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

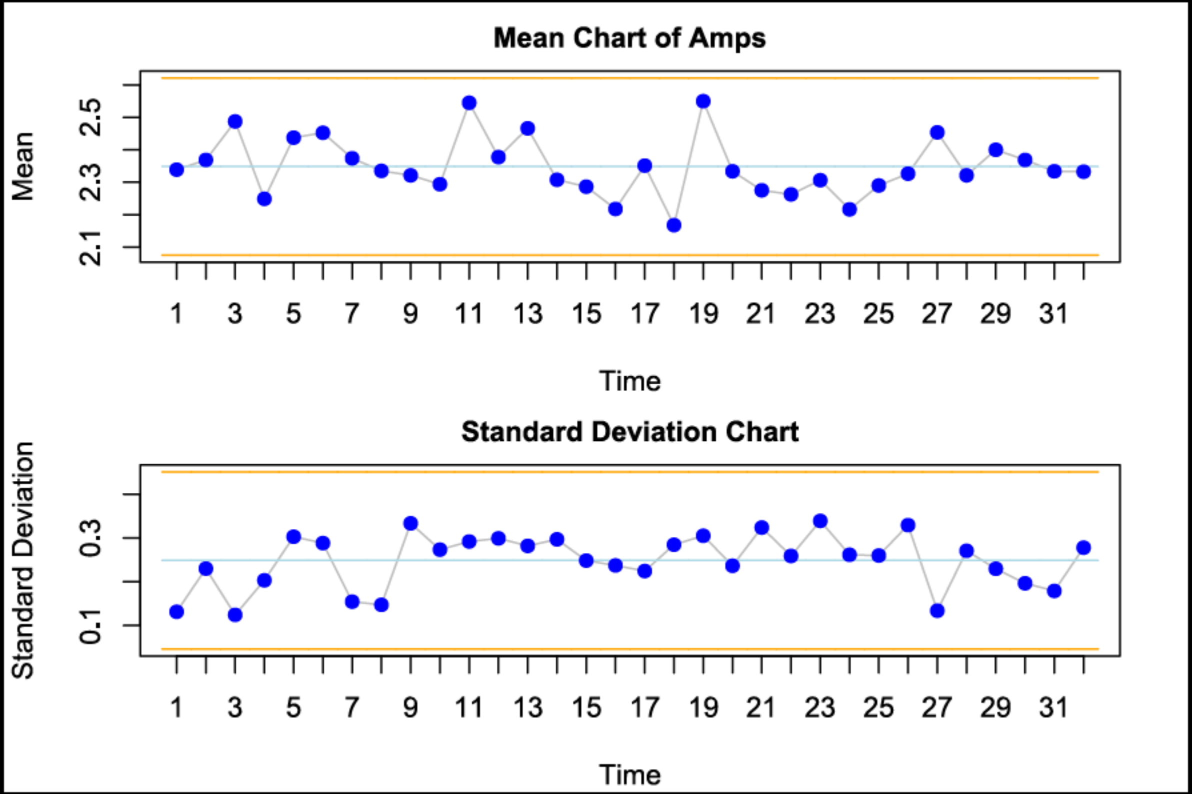
The Case of the Printed Circuit Board

- Your plant has had some customer concerns with the plating voids on your printed circuit board units.
- Your plant manager has assured the customer that they work correctly but suggests that you investigate the matter

The Case of the Printed Circuit Board

- You start by assessing the process for control and capability.
- The specifications for the current measurement are 2.5 ± 1.0 amps.
- The supervisor and the lab technician agree to assist you with the initial study of this process.

X-Bar & s Control Chart



X-Bar & s Control Chart

- ```
  spcxbar.s<-
  spc.chart.variables.mean.and.meanstand
  arddeviation(data = pcb$amps
  ,sample = pcb$sample
  ,stat.lsl = 1.5
  ,stat.target = 2.5
  ,stat.usl = 3.5
  ,chart1.main = "Mean Chart of Amps“
  ,chart2.main = “S Chart")
  ```
  ```

X-Bar & s Control Chart

- Control Analysis – In control

Estimate the Process Average

$$\hat{\mu} = \bar{\bar{X}} = 2.348$$

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

Check for Normality (within subgroup)

- ```
  subgroup_norm<-
  ro(summary.continuous(fx =
  amps~sample,
  data = pcb,
  stat.mean = F,
  stat.var = F,
  stat.miss = F),4)
  ```
  ```

Estimate the Std. Dev. From the Chart

```
sbar<-mean(spcxbar.s$parameter.standard.deviations)

c4<-spc.constant.calculation.c4(8)

sig_est.s<-sbar/c4 = 0.2575694
```

$$\hat{\sigma} = \frac{\bar{s}}{c_4} = \frac{0.249}{0.965} = 0.2576$$

Estimate the Natural Tolerance

```
nt_est<-6*sig_est.s
=  1.545417
```

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.
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- 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