Assessing Capability from an $\bar{X}$ & R Chart

Data Science for Quality Management: Process Capability

with **Wendy Martin**

Learning objective:

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

Capability of the Cartridge Bearing Production Process: Estimate the Process Average

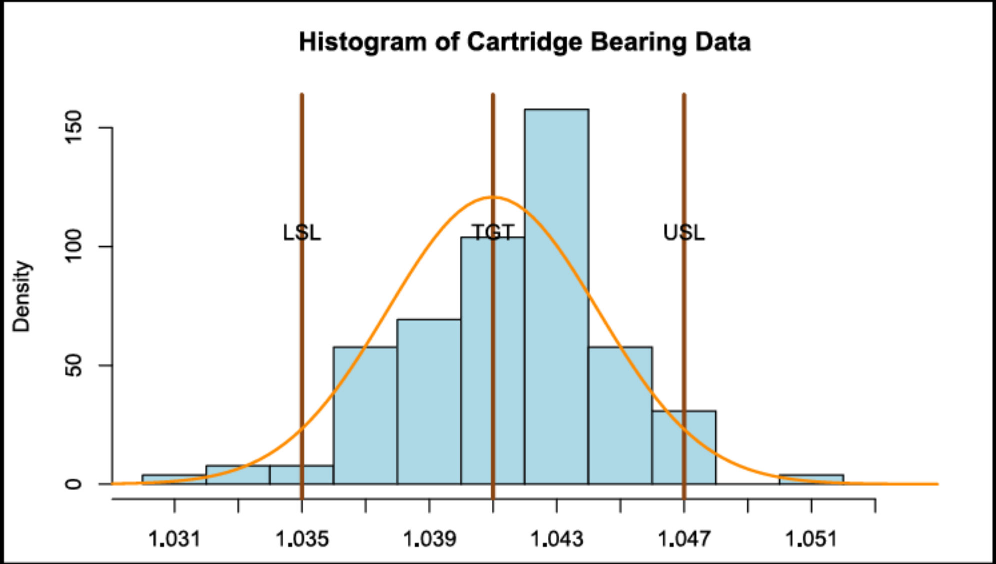
$$\hat{\mu} = \bar{\bar{X}}$$

$$\hat{\mu} = 1.0410$$

Capability of the Cartridge Bearing Production Process: Estimate the Natural Tolerance of the Process

- Test for Normality (why?)

```
nqtr(summary.continuous(xbar.r.
column$value),5)
n 130
mean                  1.04099
var                   0.00001
g3.skewness           -0.36425
g3test.p              0.0861
g4.kurtosis           0.14998
g4test.p              0.60112
```



Capability of the Cartridge Bearing Production Process: Estimate the Natural Tolerance of the Process

- Test for Normality
- Estimate the standard deviation

$$\hat{\sigma} = \frac{\bar{R}}{d_2} = \frac{0.0076}{2.326}$$

Control Chart Constants

n	A_2	D_3	D_4	d_2	d_3	c_4
2	1.880	None	3.267	1.128	0.853	0.7979
3	1.023	None	2.574	1.693	0.888	0.8862
4	0.729	None	2.282	2.059	0.880	0.9213
5	0.577	None	2.115	2.326	0.864	0.9400
6	0.483	None	2.004	2.534	0.848	0.9515
7	0.419	0.076	1.924	2.704	0.833	0.9594
8	0.373	0.136	1.864	2.847	0.820	0.9650
9	0.337	0.184	1.816	2.970	0.808	0.9693
10	0.308	0.223	1.777	3.078	0.797	0.9727
11	0.285	0.256	1.744	3.173	0.787	0.9754
12	0.266	0.283	1.717	3.258	0.778	0.9776
13	0.249	0.307	1.693	3.336	0.770	0.9794
14	0.235	0.328	1.672	3.407	0.763	0.9810
15	0.223	0.347	1.653	3.472	0.756	0.9823

Standard Deviation (Est).

$$\frac{\bar{R}}{d_2}$$

```
spcxbar.r<-
spc.chart.variables.mean.and.meanrange(
data = bearing$diameter,
sample = bearing$sample,
stat.lsl = 1.035
stat.target = 1.041
stat.usl = 1.047
chart1.main = "Mean Chart - Diameter",
chart2.main = "Range Chart")
```

Standard Deviation (Est).

$$\frac{\bar{R}}{d_2}$$

```
rbar<-
unique(spcxbar.r$chart2.center.line)

d2<-spc.constant.calculation.d2(5)

sig_est<-rbar/d2 = 0.003274126
```

Capability of the Cartridge Bearing Production Process: Estimate the Natural Tolerance of the Process

- Test for Normality
- Estimate the standard deviation
- Calculate the estimated natural tolerance (NT’) of the process

$$\mathrm{NT}' = (\mu + 3\sigma) - (\mu - 3\sigma) = 6\sigma$$

NT’=0.01965

Natural Tolerance (Normal)

- Calculate the natural tolerance
- If normally distributed, this is 6*sig_est

```
nt_est<-6*sig_est = 0.01964476
```

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
- Luftig, J. Advanced Statistical Process Control & Capability. Luftig & Associates, Inc. Farmington Hills, MI, 1984.
- Luftig, J. A Quality Improvement Strategy for Critical Product and Process Characteristics. Luftig & Associates, Inc. Farmington Hills, MI, 1991
- Luftig, J. Guidelines for Reporting the Capability of Critical Product Characteristics. Anheuser-Busch Companies, St. Louis, MO. 1994
- Spooner-Jordan, V. Understanding Variation. Luftig & Warren International, Southfield, MI 1996
- Luftig, J. and Petrovich, M. Quality with Confidence in Manufacturing. SPSS, Inc. Chicago, IL 1997
- Littlejohn, R., Ouellette, S., & Petrovich, M. Black Belt Business Improvement Specialist Training, Luftig & Warren International, 2000
- Ouellette, S. Six Sigma Champion Training, ROI Alliance, LLC & Luftig & Warren, International, Southfield, MI 2005