UNIT 1

Process capability

Process capability

❖ Process capability is the long-term performance level of the process after it has been brought under statistical control. In other words process capability is the range over which the natural variation of the process occurs as determined by the system of common causes.

❖ A capable process meets customer requirements 100% of the time. Customer requirements are defined using an upper specification limit (USL) and a lower specification limit (LSL).

There are two primary capability indices used to measure process capability.

- Cp is the Capability index. It measures how well the data fit between the upper and lower specification limits. The higher the value, the better the fit.

- Cpk is the Centering capability index. It measures how well the data is centered between the specification limits. The higher the value the more centered the data

Index Symbol	Meaning	Estimate equation
Cp	Capability Index	(USL - LSL)/6s
Cpu	Upper Capability Index	(USL – X-Bar)/3s
Cpl	Lower Capability Index	(X-Bar - LSL)/3s
Cpk	Centering Capability Index	Min of (Cpu, Cpl)

Process capability Rules of Thomb

1. If Cp >1 process is capable (product will fit between the customer's upper and lower specification limit if the process is centered).
2. If Cpk >1 process is capable and centered between the LSL and USL.
3. If Cp = Cpk the process is centered at the mid-point of the specification limits.
4. If Cp >Cpk the process is off-center.

Process capability Rules of Thomb…contd

5. If Cpk = 1 the process is barely capable.
6. If Cpk <1 the process is not capable.
7. Pp is the performance index. Like Cp it measures how well your data fits within the USL and LSL. It uses standard deviation in the calculation instead of sigma estimator.
8. Ppk is the performance centering index. Like Cpk it measures how well your data is centered between the USL and LSL. It uses standard deviation in the calculation instead of sigma estimator.
9. Cp and Cpk should be close in value to Pp and Ppk.
10. If Cp and Cpk are much greater than Pp or Ppk, the process may not be stable.

The steps in Process capability analysis

1. select the process to be analysed and collection of data;
2. identify specific limits according to which capability analysis will be evaluated;
3. verify the process is under statistical control;
4. analyse data distribution;
5. estimate capability indices.

Process capability Analysis

❖ A capable process is one where almost all the measurements fall inside the specification limits.

❖ Capability analysis can be used:

