
PROCESS CAPABILITY ANALYSIS

Learning Objectives

- Understand the role that process capability analysis plays in the successful completion of an improvement project.
- Know how to perform a process capability analysis.

How does it help?

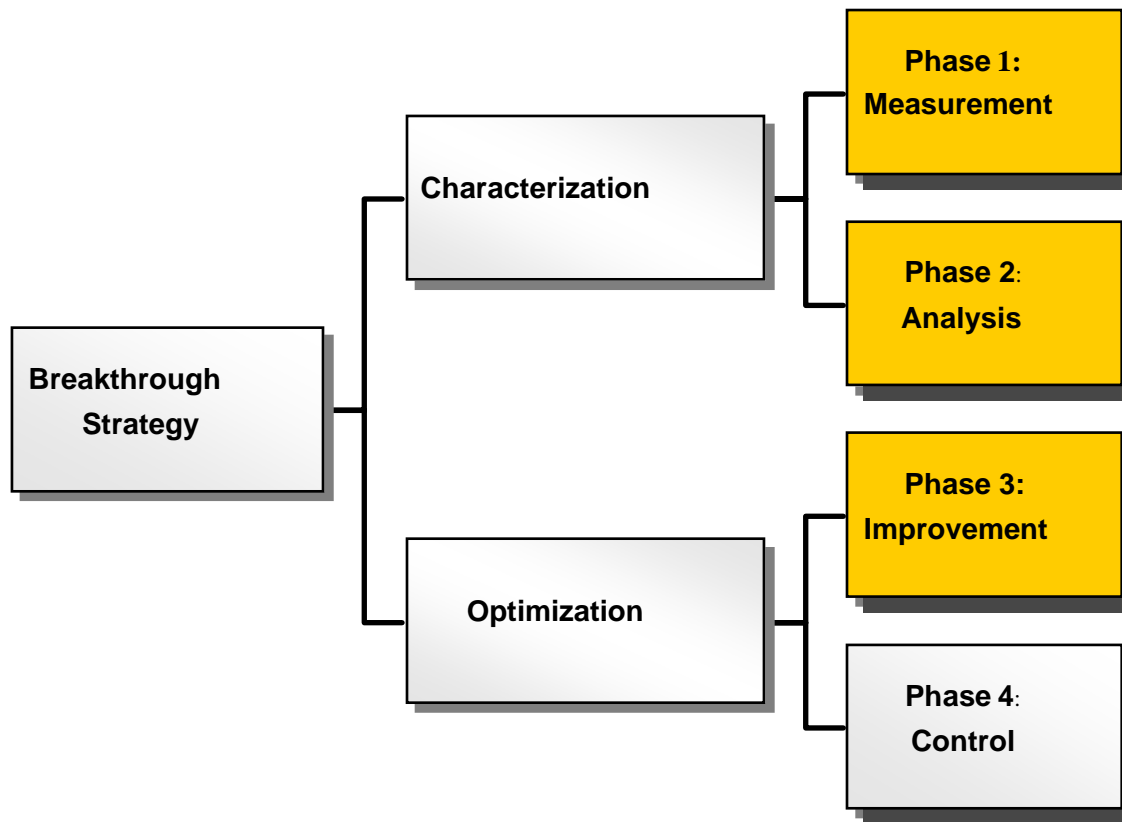
Process Capability Analysis is necessary to:

- determine the area of focus which will ensure successful resolution of the project.
- benchmark a process to enable demonstrated levels of improvement after successful resolution of the project.
- demonstrate improvement after successful resolution of the project.



