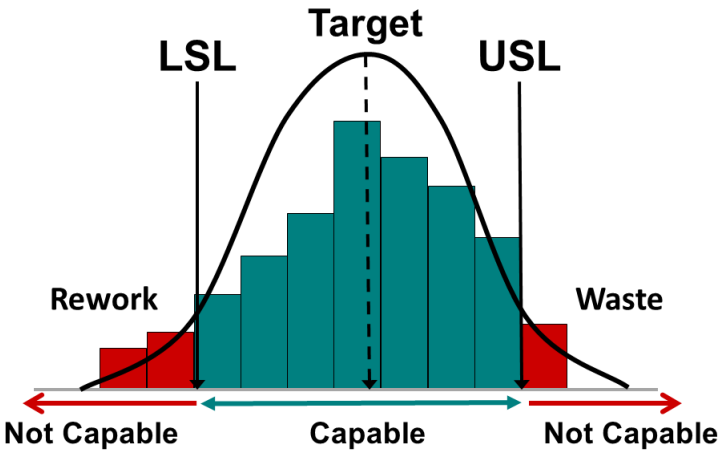
Histogram - Process Capability Analysis Cheat Sheet

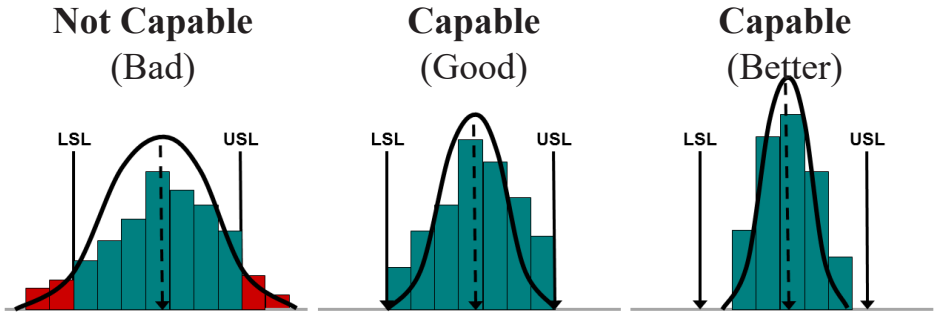
Key Concepts

- ◊ Histograms show the spread or dispersion of variable (measured) data.
- ◊ Upper and lower specification limits (USL/LSL) define customer requirements.
- ◊ Think of specification limits like goal posts on a football field.
- ◊ Data points within the spec limits meet customer requirements.
- ◊ Data points outside of the spec limits do NOT meet customer requirements.
- ◊ Process capability metrics Cp and Cpk measure how well a process fits within the specification limits.
- ◊ Cp Cpk should be calculated on data listed in the order measurements were taken. **Warning:** Do not sort your data before calculating Cp Cpk.
- ◊ A process has to be stable before it can be tested for capability.

Histogram Example

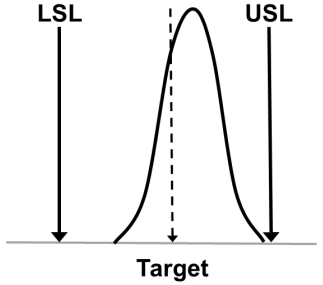


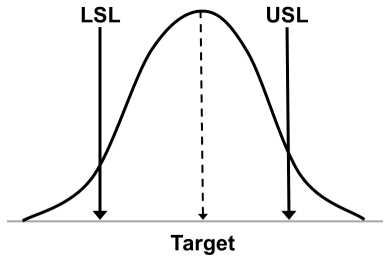
Process Capability Examples



Process Capability Metrics

Cp - Capability Index	Cpk - Capability Centering Index
Measure of how well the data fits between the LSL and USL.	Measure of how well the data is centered between the LSL and USL.
Fits, but not centered Cp ≥ 1 and Cpk ≤ Cp	Centered, but does not fit Cp ≤ 1 and Cpk ≤ 1





Cp Cpk vs Pp Ppk

Cp Cpk - Capability Indices	Pp Ppk - Performance Indices
Use with a sample when testing the capability of a process.	Use with the total population when testing the performance of a process.
Cp Cpk use sigma estimator.	Pp Ppk use standard deviation.
$\overline{R}/d_2$ $\overline{S}/c_4$ Pooled SD	