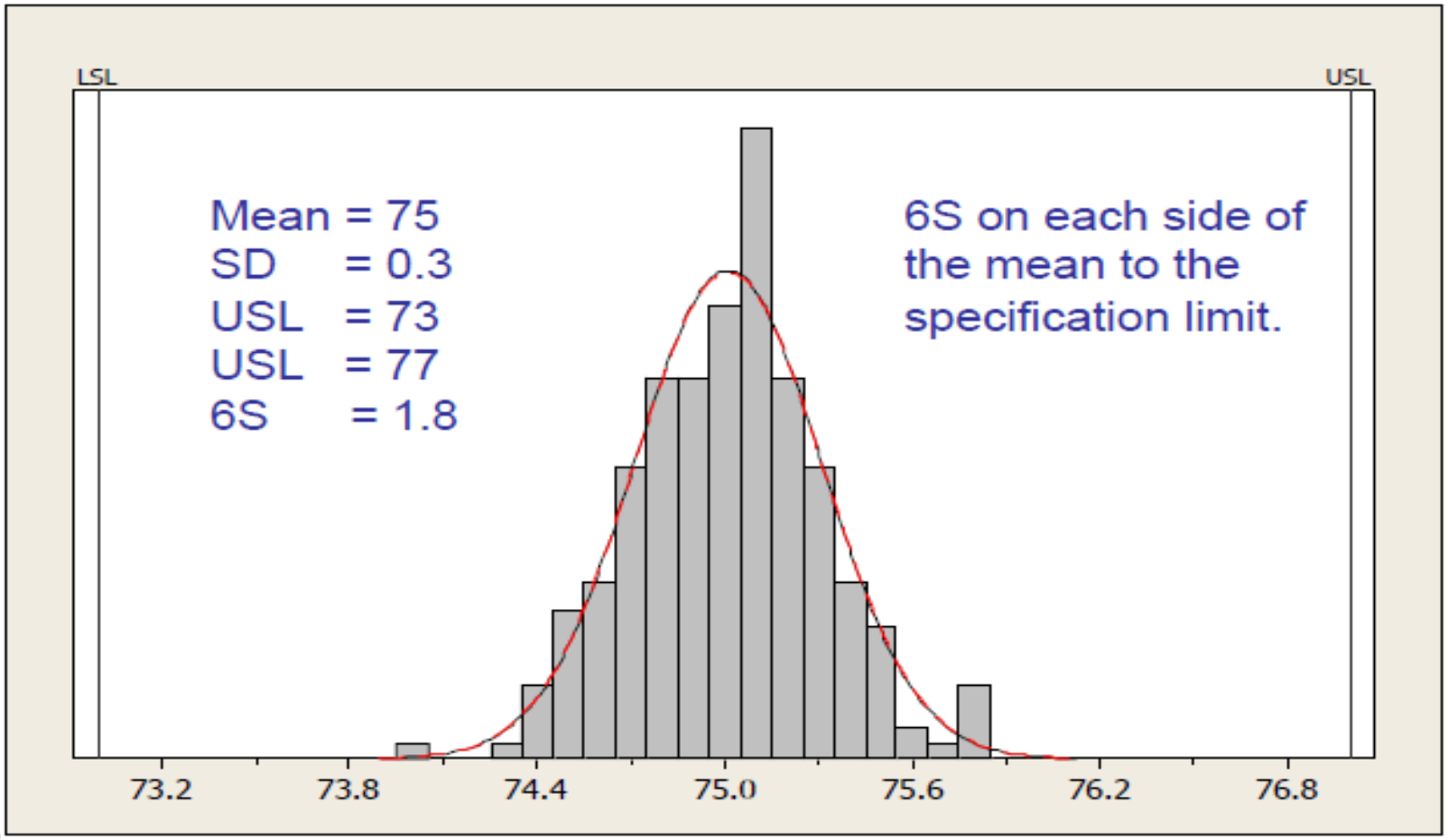
- Process that is not centered
- Process with large variability
- One-sided specifications
- Setting/confirming customer specifications

There are several methods for estimating sigma (S) used in capability analysis.