IMPROVEMENT ROADMAP

Uses of Process Capability Analysis



Common Uses

- **Baselining a process primary metric (Y) prior to starting a project.**
- **Characterizing the capability of causitive factors (x).**
- **Characterizing a process primary metric after changes have been implemented to demonstrate the level of improvement.**

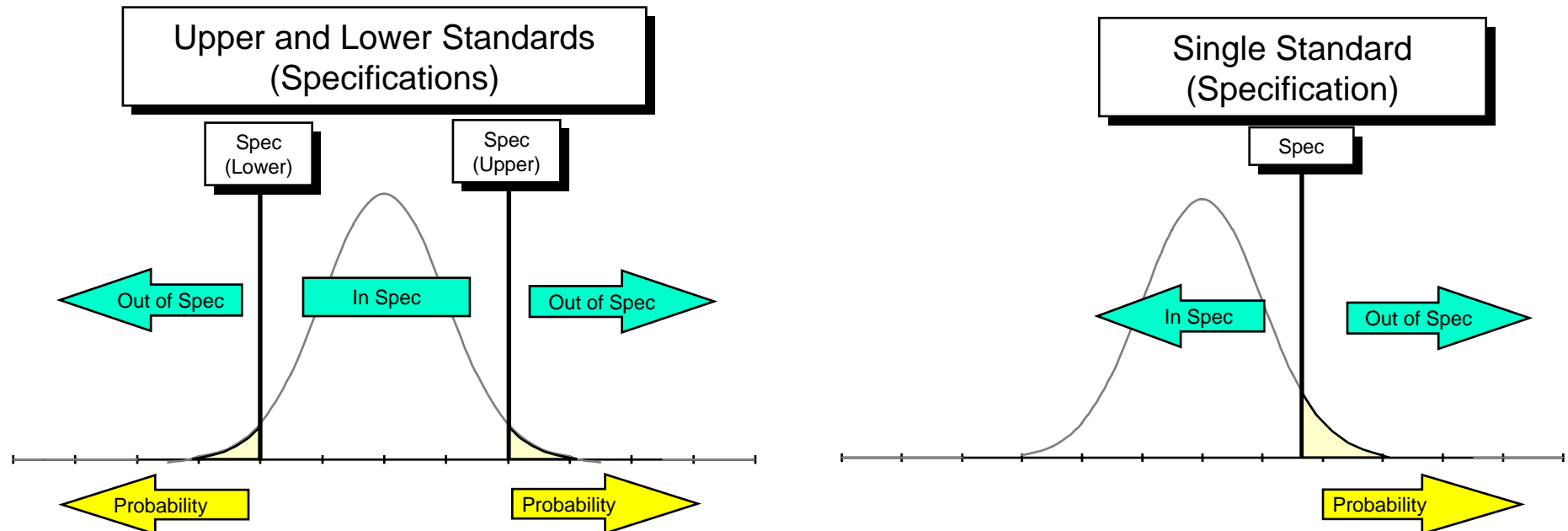
KEYS TO SUCCESS

- Must have specification limits - Use process targets if no specs available
- Don't get lost in the math
- Relate to Z for comparisons ($Cpk \times 3 = Z$)
- For Attribute data use PPM conversion to Cpk and Z



