Notes:

Process Capability Using Non-Normal Data

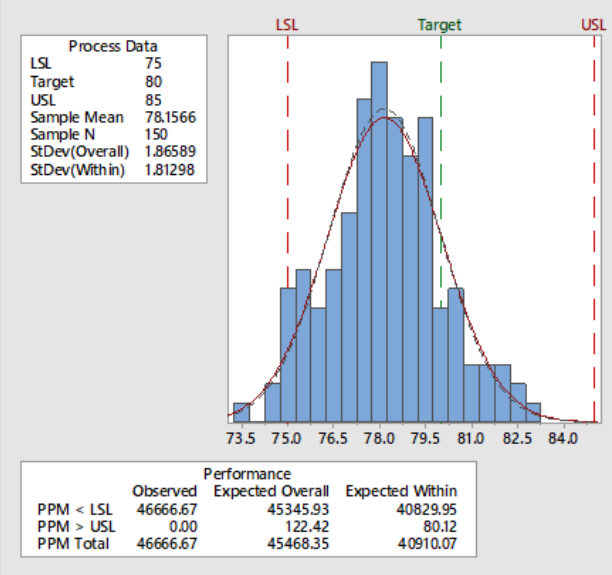
Key Learning Points

1. Describe how to identify non-normal probability distributions.
2. Explain how to generate process capability estimates with non-normal data.
3. Explain how to evaluate the output and improve process capability.

Why Study Process Capability?

Process Capability is the ability of a process to meet customer requirements or specifications.

Sigma level is the distance of the mean of a data distribution to a specification limit measured in Standard Deviations.



Process Capability Indices

Short-term Capability Indices

$$C_p = \frac{(USL - LSL)}{6 * s_{short-term}}$$

$$C_{pk} = \frac{\text{Min}\,(USL - \bar{x}, \bar{x} - LSL)}{3 * s_{short-term}}$$

Long-term Capability Indices

$$P_p = \frac{(USL - LSL)}{6 * s_{long-term}}$$

$$P_{pk} = \frac{\text{Min}\,(USL - \bar{x}, \bar{x} - LSL)}{3 * s_{long-term}}$$

C_p and P_p are Potential Process Capability measures that estimate what the process is capable of producing if the process mean were centered

C_{pk} and P_{pk} are Performance Process Capability measures given the process mean is not centered

Notes:

Capability Indices and Sigma

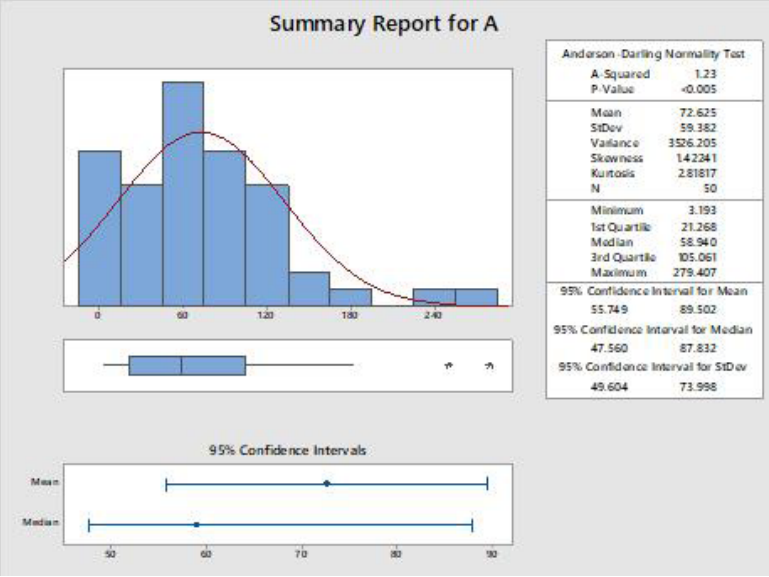
C_{pk}	Adjusted Sigma level (σ)	Process yield	DPMO
0.33	1	30.85%	691462
0.67	2	69.15%	308538
1	3	93.32%	66807
1.33	4	99.38%	6209
1.67	5	99.98%	232.6
2	6	100.00%	3.4

Non-normal Data Distributions

Parameter estimate calculations of process capability and sigma level depend on the probability distribution. Calculations to this point depended on normally distributed data.

These data are not normally distributed. Note the Anderson-Darling Test.

- Ho: Data are Normal
- Ha: Data are not Normal
- $p < .005$
- Conclude Ha not normal



Notes:

Calculating Capability & Sigma Continuous Non-Normal Data

1. From customer, set Specification Limits
    a. Upper Specification Limits (USL), Lower Specification Limits (LSL) or both.
2. Verify process is stable (”in control”).
3. Determine the probability distribution – normal or other. If NOT normal…
4. (Method A) Use MINITAB to discover the best-fit distribution and expected DPMO. (Method B & C) Use MINITAB to transform the original data into normal data
5. Find sigma in Sigma Table or Calculator.

Method A: Best Fit Distribution

Method B: Johnson Transformation

Method C: Box-Cox Transformation

When Should Non-Normal Process Capability Tests Be Used?

- If normality is rejected, traditional calculations would be inappropriate.
- The ultimate goal of statistical methods is to predict performance in the broader population of data. Knowing the correct probability distribution is paramount to this endeavor.

Pitfalls to Avoid

- Only consider distributions and transformations if p-values are greater than 0.05.
- Choose the best option by optimizing p-values, comparing histograms to probability curves, and matching expected defective units to observed defective rates.

Notes: