Lecture #15

Prof. John W. Sutherland

Sept. 30, 2005

Quality Engineering (MEEM 4650 / 5650)
Dept. of Mechanical Engineering - Engineering Mechanics
Michigan Technological University

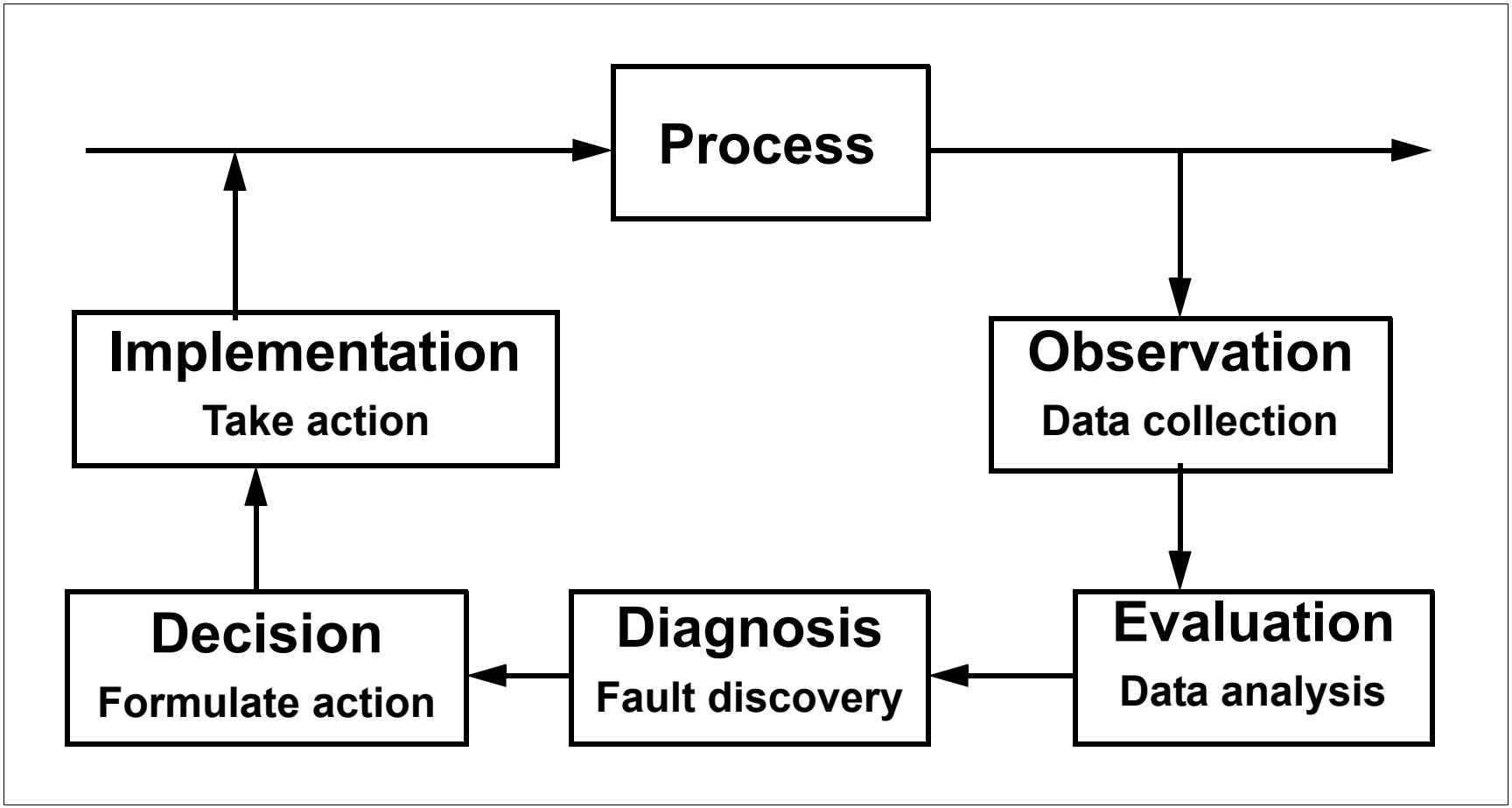
Process of Statistical Process Control

Uses of Control Charts

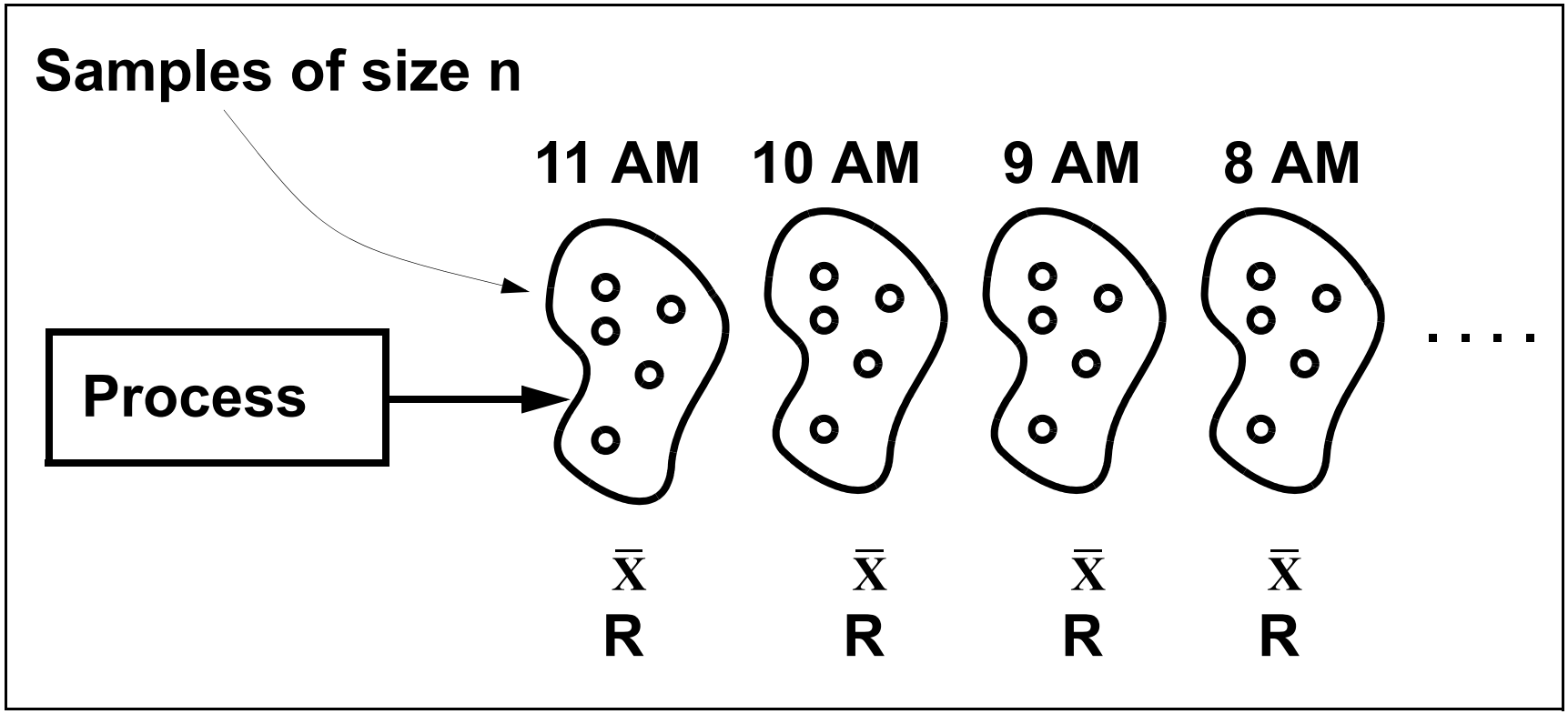
- **Off-line. To identify when special/sporadic causes enter the process and to characterize the level of common-cause variability. Where to look for improvement opportunities. Help to formulate & assess effect of actions.**

- **On-line. To serve as a tool (provide a sound economic basis) for operators to make decisions at the machine as to when to adjust the machine (and when to leave it alone).**

