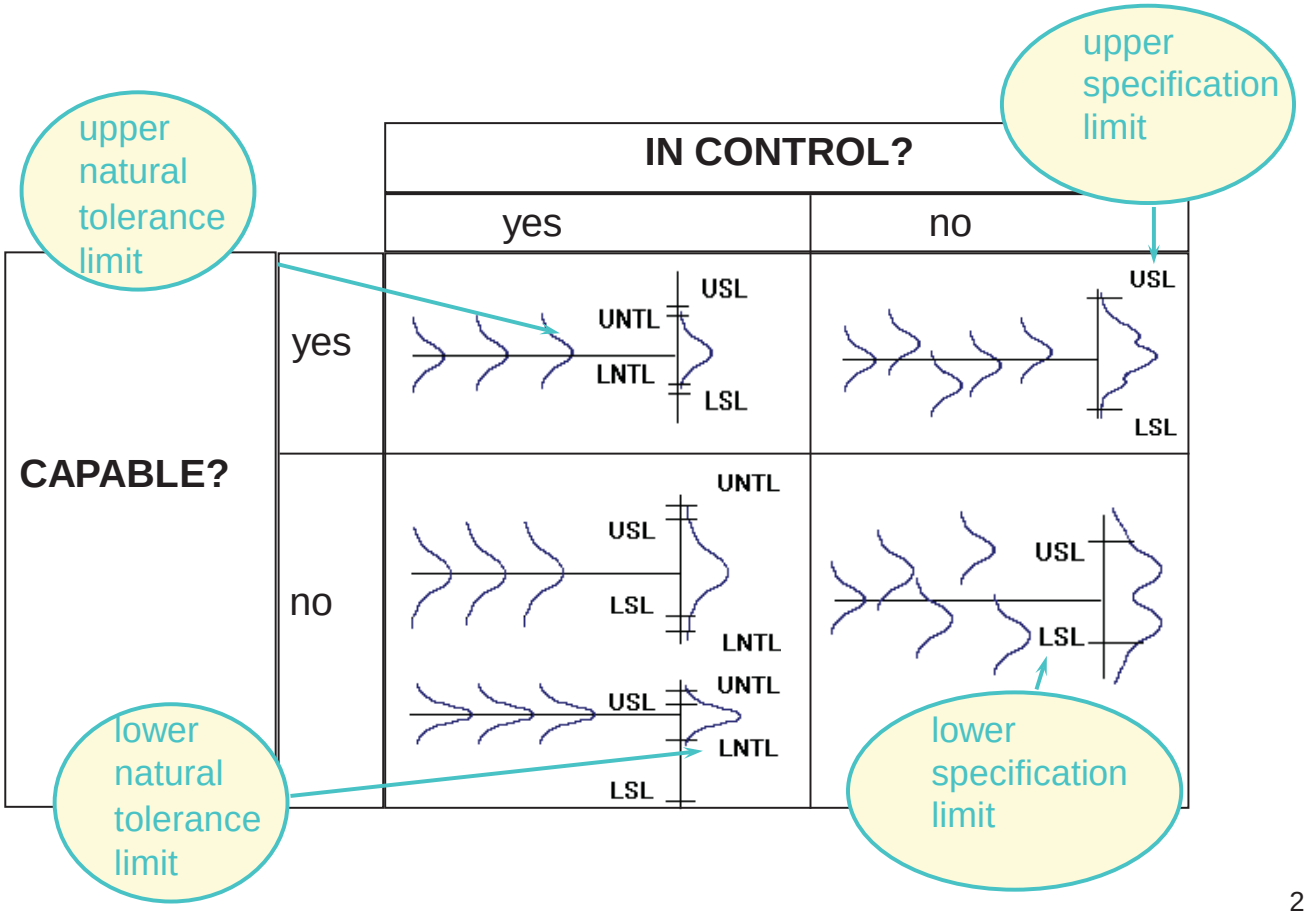
PROCESS CAPABILITY

ROLE OF QUALITY ENGINEERING



PROCESS CAPABILITY INDEX

Process capability index (Potential capability):

