Minitab®

SPC

LESSON: Quality Methods - Introduction to Control Charts

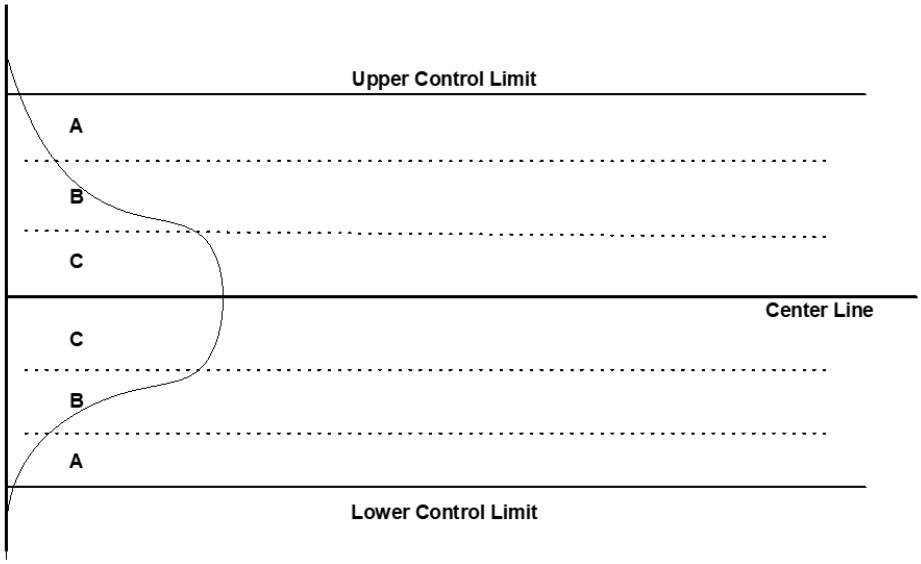
Quality Methods

Control Chart False Alarms

Dr. Diane Evans

ROSE-HULMAN
INSTITUTE OF TECHNOLOGY

"The Zones" & Other Rules for Indicating an Out of Control Process



Rules for Out of Control Process

"Most Popular" 5 Rules: A process is out of control if

- A single point plots outside the LCL or UCL
- Two out of three consecutive points fall outside the 2s warning limits on the same side of the center line
- Four of five consecutive points fall beyond the 1s limit on the same side of the center line
- Nine or more consecutive points fall to one side of center line
- A run of six or more consecutive points increasing or decreasing.

Additional Rules We'll Consider:

- Fifteen points in a row within 1s of center line (either side)
- An unusual or nonrandom pattern in the data (deterministic or trendy patterns)

✓ **Minitab** uses 8 tests for determining an out of control process. These are listed on the next slide.

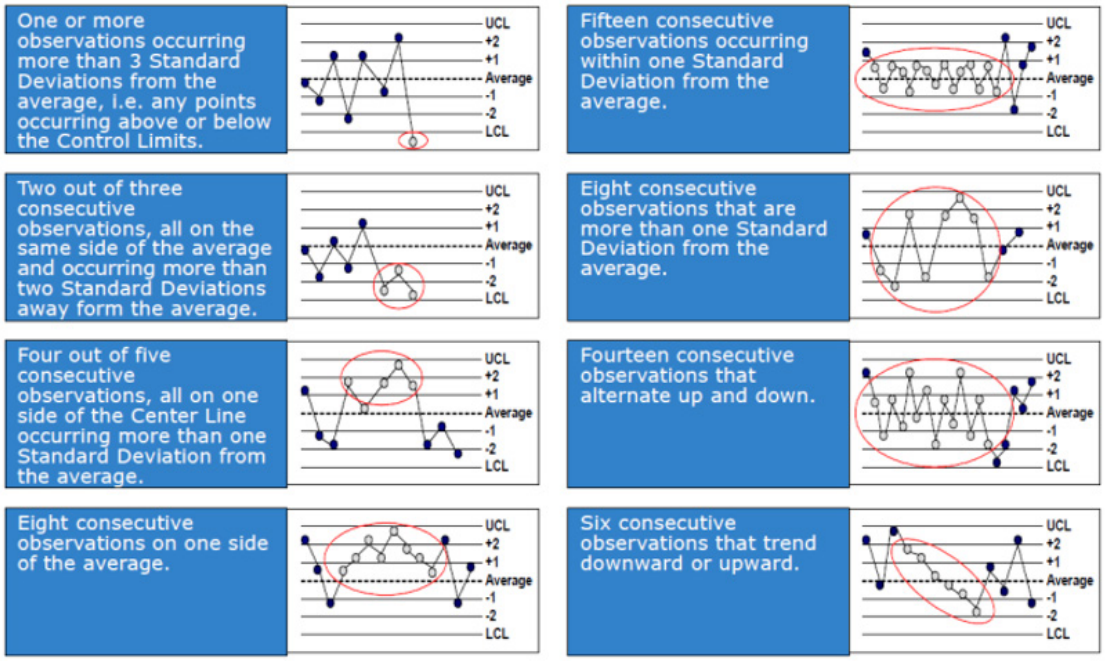
✓ Nothing 'magical' about these rules – all are simply 'very unlikely' events if a process is truly in control

