Assessing Capability from an $\overline{X}$ & s Chart

Data Science for Quality Management: Process Capability

with **Wendy Martin**

Learning objective:

Assess capability from an Xbar and s chart for data that is normally distributed

Assess Potential Capability Due to Spread

```
# Cp only
spcxbar.s$capability[1,1:4] = 1.294149
```

$$C_p = \frac{USL - LSL}{NT} = \frac{3.5 - 1.5}{1.545} = 1.294$$

Assess Capability to Produce Within Specification

$$Z_{USL} = \frac{3.50 - 2.348}{0.2576} = 4.465$$

$$Z_{LSL} = \frac{2.348 - 1.5}{0.2576} = 3.287$$

$$\text{Total \% Out} = 0.05\%$$

```
LSL<-1.5
USL<-3.5
xbar<-mean(pcb$amps)
Zu<-(USL-xbar)/sig_est.s
pnorm(Zu, lower.tail = F)
Zl<-(LSL-xbar)/sig_est.s
pnorm(Zl, lower.tail = T)
```

Assess Capability to Produce Within Specification

$$C_{pk}U = \frac{USL - \mu}{3\sigma}$$

```
mean<-mean(pcb$amps)

spc.capability.cpU.simple(upper.specifica
tion = USL,process.center = xbar,
process.variability = sig_est.s^2,
n.sigma = 6
```

$$C_{pk}L = \frac{\mu - LSL}{3\sigma}$$

```
spc.capability.cpL.simple(lower.specifica
tion = LSL,process.center = xbar,
process.variability = sig_est.s^2,
n.sigma = 6)
```

Assess Capability to Produce Within Specification

```
# Cpk only
spcxbar.s$capability[2,1:4] = 1.097853
```

Assess Capability to Conform to Nominal

```
# Cpm only
spcxbar.s$capability[3,1:4] = 1.115153
```

$$C_{pm} = \frac{USL - LSL}{6\sqrt{\hat{\sigma}^2 + (\mu - Nominal)^2}} = 1.1151$$

Performance Measures

```
# Calculate overall standard deviation
s<-sd(pcb$amps)
= 0.2559824

# Calculate the natural tolerance
# If normally distributed, this is 6*s
nt_s<-6*s
= 1.535894
```

Performance Measures – Pp

```
# Pp only
spcxbar.s$capability[4,1:4] = 1.302173
```

Performance Measures – Ppk

```
# Ppk only
spcxbar.s$capability[5,1:4] = 1.10466
```

Performance Measures – Ppm

```
# Ppm only
spcxbar.s$capability[6,1:4] = 1.120274
```

Capability & Performance Data

statistic	eq	n	value
Cp	=		1.2941
Cpk	=		1.0979
Cpm	=		1.1152
Pp	=		1.3022
Ppk	=		1.1047
Ppm	=		1.1203
Obs. n / PPM (lower)	=	0	0.0000
Obs. n / PPM (upper)	=	0	0.0000
Obs. n / PPM (total)	=	0	0.0000
Pot. PPM (lower)	=		495.0000
Pot. PPM (upper)	=		4.0000
Pot. PPM (total)	=		499.0000

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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