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

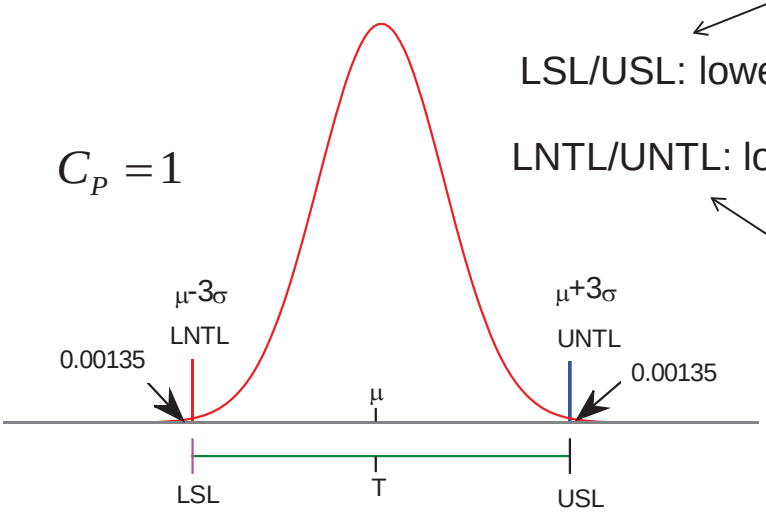
This is what we want

LSL/USL: lower/upper specification limit

LNTL/UNTL: lower/upper natural tolerance limit

This is what the process is capable of

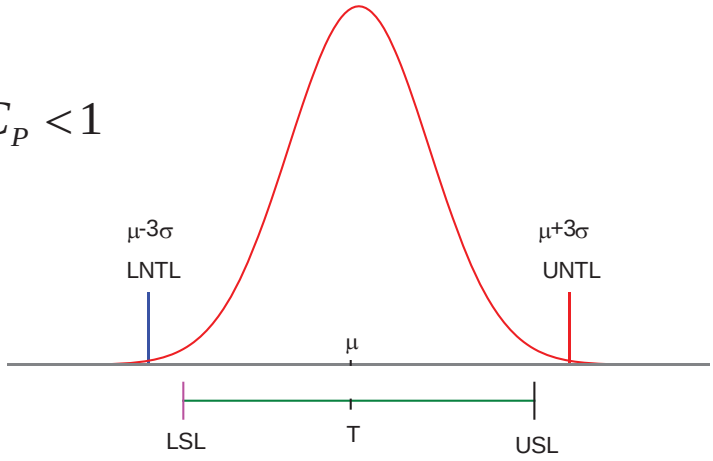
$C_P = 1$



PROCESS CAPABILITY INDEX

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

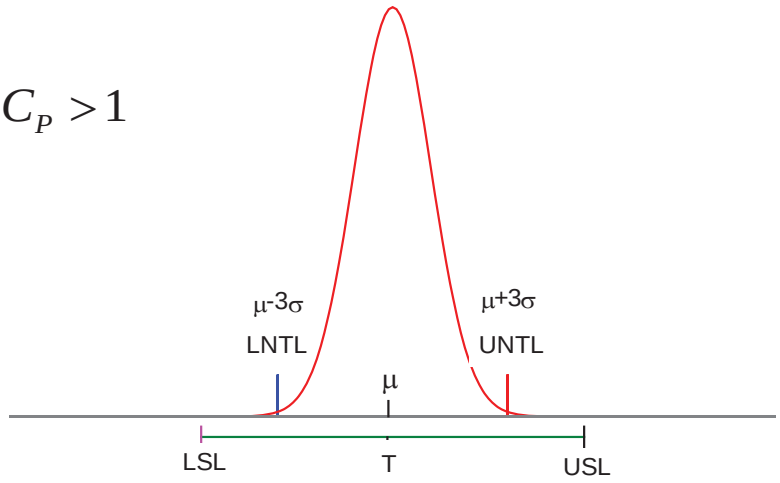
$C_P < 1$



PROCESS CAPABILITY INDEX

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

$C_P > 1$



Example 1

In a manufacturing process the expected value of a quality characteristic is 250.727 unit, the standard deviation is 1.286 unit. The specification is 250.5±3unit.

How much is the proportion of defectives in this process?

Calculate the C_P capability index!

