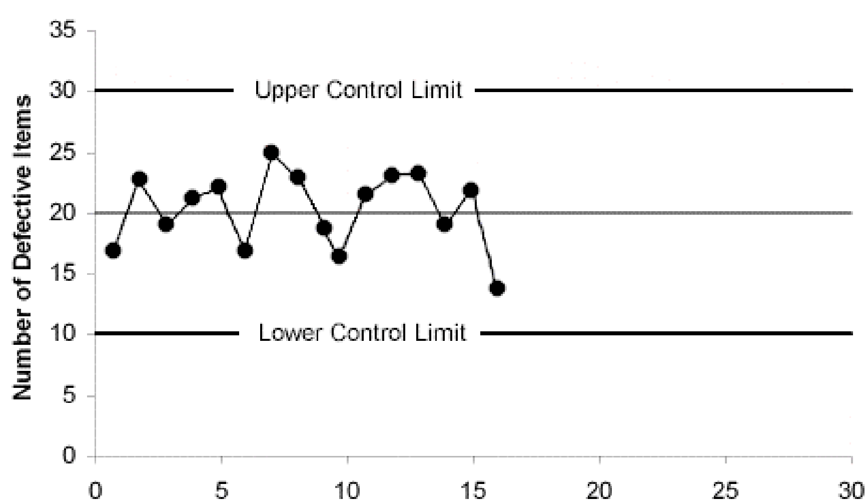
CHART TYPE	np Charts
USAGE	These control charts are used when: • the subgroup size is constant • units nonconforming are being monitored
CONTROL LIMITS	$LCL_{np} = n\bar{p} - 3\sqrt{n\bar{p}(1-\bar{p})}$ $UCL_{np} = n\bar{p} + 3\sqrt{n\bar{p}(1-\bar{p})}$ $\bar{p}$: the estimated proportion of defects in the population n : the subgroup size $\bar{p} = \frac{\text{total number of defective items}}{\text{total number inspected}}$
EXAMPLE	

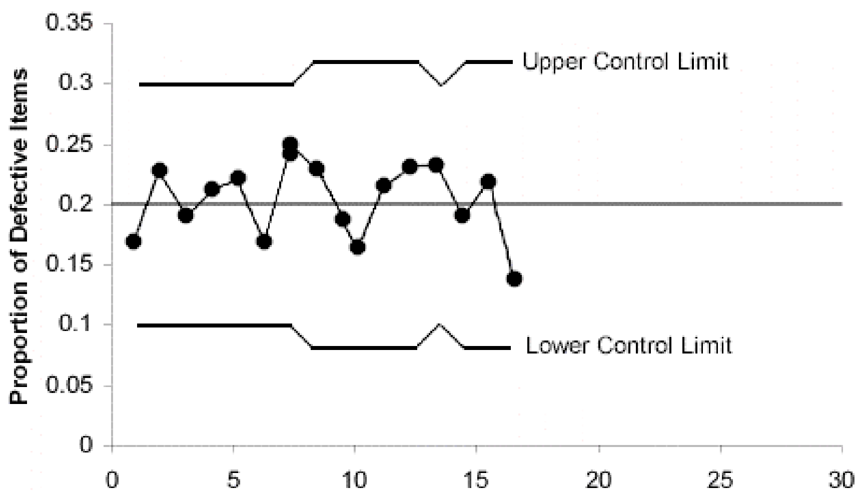
CHART TYPE	**p Charts**
USAGE	These control charts are used when: • the subgroup size varies • units nonconforming are being monitored
CONTROL LIMITS	$LCL_p = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$ $UCL_p = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$ $\bar{p}$: the estimated proportion of defects in the population n : the subgroup size $\bar{p} = \frac{\text{total number of defective items}}{\text{total number inspected}}$ **Note** that the control limits are 'dynamic'. They depend on the subgroup size (the larger the subgroup the narrower the control limits).
EXAMPLE	