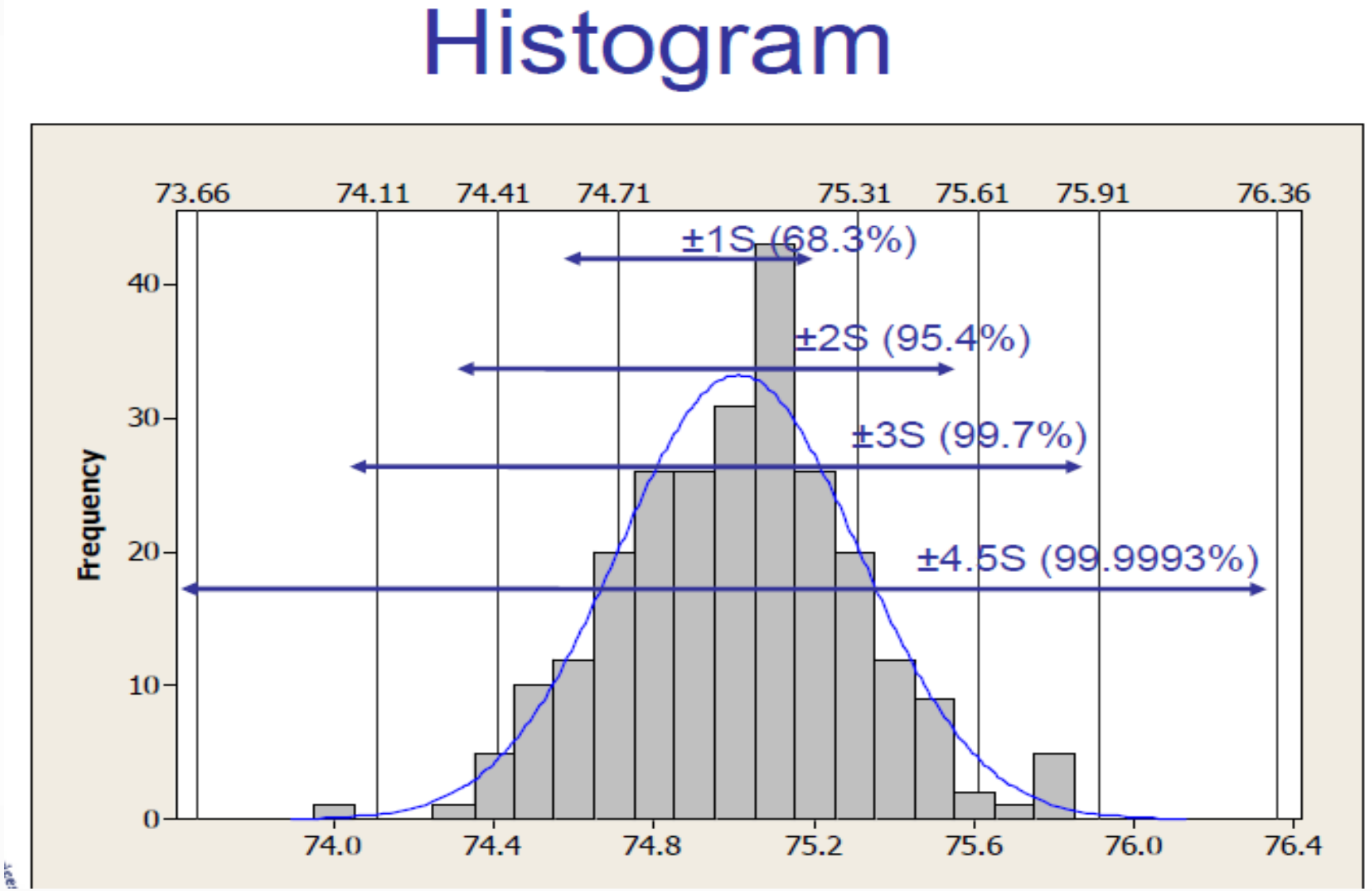
- Control charts
  - Rbar
  - Sbar
  - Moving Range
  - MSSD
- Pooled standard deviation
- Total standard deviation (Long-Term)

