Individuals and Moving Range Charts

Data Science for Quality Management: Xbar and R / Xbar and S charts / X and MR charts

with **Wendy Martin**

Learning objective:

Create centerlines for the normally distributed X and MR chart

The Case of Chrome Plate Tank

- A quality improvement team has been working to minimize variation in chrome thickness in a plating operation.

The Case of Chrome Plate Tank

- From experimental design efforts, you have discovered the critical variables that influence chrome thickness and produce chrome defects.
- One of these variables is the chemical concentration of the chrome plate bath.

The Case of Chrome Plate Tank

- Periodically, an operator manually adds chemicals to the bath.

- You have been taking a single measure every two hours. Since the bath is homogenous, only a single measure needs to be taken.

The Case of Chrome Plate Tank

- The team has suggested displaying the data on a control chart to monitor changes through time.

- You agree and recommend using an individuals and moving range chart.

Step 1: Select the Characteristic

- Chemical concentration is selected
- Measurement process — OK
- Specifications are 32 ± 3%

Step 2: Select the Sampling Plan

- Concentration levels do not change rapidly
- If the concentration level does change, and is not detected, scrap and high costs result
  - Balance the cost of sampling with the risk of not detecting

Step 2: Select the Sampling Plan

- Take sample measures randomly within each two hour period from Tank #6 while it is in operation.

Step 3 : Select the Chart Type

- Since only single values will be taken, we should use the:

X and
Moving Range Chart

Step 4: Collect Data

Data collected for 25 consecutive 2-hour periods

Period	Data	Period	Data	Period	Data	Period	Data	Period	Data
1	32.00	6	32.00	11	31.00	16	31.00	21	30.00
2	33.00	7	33.00	12	33.00	17	33.00	22	31.00
3	32.00	8	32.00	13	33.00	18	35.00	23	32.00
4	31.00	9	34.00	14	30.00	19	34.00	24	32.00
5	31.00	10	32.00	15	29.00	20	32.00	25	33.00

Step 5: Generate Chart

- RStudio
  - File | Import Dataset
  - Choose Chrome.dat
  - spc.chart.variables.individual.and.movingrange.normal.simple( )

Sample Statistics

- The Moving Range (MR) is the range between successive values
- No MR for first subgroup
- Because the Moving Range values are dependent, standard rules for runs and trends do not apply

Sample Statistics — MR

The Moving Range Calculations

X	2	4	6	3	1	4	5
MR	-	2	2	3	2	3	1

Centerlines

- Centerlines for individual charts
  - $\bar{X}$
  - Median ($\tilde{X}$)

- Centerlines for moving range charts
  - $\overline{MR}$
  - Median MR ($\widetilde{MR}$)

Centerlines

$$\overline{\mathrm{X}} = \mathrm{CL}_{\mathrm{x}} = 32.040$$

$$\overline{\mathrm{MR}} = \mathrm{CL}_{MR} = 1.292$$

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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