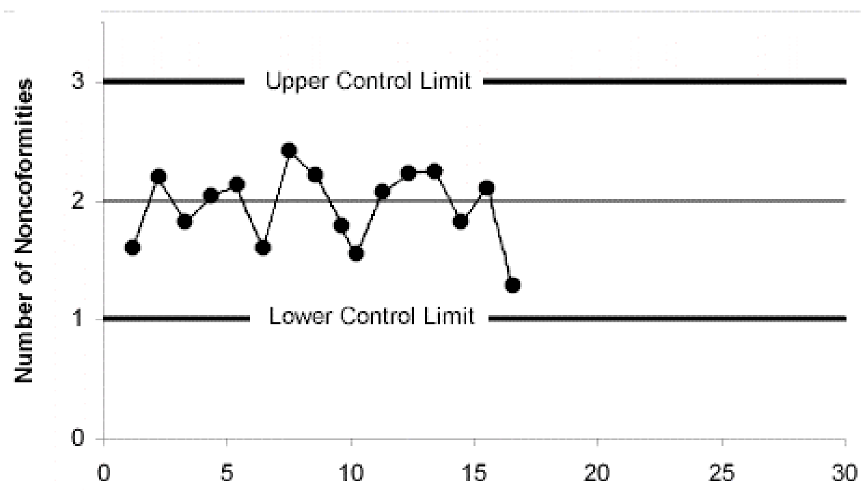
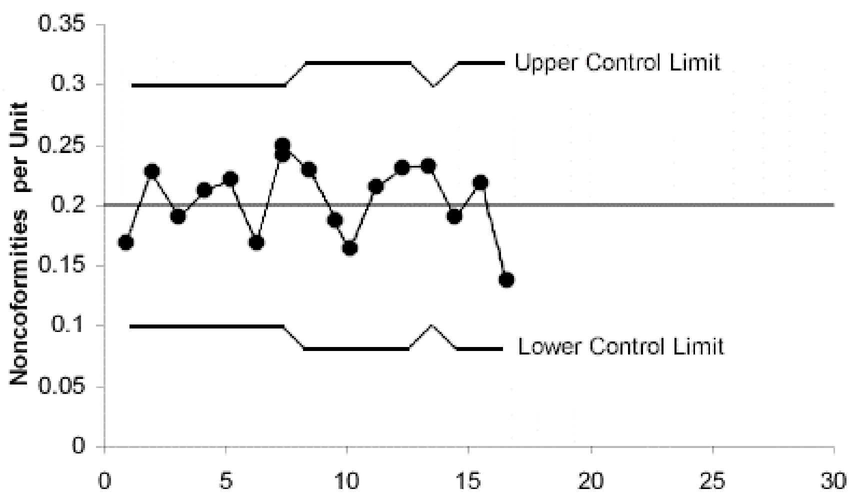
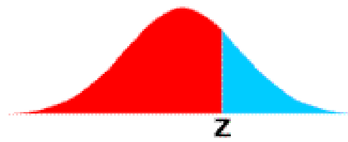
CHART TYPE	c Charts
USAGE	These control charts are used when: • the number of units in the sample is constant • nonconformities per unit are being monitored.
CONTROL LIMITS	$LCL_c = \bar{c} - 3\sqrt{\bar{c}}$ $UCL_c = \bar{c} + 3\sqrt{\bar{c}}$
EXAMPLE	

CHART TYPE	**u Charts**
USAGE	These control charts are used when: • the number of units in the sample varies • nonconformities per unit are being monitored
CONTROL LIMITS	$LCL_u = \bar{u} - 3\sqrt{\frac{\bar{u}}{n}}$ $UCL_u = \bar{u} + 3\sqrt{\frac{\bar{u}}{n}}$
EXAMPLE	