Process capability Analysis…contd

Graphical Representation



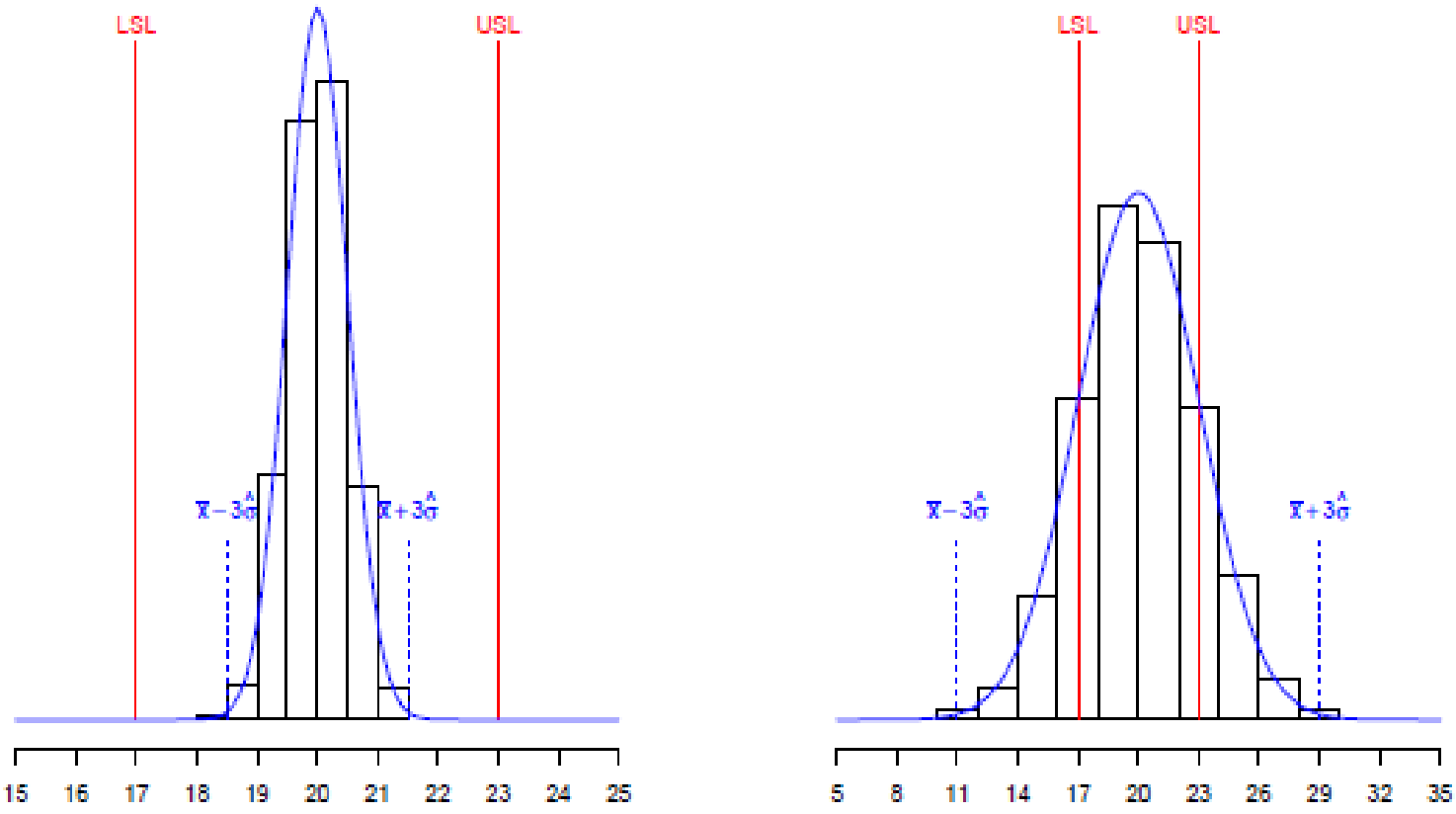
Process capability Analysis…contd



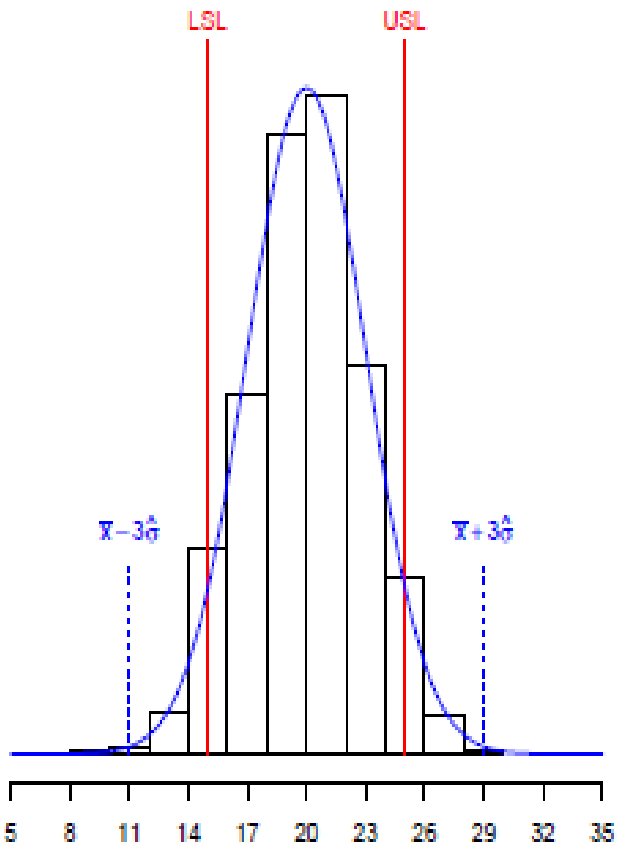
- To sum up, a process is capable when:
  - it is under statistical control;
  - it has a low variability rate compared to the range of specified limits;
  - process distribution is possibly centered on specification limits (centering).