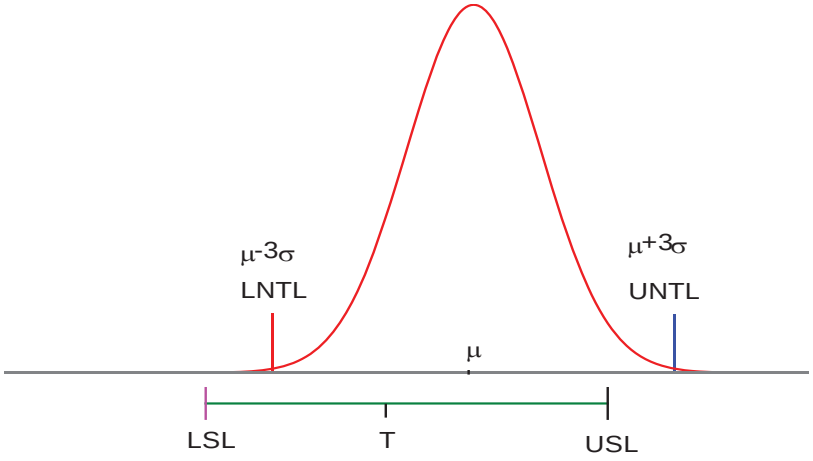
$$z_{\text{upper}} = \frac{USL - \mu}{\sigma} = \qquad P(x > USL) =$$

$$z_{\text{lower}} = \frac{LSL - \mu}{\sigma} = \qquad P(x < LSL) =$$

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

CORRECTED INDICES (DEMONSTRATED CAPABILITY)

$$C_{PU} = \frac{USL - \mu}{3\sigma}; \quad C_{PL} = \frac{\mu - LSL}{3\sigma}; \qquad C_{PK} = \min\left(C_{PU}, C_{PL}\right)$$



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

MODIFIED PROCESS CAPABILITY INDEX

capability index

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

modified capability index

$$C_{Pm} = \frac{USL - LSL}{6\tau} = \frac{USL - LSL}{6\sqrt{\sigma^2 + (\mu - T)^2}}$$

$$MSE = E\left[(x - T)^2\right] = \tau^2 \qquad \tau^2 = \sigma^2 + (\mu - T)^2$$

related to Taguchi's quadratic loss function

INTERPRETING THE RESULTS

Example 2

Compare two processes, the specification for both is 100±1.

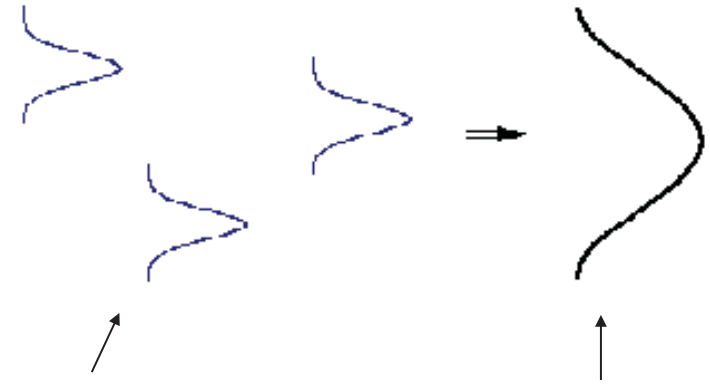
I. σ =0.2, μ=99.5, that is the center of fluctuation deviates from the nominal value

II. σ =0.4, μ =100, that is the center of fluctuation is the nominal value, but the fluctuation is larger

Example 3

The specification is 100±1, σ =0.2. Calculate the capability indices and the proportion beyond specs (above *USL* or below *LSL),* if the expected value is 100, 99.5 and 100.5!

PROCESS CAPABILITY AND PROCESS PERFORMANCE



σ_{ST} (short term)

σ_{LT} (long term)

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

which σ ?

$$P_P \leq C_P$$

Estimating variance from the within-samples (short term) changes refers the internal, random fluctuation C_P (potential capability)

Combining both within-samples and between-samples changes the long term fluctuation is considered P_P (process performance)

PROCESS CAPABILITY AND PROCESS PERFORMANCE

„Kotz and Lovelace (1998) strongly recommend against the use of P_p and P_{pk}, indicating that these indices are actually a step backward in quantifying process capability. They refer to the mandated use of P_p and P_{pk} through quality standards or industry guidelines as undiluted "statistical terrorism" (i.e., the use or misuse of statistical methods along with threats and/or intimidation to achieve a business objective).

This author agrees completely with Kotz and Lovelace. The process performance indices P_p and P_{pk} are actually more than a step backward. They are a waste of engineering and management effort — they tell you nothing."

Douglas C. Montgomery, Introduction to Statistical Quality Control