Introduction to Process Capability

Data Science for Quality Management: Process Capability

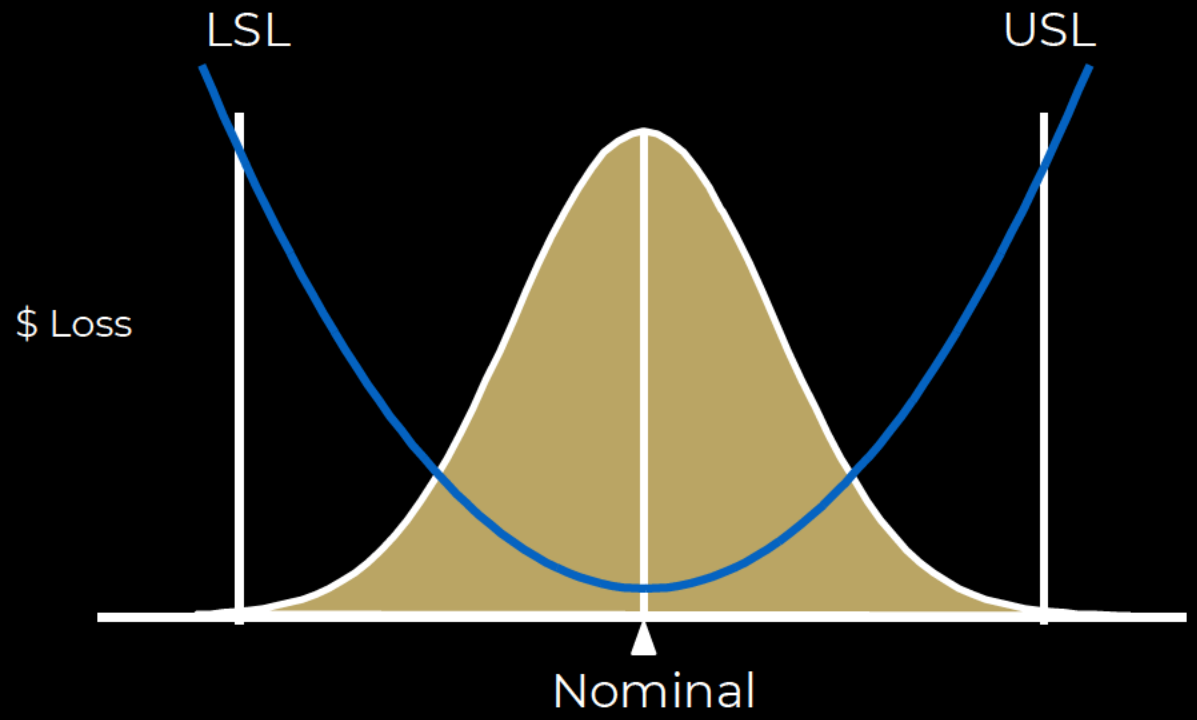
with **Wendy Martin**

Learning objectives:

Define the three indices of capability: C_p, C_{pk} and C_{pm}

Relate the C_{pm} index to the Taguchi Loss Function

Understanding the True Capability of a Process:
The Taguchi Loss Function



Understanding the True Capability of a Process:
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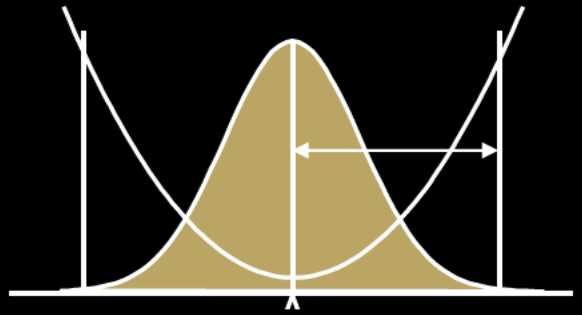


Given:

C_x : Countermeasure Cost;