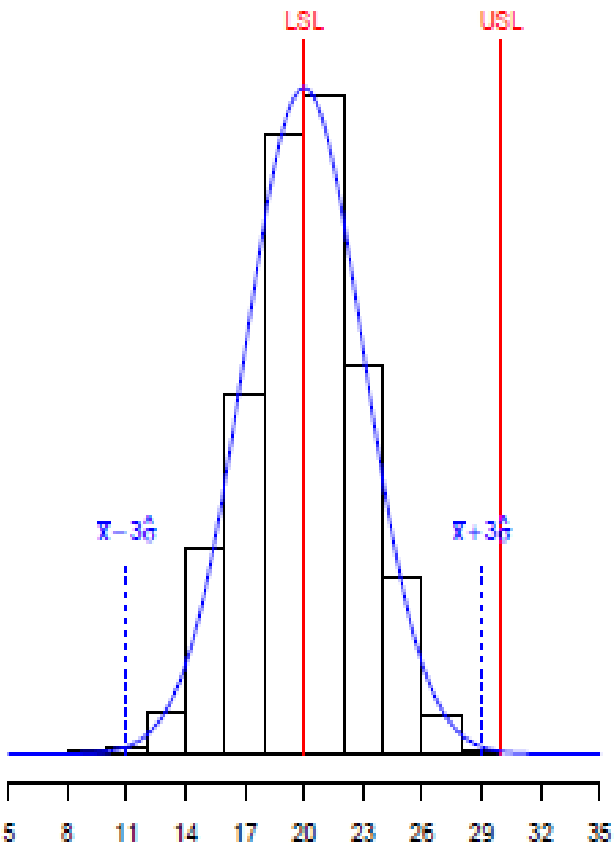
- If a process respects specifications and is under statistical control it can be foreseen that specifications will not change in the future. If a process respects specifications but is not under statistical control, specification could change in the future.

- Process variability indicates the spread within which 99.73% of the process distribution is contained. A normal distribution has a 6σ width range centered on the mean $(\mu \pm 3\sigma)$.

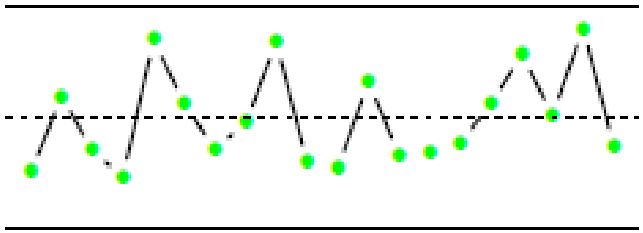


The two distributions have same mean and specification limits. However, dispersion in the distribution on the right is higher. Therefore, the process capability of the distribution on the right is lower than the process capability of the distribution on the left.

