# Process and Performance Capability

Green Belt - Six Sigma MOOC

Course 3 Module 3

Kennesaw State University

# Designing a Process Capability Study

Video 2

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## Designing a Process Capability Study

Steps for a Process Capability Study

1. Perform a Measurement System Analysis. This helps remove variability due to part measuring
2. Identify an appropriate subgroup size from 4-10. This is the sample size you will be measuring. Most between 3-5.
3. Identify the time sequence for drawing these samples. Every hour? Every shift? Every day?

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## Designing a Process Capability Study

Steps for Process Capability Studies

4. For each subgroup of 3-5 sample parts, take measurements, average, and plot the average number on the X-bar chart.
5. Do this for 20 group readings
6. Analyze for statistical stability and process capability

## In-Video Quiz 1

How many samples should there be in a subgroup?

- 1 to 2
  - Incorrect. Between 3 and 5 is typical
- 3 to 5
  - Correct! No less than 2 and rarely more than 5 is typical
- 10 to 15
  - Incorrect. Between 3 and 5 is typical
- 34 to 43
  - Incorrect. Between 3 and 5 is typical

## Designing a Process Capability Study

Construct an $\overline{X}$ (X-bar) and R chart

1. Determine the sample subset size (n = 3, 4, or 5)
2. Collect 20-25 sets of time-sequenced samples (60-90 data points)
3. Calculate the average for each subset of samples to equal X-bar
4. Calculate the Range for each set of samples to equal R

## Designing a Process Capability Study

Construct an $\overline{X}$ (X-bar) and R chart

5. Calculate $\overline{\overline{X}}$ (X-double bar) or the average of all the X-bars
6. Calculate $\overline{R}$ (R-bar) or the average of all the R's

## Designing a Process Capability Study

Construct an $\overline{X}$ (X-bar) and R chart

7. Calculate the control limits:

X-bar Chart:

$$UCL_{\overline{X}} = \overline{\overline{X}} + A_2 * \overline{R}$$

$$LCL_{\overline{X}} = \overline{\overline{X}} - A_2 * \overline{R}$$

R Chart:

$$UCL_R = D_4 * \overline{R}$$

$$LCL_R = D_3 * \overline{R}$$

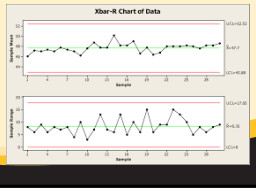
Chart of statistical constants

| n | $A_2$ | $D_3$ | $D_4$ | $d_2$ |
|---|---|---|---|---|
| 2 | 1.88 | 0 | 3.27 | 1.13 |
| 3 | 1.02 | 0 | 2.57 | 1.69 |
| 4 | 0.73 | 0 | 2.28 | 2.06 |
| 5 | 0.58 | 0 | 2.11 | 2.33 |
| 6 | 0.48 | 0 | 2.00 | 2.53 |

## Designing a Process Capability Study

Construct an $\overline{X}$ (X-bar) and R chart

8. Draw X-bar and R charts with UCL and LCL for each
9. Plot the data and interpret the chart for special or assignable causes



## X-bar and R Chart Example

Suppose we have a subgroup of 5 parts and we recorded the measurements of 20 sample groups on a timed interval of every hour.

After some averaging we get $\overline{\overline{X}}$ = 45 and $\overline{R}$ of 20. Using the formulas we get:

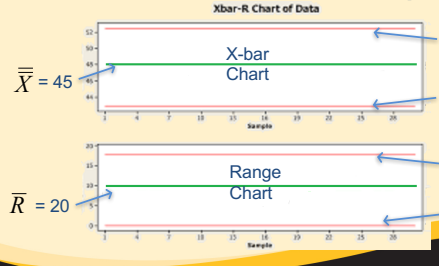
For the X-bar chart: $UCL_{x\text{-}bar}$ = 45 + 0.58*20 = 56.6
$LCL_{x\text{-}bar}$ = 45 – 0.58*20 = 33.4
For the R chart: $UCL_R$ = 2.11*20 = 42.2
$LCL_R$ = 0*20 = 0

## In-Video Quiz 1

What is the correct formula for $UCL_R$?

- $\overline{\overline{X}} - A_2 * \overline{R}$
  - Incorrect. The correct formula is $UCL_R = D_4 * \overline{R}$
- $D_4 * \overline{R}$
  - Correct! This is the correct formula for $UCL_R$
- $D_3 * \overline{R}$
  - Incorrect. The correct formula is $UCL_R = D_4 * \overline{R}$
- $\overline{\overline{X}} + A_2 * \overline{R}$
  - Incorrect. The correct formula is $UCL_R = D_4 * \overline{R}$

## X-bar and R Chart Example




$\overline{\overline{X}}$ = 45
$\overline{R}$ = 20
$UCL_{x\text{-}bar}$ = 45
$LCL_{x\text{-}bar}$ = 33.4
$UCL_{x\text{-}bar}$ = 42.2
$LCL_R$ = 0
= 45

## X-bar and R Chart Example

After adding in X-bar data points, we can see the monitoring ability of a control chart.


X-bar Chart

Range Chart

= 45

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End video

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