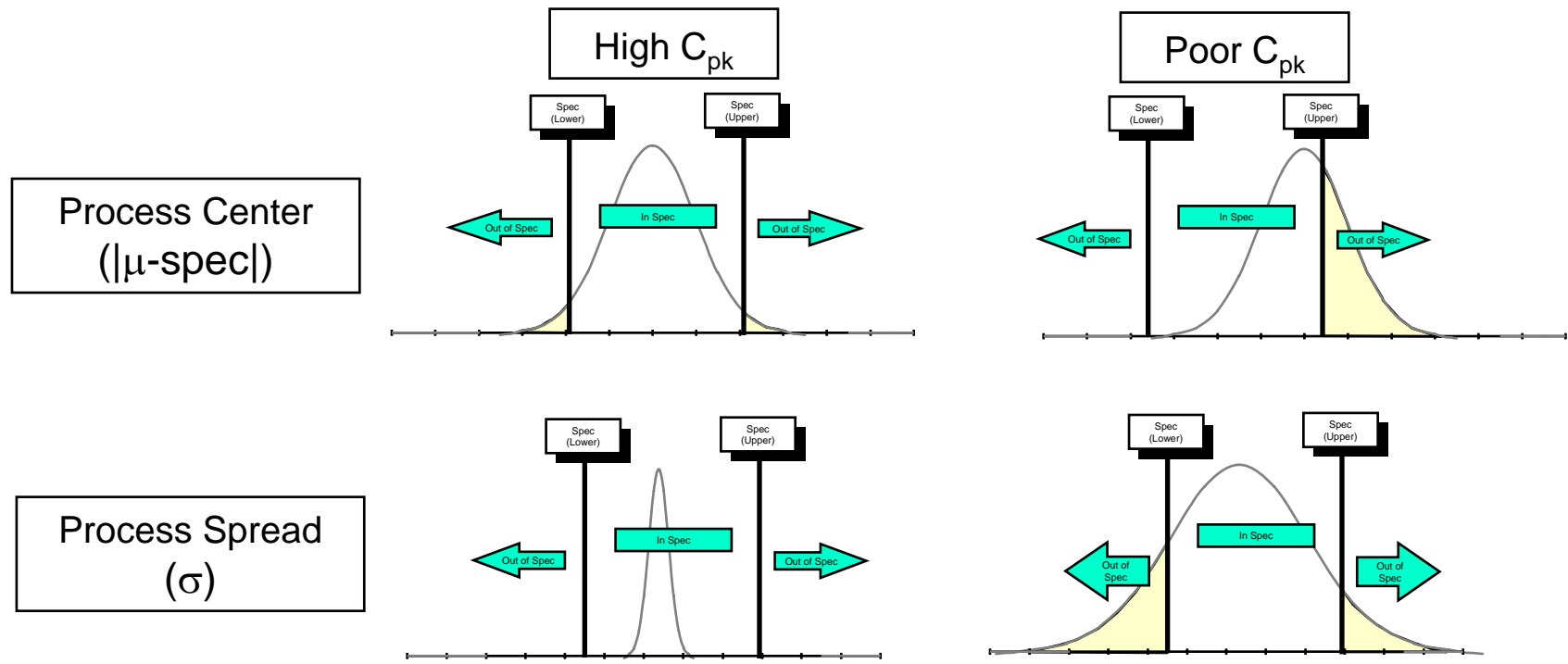
WHAT IS PROCESS CAPABILITY?

Process capability is simply a measure of how good a metric is performing against an established standard(s). Assuming we have a stable process generating the metric, it also allows us to predict the probability of the metric value being outside of the established standard(s).

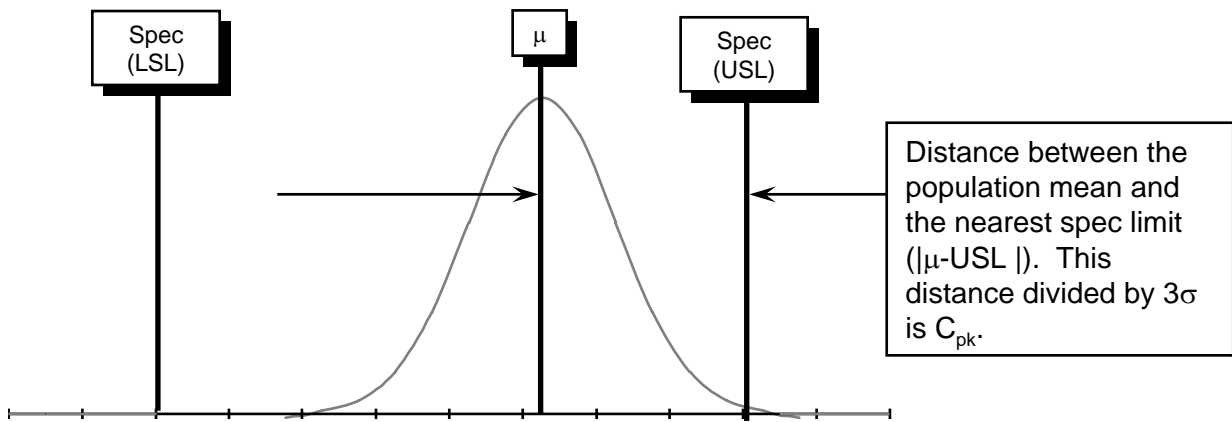


WHAT IS PROCESS CAPABILITY?

