Process Capability metrics (Cp and Cpk)

Problem
How to statistically assess a process?

Difficulty
Work with an SME

- **Process capability** is a statistical assessment of whether or not a process is *capable* and/or *centered*. You want both.
- Consider a car entering a garage:
  - *capable* (Cp>1) means the car usually arrives at the same location,
  - *centered* (Cpk>1) means the car enters the center of the garage.

Existing process → **Statistical Process Analysis** → Process assessment

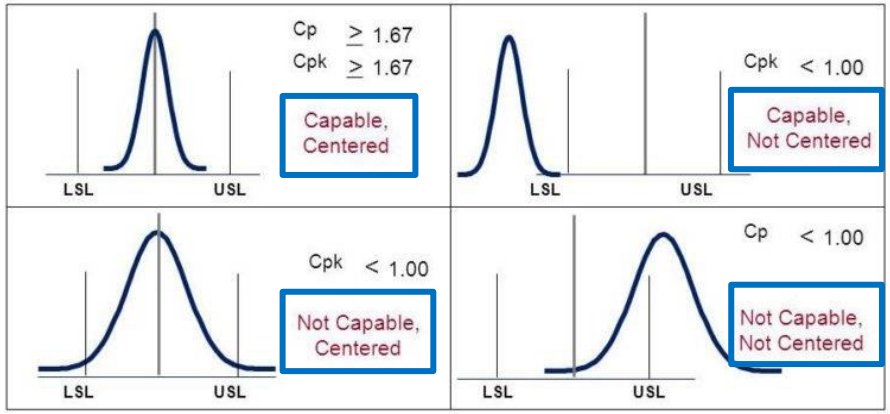
1. Obtain customer specs (USL & LSL)
2. Determine the process' sample mean (m) and standard deviation (s)
3. Compute the Cp and Cpk metrics
4. Interpret the metrics

Formulae

Cp = (USL – LSL) / (6*s)

Cpk = minimum((USL–m)/(3*s), (m–LSL)/(3*s))

- **Cp** = **Process Capability** = the number of times the spread of the process fits into the tolerance width. Larger values are better.
- **Cpk** = **Process Capability corrected for position**. Larger values are better.
- **USL** & **LSL** – Customer's Upper & Lower Specification Limits
- **m** = process mean
- **s** = process standard deviation



https://www.latestquality.com/how-to-calculate-cp-and-cpk/

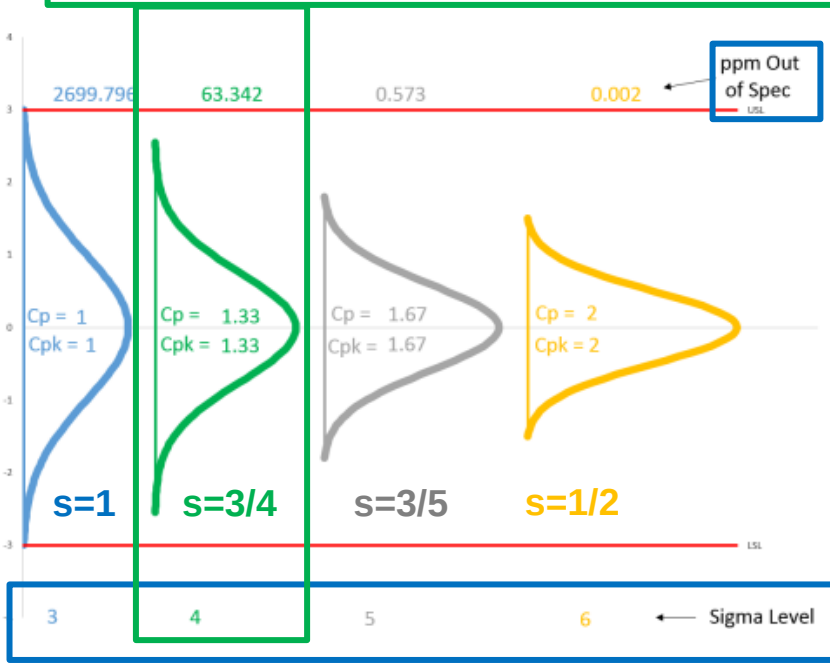
Process Capability metrics – Example

Consider the following case

- m = average = 0
- s = standard deviation = as specified below
- LSL = Lower Specification Limit = – 3
- USL = Upper Specification Limit = 3

Deceasing variance ➔ fewer parts out of spec

Interpretation: if s=3/4 then, at a 4 sigma level, Cp=CPK=1.33, and 63 parts per million (ppm) will be out of spec

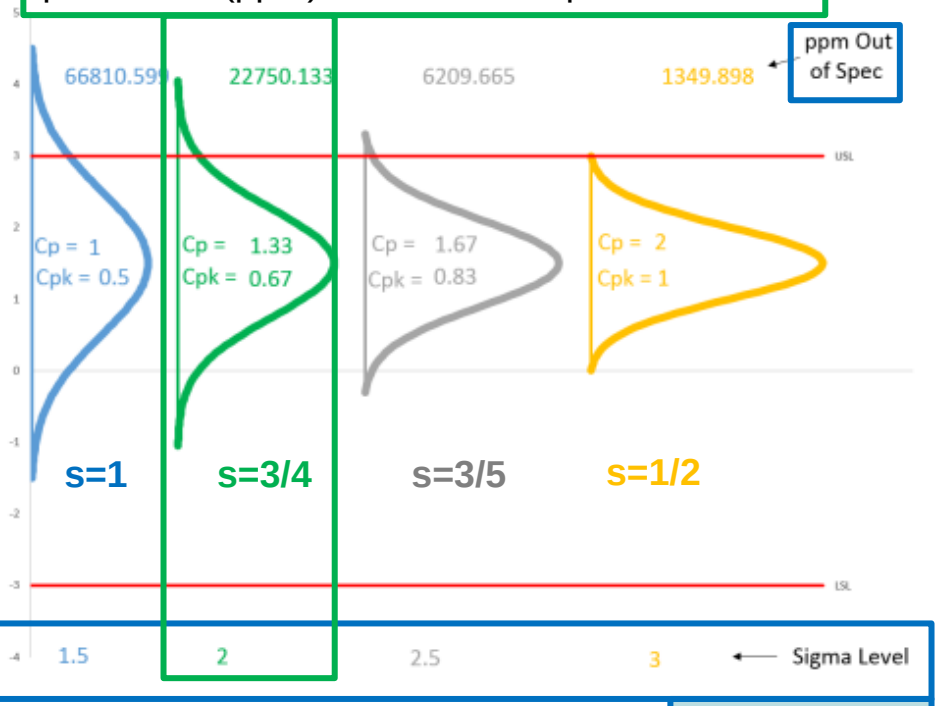


Change the example to have

- m = average = 1.5

Note: a capable process (Cp > 1.0) does not ensure that a product is within specifications.

Interpretation: if s=3/4 then, at a 2 sigma level, Cp=1.33, CPK=0.67, and 22,750 parts per million (ppm) will be out of spec



https://www.spcforexcel.com/knowledge/process-capability/interactive-look-process-capability

Specified six sigma level

Process Capability – Notes

Slide 1

1. The process standard deviation should be obtained from a range chart.
2. The formulae are straightforward to compute and to interpret.

Slide 2

1. On the figures, “ppm” = parts per million
2. As the process variance decreases the performance improves (i.e., more results are within the customer specification, which is the same as reduced defects)
3. However, if the process is not centered, then there may still be a large number of defects, even with a small variance.