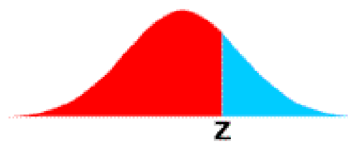
APPENDICES

APPENDIX 1:
NORMAL DISTRIBUTION TABLES



Z	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
-3.40	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
-3.30	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
-3.20	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
-3.10	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
-3.00	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
-2.90	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
-2.80	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
-2.70	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
-2.60	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
-2.50	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
-2.40	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
-2.30	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
-2.20	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
-2.10	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
-2.00	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
-1.90	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
-1.80	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
-1.70	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
-1.60	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
-1.50	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
-1.40	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
-1.30	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
-1.20	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
-1.10	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
-1.00	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
-0.90	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
-0.80	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
-0.70	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
-0.60	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
-0.50	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
-0.40	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
-0.30	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
-0.20	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
-0.10	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
0.00	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641

Appendix 1:
Normal Distribution Tables continued



	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.00	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.10	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.20	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.30	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.40	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.50	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.60	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.70	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.80	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.90	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.00	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.10	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.20	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.30	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.40	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.50	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.60	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.70	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.80	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.90	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.00	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.10	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.20	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.30	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.40	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.50	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.60	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.70	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.80	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.90	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.00	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.10	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.20	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.30	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.40	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

Appendix 2: Values of d_2 and d_2^*

	Size of Sample (n)													
# Samples (k)	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	1.414	1.912	2.239	2.481	2.673	2.830	2.963	3.078	3.179	3.269	3.350	3.424	3.491	3.553
2	1.2879	1.805	2.151	2.405	2.604	2.768	2.906	3.025	3.129	3.221	3.305	3.380	3.449	3.513
3	1.231	1.769	2.120	2.379	2.581	2.747	2.886	3.006	3.112	3.205	3.289	3.366	3.435	3.499
4	1.206	1.750	2.105	2.366	2.570	2.736	2.877	2.997	3.103	3.197	3.282	3.358	3.428	3.492
5	1.191	1.739	2.096	2.358	2.563	2.730	2.871	2.992	3.098	3.192	3.277	3.354	3.424	3.488
6	1.181	1.731	2.090	2.353	2.558	2.726	2.867	2.988	3.095	3.189	3.274	3.351	3.421	3.486
7	1.173	1.726	2.085	2.349	2.555	2.723	2.864	2.986	3.092	3.187	3.272	3.349	3.419	3.484
8	1.168	1.721	2.082	2.346	2.552	2.720	2.862	2.984	3.090	3.185	3.270	3.347	3.417	3.482
9	1.164	1.718	2.080	2.344	2.550	2.719	2.860	2.982	3.089	3.184	3.269	3.346	3.416	3.481
10	1.160	1.716	2.077	2.342	2.549	2.717	2.859	2.981	3.088	3.183	3.268	3.345	3.415	3.480
11	1.157	1.714	2.076	2.340	2.547	2.716	2.858	2.980	3.087	3.182	3.267	3.344	3.415	3.479
12	1.155	1.712	2.074	2.3439	2.546	2.715	2.857	2.979	3.086	3.181	3.266	3.343	3.414	3.479
13	1.153	1.710	2.073	2.338	2.545	2.714	2.856	2.978	3.085	3.180	3.266	3.343	3.413	3.478
14	1.151	1.709	2.072	2.337	2.545	2.714	2.856	2.978	3.085	3.180	3.265	3.342	3.413	3.478
15	1.150	1.708	2.071	2.337	2.544	2.713	2.855	2.977	3.084	3.179	3.265	3.342	3.412	3.477
d_2	**1.128**	**1.693**	**2.059**	**2.326**	**2.534**	**2.704**	**2.847**	**2.970**	**3.078**	**3.173**	**3.259**	**3.336**	**3.407**	**3.472**