Process capability (C_{pk}) is a function of how the population is centered ($|\mu - \text{spec}|$) and the population spread (σ).



HOW IS PROCESS CAPABILITY CALCULATED



Expressed mathematically, this looks like:

$$C_{PK} = \frac{MIN(\mu - LSL, USL - \mu)}{3\sigma}$$

Note:

LSL = Lower Spec Limit

USL = Upper Spec Limit

PROCESS CAPABILITY EXAMPLE

We want to calculate the process capability for our inventory. The historical average monthly inventory is \$250,000 with a standard deviation of \$20,000. Our inventory target is \$200,000 maximum.

- Calculation Values:

- Upper Spec value = \$200,000 maximum
- No Lower Spec
- m = historical average = \$250,000
- s = \$20,000

- Calculation:

$$C_{PK} = \frac{\text{MIN}(\mu - LSL, USL - \mu)}{3\sigma} = \frac{(\$200,000 - \$250,000)}{3 * \$20,000} = -.83$$

Answer: $C_{pk} = -.83$

ATTRIBUTE PROCESS CAPABILITY TRANSFORM

Z	PPM _{ST}	C _{pk}	PPM _{LT (+1.5 σ)}
0.0	500,000	0.0	933,193
0.1	460,172	0.0	919,243
0.2	420,740	0.1	903,199
0.3	382,089	0.1	884,930
0.4	344,578	0.1	864,334
0.5	308,538	0.2	841,345
0.6	274,253	0.2	815,940
0.7	241,964	0.2	788,145
0.8	211,855	0.3	758,036
0.9	184,060	0.3	725,747
1.0	158,655	0.3	691,462
1.1	135,666	0.4	655,422
1.2	115,070	0.4	617,911
1.3	96,801	0.4	579,260
1.4	80,757	0.5	539,828
1.5	66,807	0.5	500,000
1.6	54,799	0.5	460,172
1.7	44,565	0.6	420,740
1.8	35,930	0.6	382,089
1.9	28,716	0.6	344,578
2.0	22,750	0.7	308,538
2.1	17,864	0.7	274,253
2.2	13,903	0.7	241,964
2.3	10,724	0.8	211,855
2.4	8,198	0.8	184,060
2.5	6,210	0.8	158,655
2.6	4,661	0.9	135,666
2.7	3,467	0.9	115,070
2.8	2,555	0.9	96,801
2.9	1,866	1.0	80,757
3.0	1,350	1.0	66,807
3.1	968	1.0	54,799
3.2	687	1.1	44,565
3.3	483	1.1	35,930
3.4	337	1.1	28,716
3.5	233	1.2	22,750
3.6	159	1.2	17,864
3.7	108	1.2	13,903
3.8	72.4	1.3	10,724
3.9	48.1	1.3	8,198
4.0	31.7	1.3	6,210

If we take the Cpk formula below

$$C_{PK} = \frac{MIN(\mu - LSL, USL - \mu)}{3\sigma}$$

We find that it bears a striking resemblance to the equation for Z which is:

$$Z_{CALC} = \frac{\mu - \mu_0}{\sigma}$$

with the value $\mu - \mu_0$ substituted for $MIN(\mu - LSL, USL - \mu)$.

Making this substitution, we get :

$$C_{pk} = \frac{1}{3} * \frac{MIN(\mu - LSL, USL - \mu)}{\sigma} = \frac{Z_{MIN(\mu - LSL, USL - \mu)}}{3}$$

We can now use a table similar to the one on the left to transform either Z or the associated PPM to an equivalent C_{pk} value.

So, if we have a process which has a short term PPM=136,666 we find that the equivalent Z=1.1 and Cpk=0.4 from the table.

Learning Objectives

- Understand the role that process capability analysis plays in the successful completion of an improvement project.
- Know how to perform a process capability analysis.