Control System View of SPC

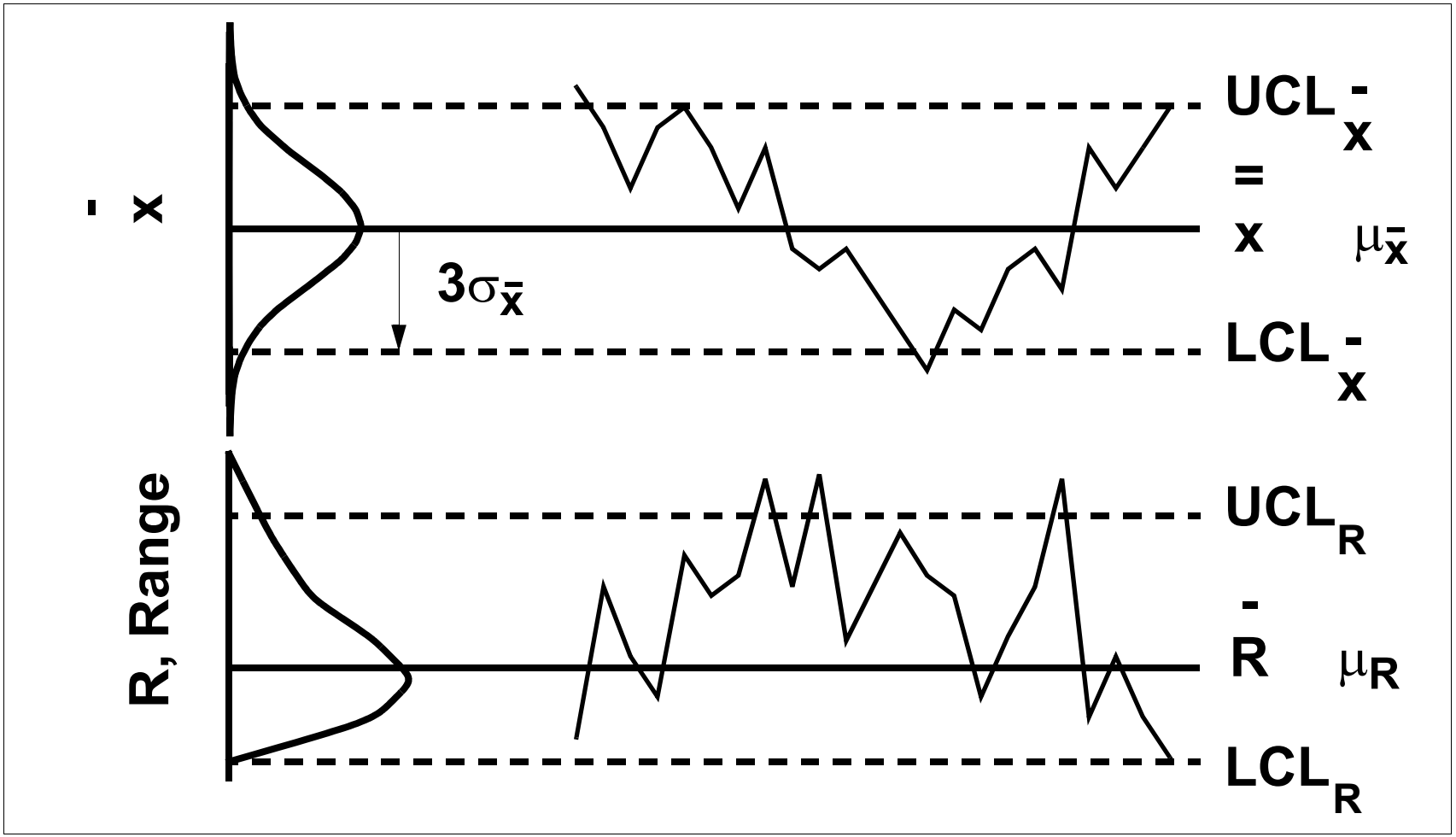


So, where do we stand??