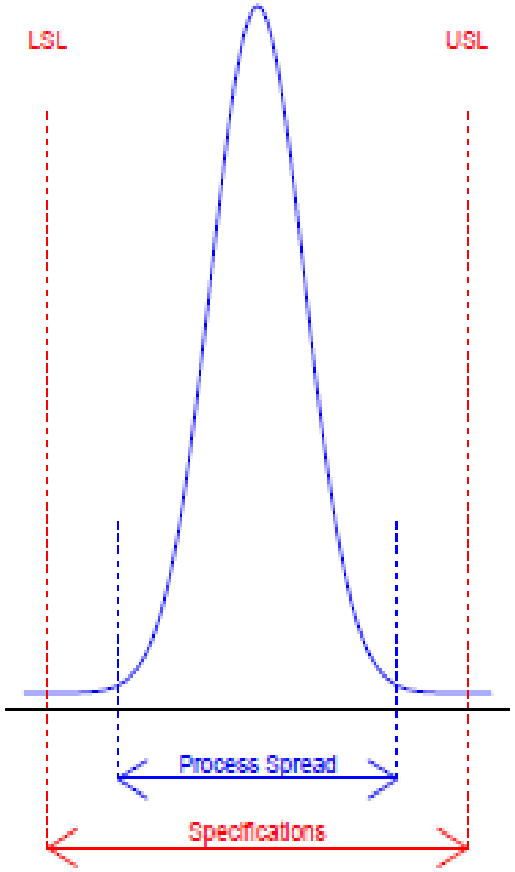




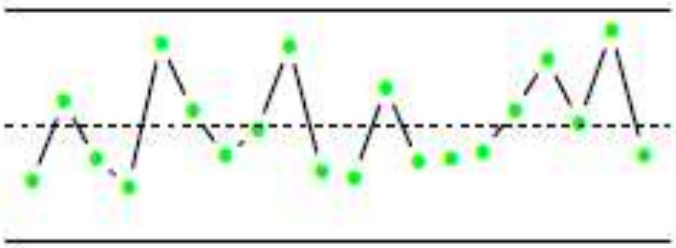
The two distributions have the same characteristics as far as shape, position and dispersion are concerned. The limit spread is the same. The process on the right is not centered with respect to its specification limits. Therefore process capability on the right will be lower.



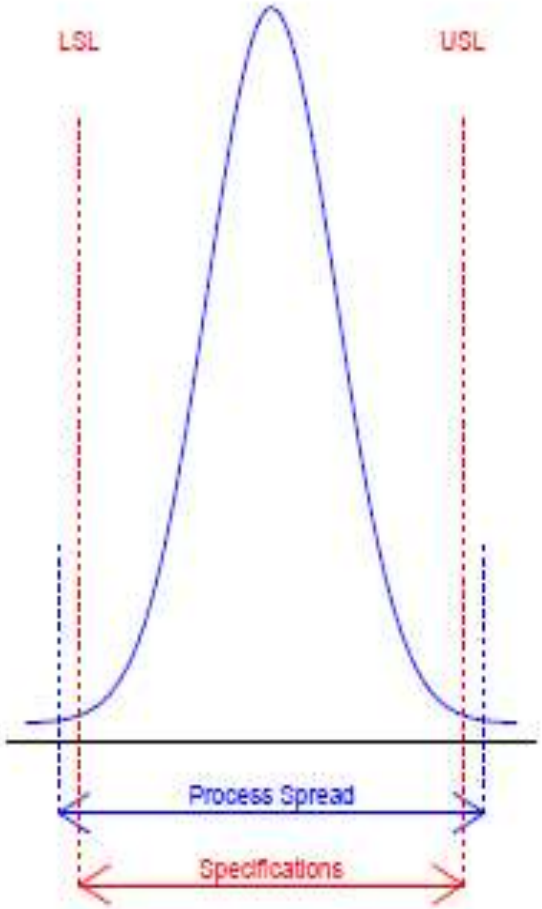
The process is both under statistical control and capable.



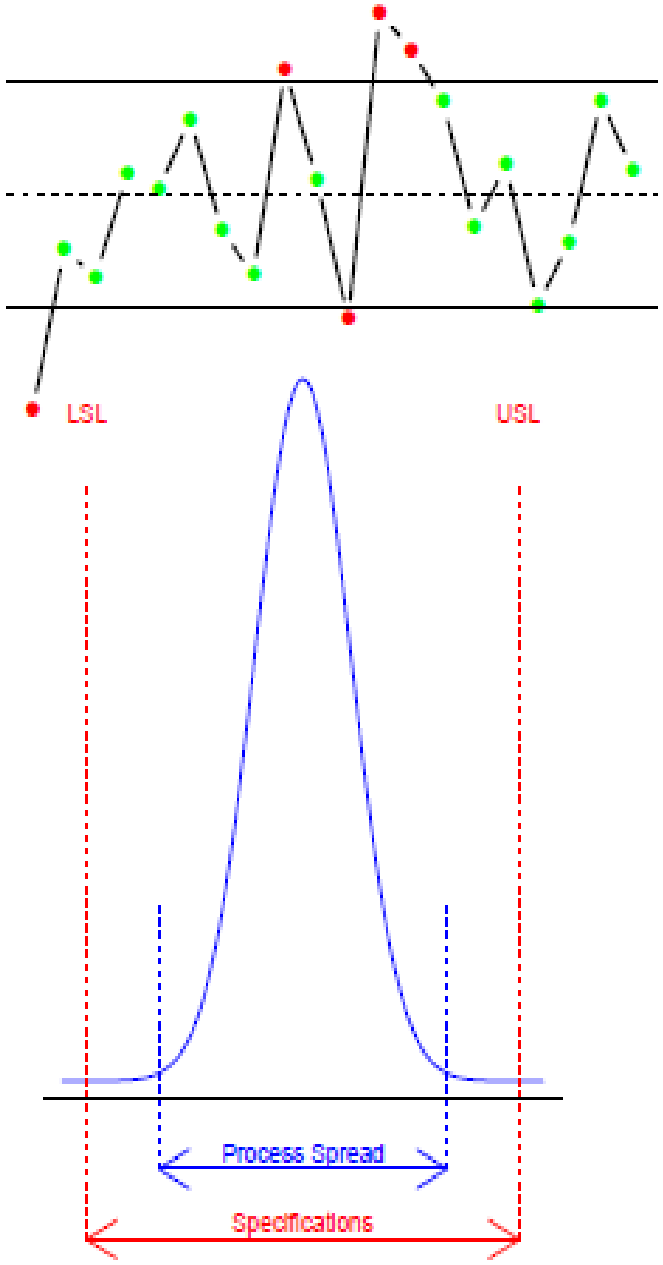
This process will produce conforming products as long as it remains in statistical control.