Duncan A. J (1986), Quality Control and Industrial Statistics Appendix D3

Appendix 3: Standard Factors for Control Charts

Observations in Sample (n)	A	A_2	D_1	D_2	D_3	D_4	A_3	B_3	B_4	d_2	c_4
2	2.121	1.880	0	3.686	0	3.267	2.659	0	3.267	1.128	0.7979
3	1.732	1.023	0	4.358	0	2.574	1.954	0	2.568	1.693	0.8862
4	1.500	0.729	0	4.698	0	2.282	1.628	0	2.266	2.059	0.9213
5	1.342	0.577	0	4.918	0	2.114	1.427	0	2.089	2.326	0.9400
6	1.225	0.483	0	5.078	0	2.004	1.287	0.030	1.970	2.534	0.9515
7	1.134	0.419	0.204	5.204	0.076	1.924	1.182	0.118	1.882	2.704	0.9594
8	1.061	0.373	0.388	5.306	0.136	1.864	1.099	0.185	1.815	2.847	0.9650
9	1.000	0.337	0.547	5.393	0.184	1.816	1.032	0.239	1.761	2.970	0.9693
10	0.949	0.308	0.687	5.469	0.223	1.777	0.975	0.284	1.716	3.078	0.9727
11	0.905	0.285	0.811	5.535	0.256	1.744	0.927	0.321	1.679	3.173	0.9754
12	0.866	0.266	0.922	5.594	0.283	1.717	0.886	0.354	1.646	3.258	0.9776
13	0.832	0.249	1.025	5.647	0.307	1.693	0.850	0.382	1.618	3.336	0.9794
14	0.802	0.235	1.118	5.696	0.328	1.672	0.817	0.406	1.594	3.407	0.9810
15	0.775	0.223	1.203	5.741	0.347	1.653	0.789	0.428	1.572	3.472	0.9823
16	0.750	0.212	1.282	5.782	0.363	1.637	0.763	0.448	1.552	3.532	0.9835
17	0.728	0.203	1.356	5.820	0.378	1.622	0.739	0.466	1.534	3.588	0.9845
18	0.0707	0.194	1.424	5.856	0.391	1.608	0.718	0.482	1.518	3.640	0.9854
19	0.688	0.187	1.487	5.891	0.403	1.597	0.698	0.497	1.503	3.689	0.9862
20	0.671	0.180	1.549	5.921	0.415	1.585	0.680	0.510	1.490	3.735	0.9869
21	0.655	0.173	1.605	5.951	0.425	1.575	0.663	0.523	1.477	3.778	0.9876
22	0.640	0.167	1.659	5.979	0.434	1.566	0.647	0.534	1.466	3.819	0.9882
23	0.626	0.162	1.710	6.006	0.443	1.557	0.633	0.545	1.455	3.858	0.9887
24	0.612	0.157	1.759	6.031	0.451	1.548	0.619	0.555	1.445	3.895	0.9892
25	0.600	0.153	1.806	6.056	0.459	1.541	0.606	0.565	1.435	3.931	0.9896

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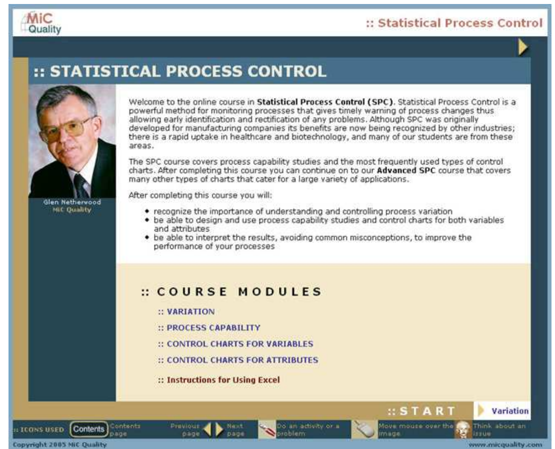
(see previous page for more information)



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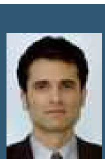

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