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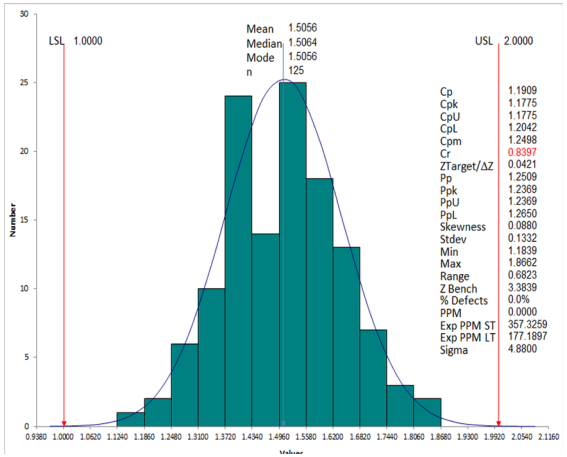
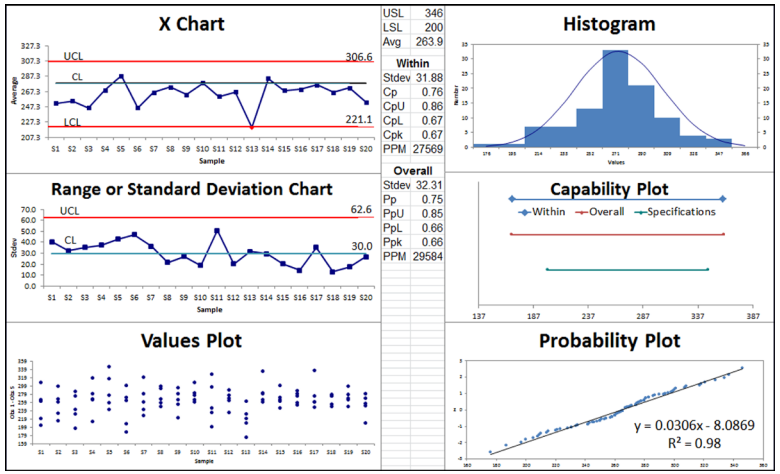
Examples of Tools included in QI Macros for Excel

Histogram with Cp Cpk



Histograms: normal data
Histogram Weibull: non-normal data
Frequency Histograms

Capability Suite of Six Charts



X chart
Range chart
Values plot

Histogram
Capability plot
Probability plot

Cp Cpk Template

Characteristic	S 1	S2	S3	S4	S5
Target	1.500	1.500	1.500	1.500	1.500
+ Tol	0.250	0.250	0.250	0.250	0.250
- Tol	0.250	0.250	0.250	0.250	0.250
USL	1.750	1.750	1.750	1.750	1.750
LSL	1.250	1.250	1.250	1.250	1.250
AVE	1.488	1.487	1.524	1.466	1.564
MAX	1.711	1.767	1.837	1.646	1.866
MIN	1.286	1.274	1.236	1.184	1.193
USL-LSL	0.500	0.500	0.500	0.500	0.500
σ	0.111	0.137	0.137	0.122	0.145
σest	0.099	0.131	0.132	0.114	0.152
Cp	0.840	0.634	0.630	0.728	0.548
Cpk	0.798	0.601	0.570	0.629	0.409
CpU	0.881	0.667	0.570	0.827	0.409
CpL	0.798	0.601	0.689	0.629	0.688
Cr	1.191	1.577	1.588	1.374	1.823
ΔZ	0.112	0.095	0.173	0.279	0.440
Cpm	0.748	0.607	0.600	0.659	0.526
Pp	0.753	0.609	0.609	0.684	0.575
Ppk	0.716	0.578	0.551	0.591	0.429
PpU	0.791	0.641	0.551	0.777	0.429
PpL	0.716	0.578	0.666	0.591	0.722
Sample #	S 1	S2	S3	S4	S5
1	1.324	1.413	1.674	1.457	1.691
2	1.431	1.359	1.608	1.467	1.611
3	1.428	1.487	1.493	1.432	1.567

Up to 35 characteristics with 100 data pts.
Cp Cpk True Position
MMC Cpk True Position

Advantages of Using QI Macros Histogram Maker

- Just select your data and the tool you want from the QI Macros menu.
- QI Macros does all of the calculations and draws the charts for you.
- Easily change spec limits to determine impact on Cp Cpk.
- Easily change bin/bar width and number of bars.
- Calculates unilateral or one-sided spec limits.
- Works with PC and Mac. Excel 2013-2021 and Office 365.
- Reduce risk of manual calculations.
- Saves Time!

Cp Cpk to Sigma Estimator

Cp Cpk	Equivalent to
1.00	3 Sigma
1.33	4 Sigma
1.67	5 Sigma
2.00	6 Sigma

QIMacros®
rev 2-2022

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