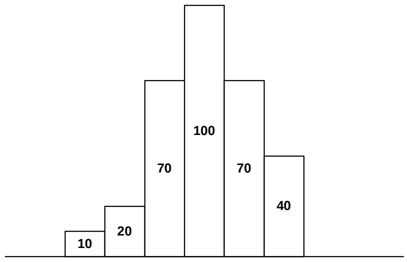
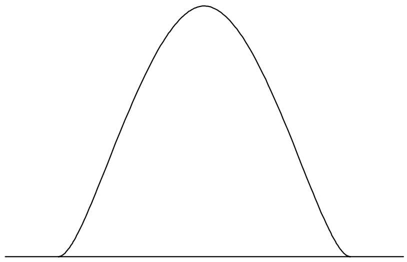
Essentials of Statistical Process Control

Sheet 1 - Process Capability

1. **Before starting to use statistical process control it is necessary to determine if the process is ‘capable’ of producing within the specified tolerances. This requires a ‘Process Capability Study’ to be carried out.**
2. **Select 50 samples from a continuous run of product.**
3. **Measure the desired feature and plot results in a histogram using 6 bars.**



4. **If the distribution is a normal distribution then proceed.**



Note: If the distribution is not a normal distribution then other techniques are needed.

Calculate the mean ($\overline{X}$) and the standard deviation (σ) for the 50 results using a standard calculator.

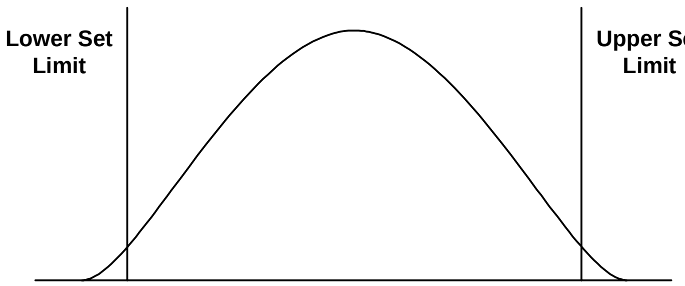
5. **Estimate the process variability (relative to the specified tolerances) from the formula:**

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

USL = Upper Set Limit or Upper Acceptable Tolerance.

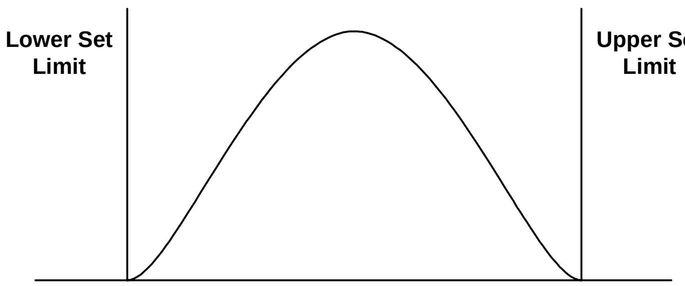
LSL = Lower Set Limit or Lower Acceptable Tolerance.

This value is a measure of the ‘process spread’. If C_p is less than 1.00 then it will not be possible for the process to produce parts within tolerance. When C_p is > 1.33 the process is said to be ‘capable’.



C_p is less than 1.00

The process is centred on the tolerances but it will never be possible to produce all the parts inside the tolerance.



C_p is equal to 1.00

It will be possible to produce 99.73% of the parts inside the tolerances but only if the process is exactly centred on the tolerance band and does not vary.

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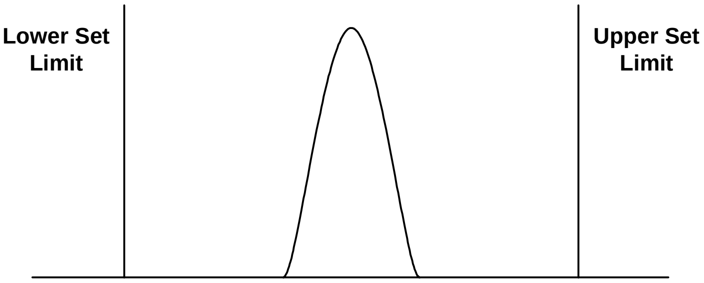


C_p is greater than 1.33

The process spread is less than the tolerances. It will be possible to produce all the parts inside the tolerances even with process variations.

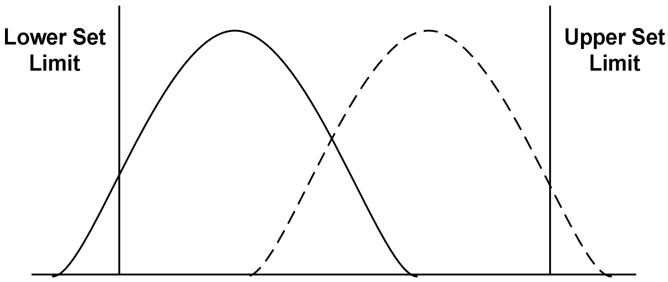
6. **C_p only describes the spread, it does not describe the location and even with a small spread (C_p >1.33) it is possible to produce out of tolerance parts. We need to be able to describe the location of the curve, this is done as follows:**

   Calculate Z_{UPPER} and Z_{LOWER} from the formulae below and find the smaller of the two:

   $Z_{\min}$ **is the smaller of** $Z_{UPPER} = \frac{USL - \overline{X}}{\sigma}$ **and** $Z_{LOWER} = \frac{\overline{X} - LSL}{\sigma}$**.**

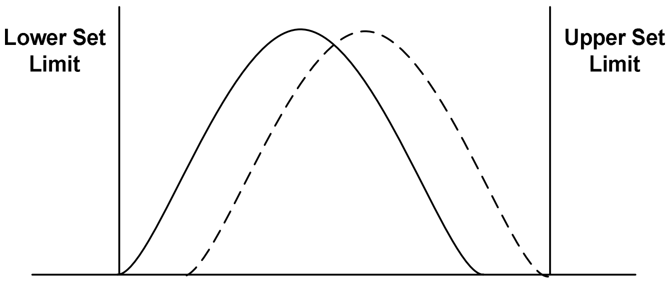
   $C_{pk} = \frac{Z_{\min}}{3}$ **,**

   As with C_p, if C_{pk} is less than 1.00 then it will not be possible for the process to produce parts within tolerance. When C_{pk} is > 1.33 the process is said to be 'capable'.



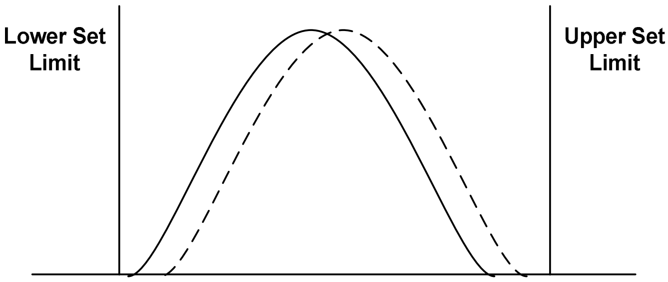
C_{pk} is less than 1.00

The process location is outside the tolerances. It will not be possible to produce all the parts inside the tolerances.



C_{pk} is equal to 1.00

The process location is inside the tolerances but close to the limits. It will just be possible to produce all the parts inside the tolerances.



C_{pk} is greater than 1.33

The process location is well inside the tolerances. It will be easily possible to produce all the parts inside the tolerances.

7. **The values for Z_{UPPER} and Z_{LOWER} can be used with P_z tables to calculate the proportion of the output that will be beyond the specification limits.**