✓ Minitab places a small number by the point on the control chart when a rule is broken

Rule	Minitab Xbar Chart	Minitab R Chart
Point Outside LCL or UCL	1	1
9 Above/Below CL (same side)	2	2
Run of 6 or More All Increasing/Decreasing	3	3
14 in Row Oscillating	4	4
2 of 3 in Zone A (same side)	5	
4 of 5 In Zones A or B (same side)	6	
15 in Zones C	7	
8 in a Row in Either A or B	8	
Abnormal patterns		

Minitab places a small number by the point on the control chart when a rule is broken

Rules for Out of Control Process

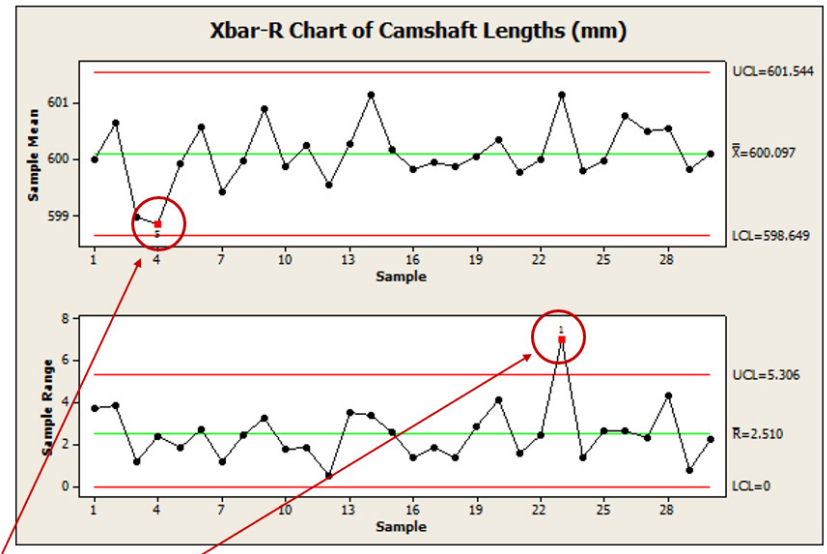


Example 1. Camshaft Lengths

You work at an **automobile engine assembly plant**. One of the parts, a camshaft, must be **600 mm + 2 mm long** to meet engineering **specifications**.

There has been a chronic problem with camshaft length being **out of specification**, which causes poor-fitting assemblies, resulting in **high scrap** and **rework rates**.

Your supervisor wants to run **$\bar{X}$ and R charts** to monitor this characteristic. For the next 20 days, you collect a subgroup of **n = 5 camshafts** each day and place their average length on an $\bar{X}$ control chart. The range of the 5 observations is placed on the R chart.



TEST 5. 2 out of 3 points more than 2 standard deviations from center line (on one side of CL). Test Failed at points: 4

TEST 1. One point more than 3.00 standard deviations from center line. Test Failed at points: 23

Which Rules to Apply?

As more rules are applied, the risk of a Type ___ error increases. Why?

The thinking today is to apply only 2 or 3 rules (perhaps Rules 1 and 4). Pick ones to suit process history and trends.

Possibly apply the rest to highlight potential trouble for closer monitoring, but not to take immediate action.

Must ultimately conclude – **My process is or is not in control and then take action**.

False alarm rate

Suppose you're using r "independent" rules for determining an out of control process, where each rule has probability of Type I error as p

The overall probability of a Type I error is:

Example 2. 4 independent rules are being used to declare a process out of control; their a values are: 0.05, 0.01, 0.10, 0.05. Overall probability of Type I error?

Example 2. A manager is contemplating using **Rule 1** (one sample point beyond the LCL or UCL) and **Rule 2** (at least 9 points on same side of the center line) for determining an out-of-control process.

- What is the probability of committing a Type I Error using Rule 1 only?
- What is the probability of committing a Type I Error using Rule 2 only?
- Are Rules 1 and 2 MUTUALLY EXCLUSIVE? Why or why not?
- What is probability of committing a Type I Error if both rules are applied simultaneously? Assume independence of the two rules.

Example 3. What is the probability of a Type I error using Rule 5 only? **Rule 5**: Two out of three consecutive points fall outside the 2o warning limits on the same side of the center line. I'll give you the unsimplified options to help you reason through the choices.

(A) $\binom{3}{2}\cdot(0.0228)^2\cdot(1-0.0228)$

(B) $2\cdot\binom{3}{2}\cdot(0.0228)^2\cdot(1-0.0228)$

(C) (0.0228)^2·(1–0.0228)

(D) $2\cdot\binom{3}{2}\cdot(0.00135)^2\cdot(1-0.00135)$

(E) $(0.00135)^2\cdot(1-0.00135)$