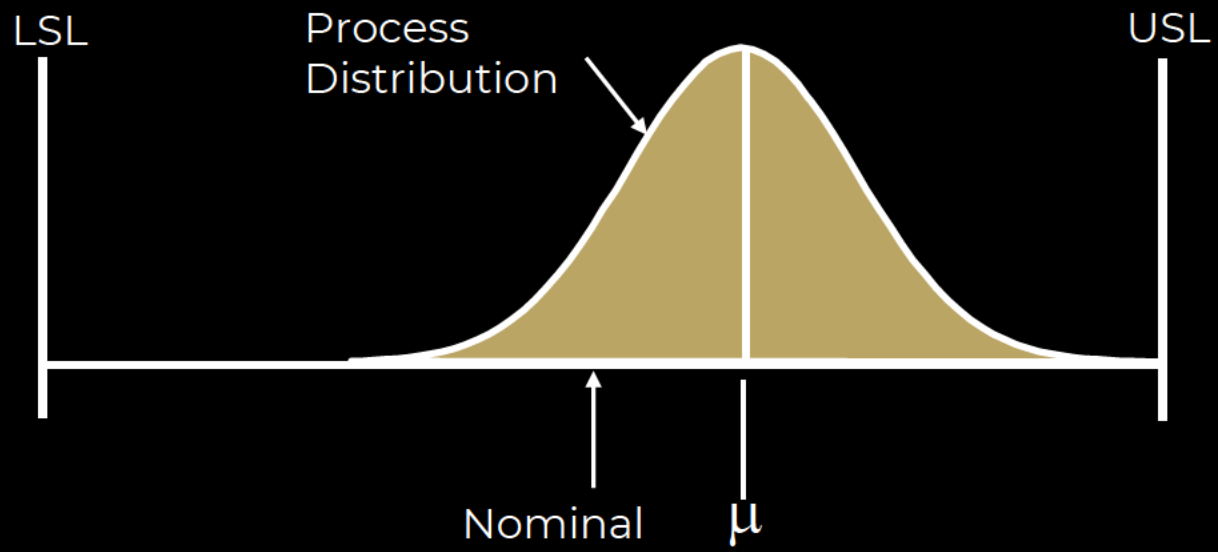
and

Δ : SL - Nominal

This function can be used to estimate Total Loss to the System for comparative analyses, where

$$L_y = \frac{C_x}{\Delta^2}(\sigma^2 + (\mu - \text{Nominal})^2)$$

A True Process Capability Index: C_{pm}



$$C_{pm} = \frac{USL - LSL}{6\sqrt{\sigma^2 + (\mu - Nominal)^2}}$$

Definition: C_{pm}

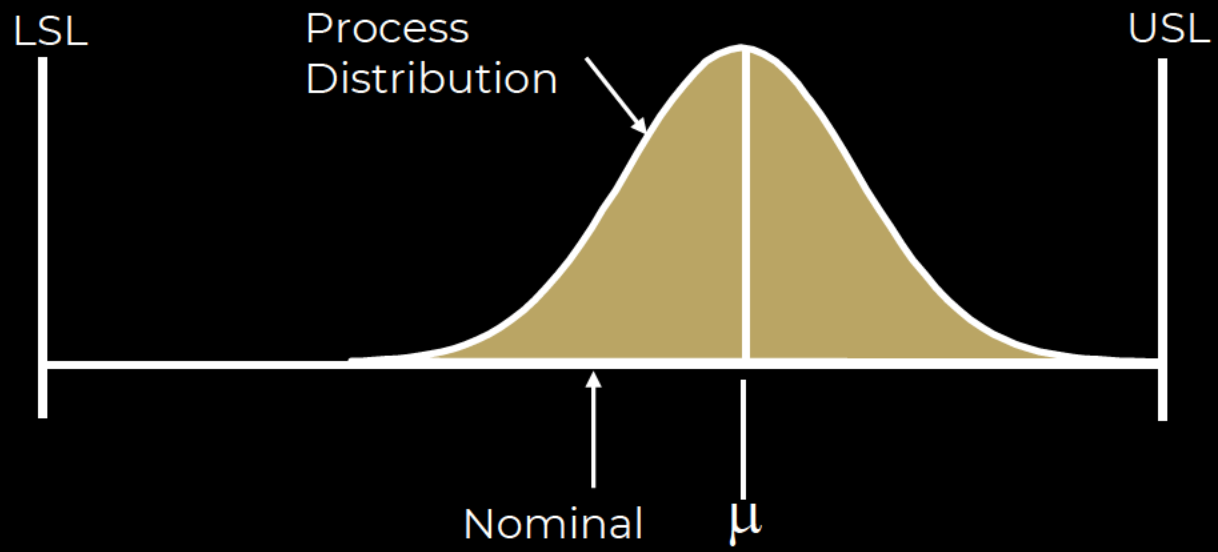
- C_{pm}: Is a C_p that is modified in two ways:

- Deviation of Mean from Target (Nominal) is applied, but in the form of a penalty imposed as an inflator of overall variability

Definition: C_{pm}

- Based on dispersion/spread only but the dispersion includes both within process and deviation of mean from target
- Definition may apply to both normal and non-normal process distributions but care must be used (NT vs just descriptive statistics)

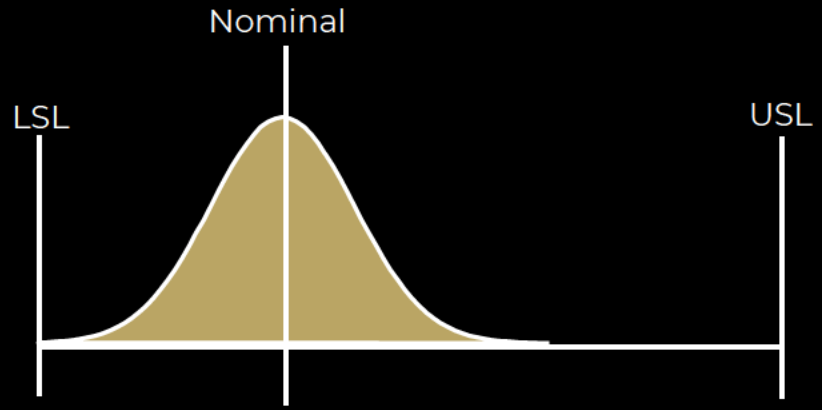
A True Process Capability Index: C_{pm}



Note the similarity between the Taguchi Loss Function formula and the formula for the C_{pm} Index

$$C_{pm} = \frac{USL - LSL}{6\sqrt{\sigma^2 + (\mu - Nominal)^2}}$$

A True Process Capability Index: C_{pm}



$$C_p = \frac{USL - LSL}{6\sigma}$$

$$C_{pk} = \frac{|CSL - Mean|}{3\sigma}$$

$$C_{pm} = \frac{USL - LSL}{6\sqrt{\sigma^2 + (\mu - Nominal)^2}}$$

A True Process Capability Index: C_{pm}

- Note that this index may also be calculated as shown below.

$$C_{pm} = \frac{C_p}{\sqrt{1 + (\mu - Nominal)^2/\sigma^2}}$$

Sources

The material used in the PowerPoint presentations associated with this course was drawn from a number of sources. Specifically, much of the content included was adopted or adapted from the following previously-published material:

- Luftig, J. An Introduction to Statistical Process Control & Capability. Luftig & Associates, Inc. Farmington Hills, MI, 1982
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- Luftig, J. Guidelines for Reporting the Capability of Critical Product Characteristics. Anheuser-Busch Companies, St. Louis, MO. 1994
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- Littlejohn, R., Ouellette, S., & Petrovich, M. Black Belt Business Improvement Specialist Training, Luftig & Warren International, 2000
- Ouellette, S. Six Sigma Champion Training, ROI Alliance, LLC & Luftig & Warren, International, Southfield, MI 2005