The process is under statistical control but it is not capable.

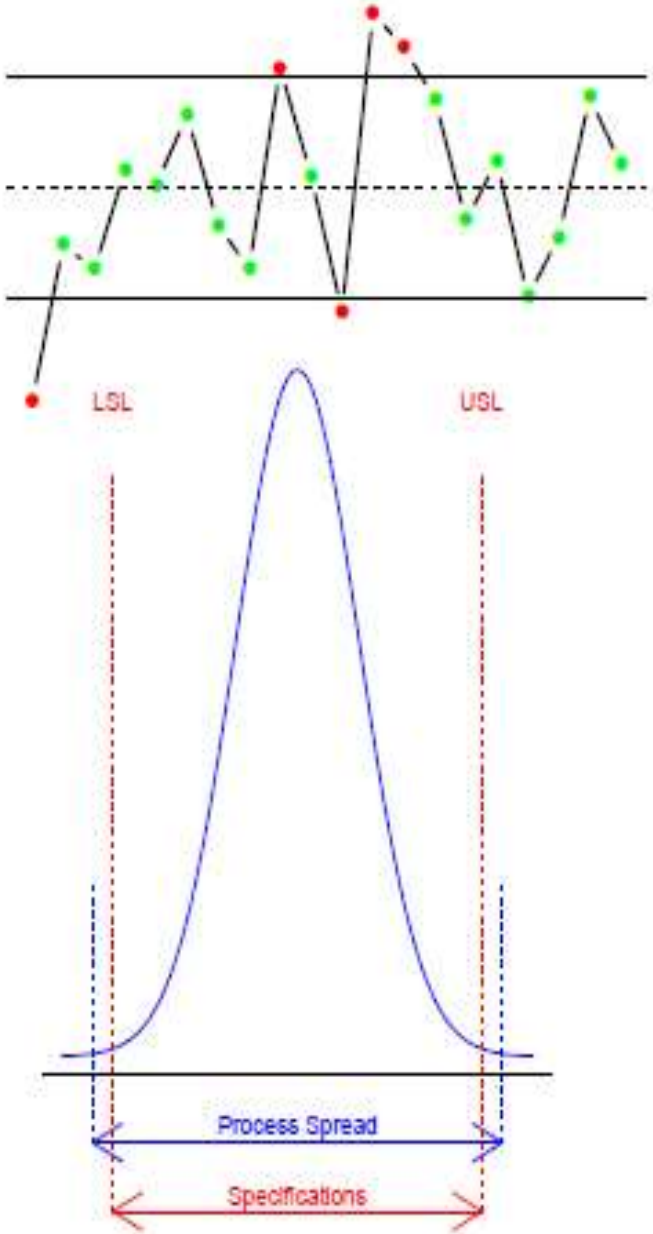


If the specifications are realistic, an effort must be immediately made to improve the process (i.e. reduce variation) to the point where it is capable of producing consistently within specifications.



The process is out of control but it is capable.

The process must be monitored: it cannot be expected it will respect specifics in the future.



The process is both out of control and it is not capable.

The process must be adjusted to be under control, then the capability analysis must be performed again.

REFERENCE BOOKS

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