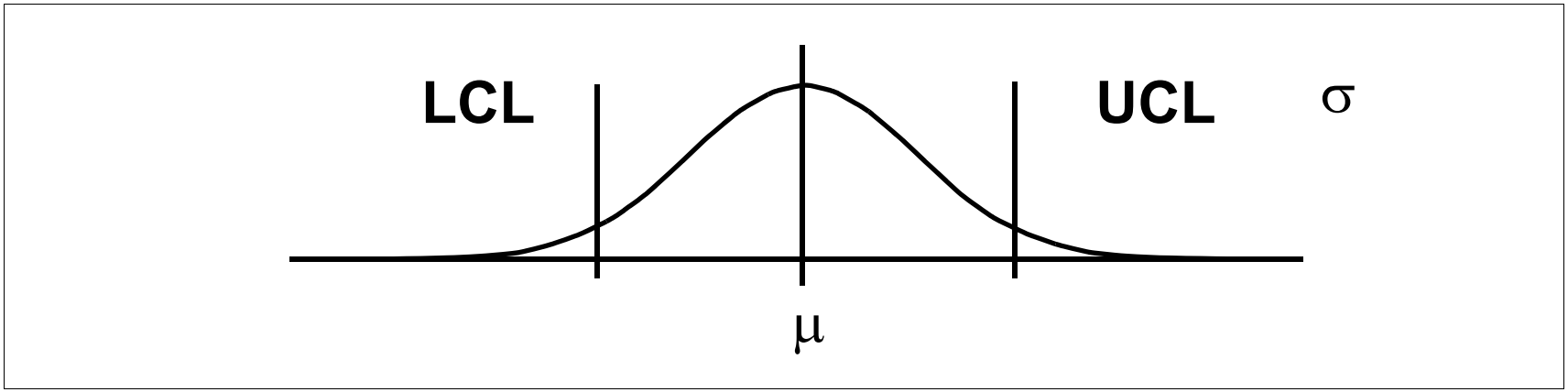


Monitor changes in $\bar{X}$ and R as a function of time

Shewhart Control Chart Model

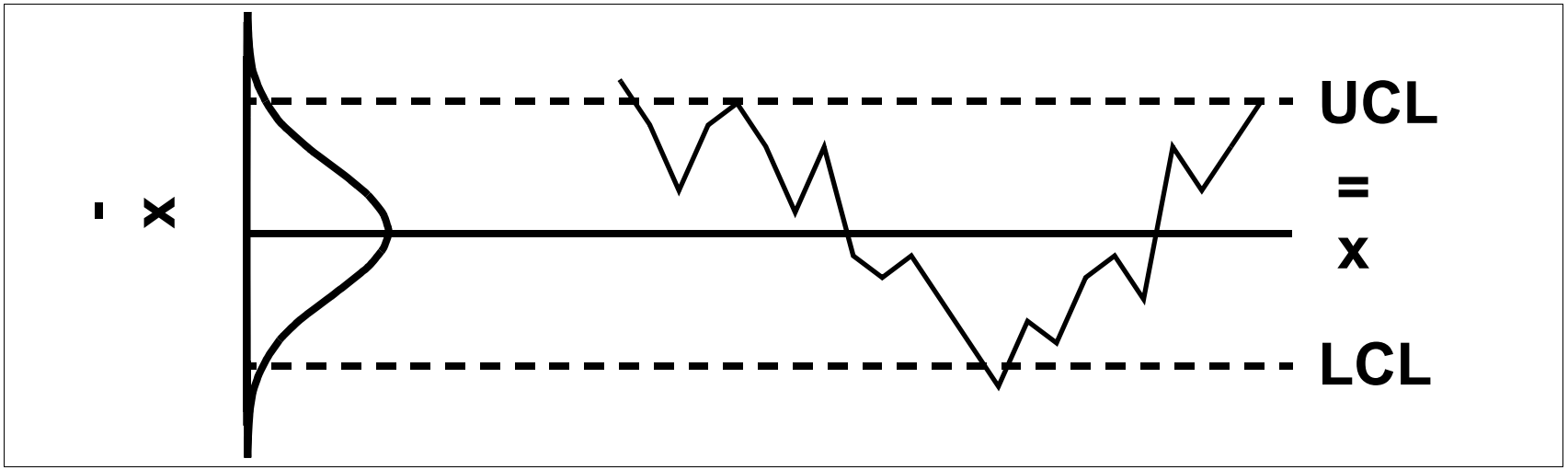


Control Chart - Hypothesis Test



Control limits depend, of course, on the risk level, α

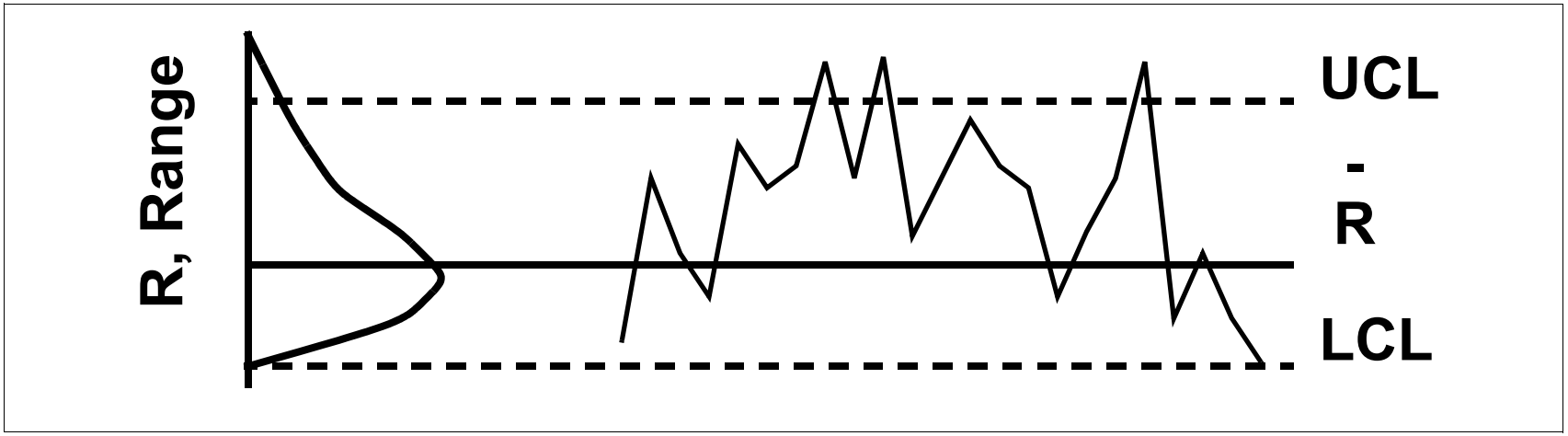
Where do we put the limits??



Centerline

Put the limits 3 standard deviations from the mean

Limits??



Centerline

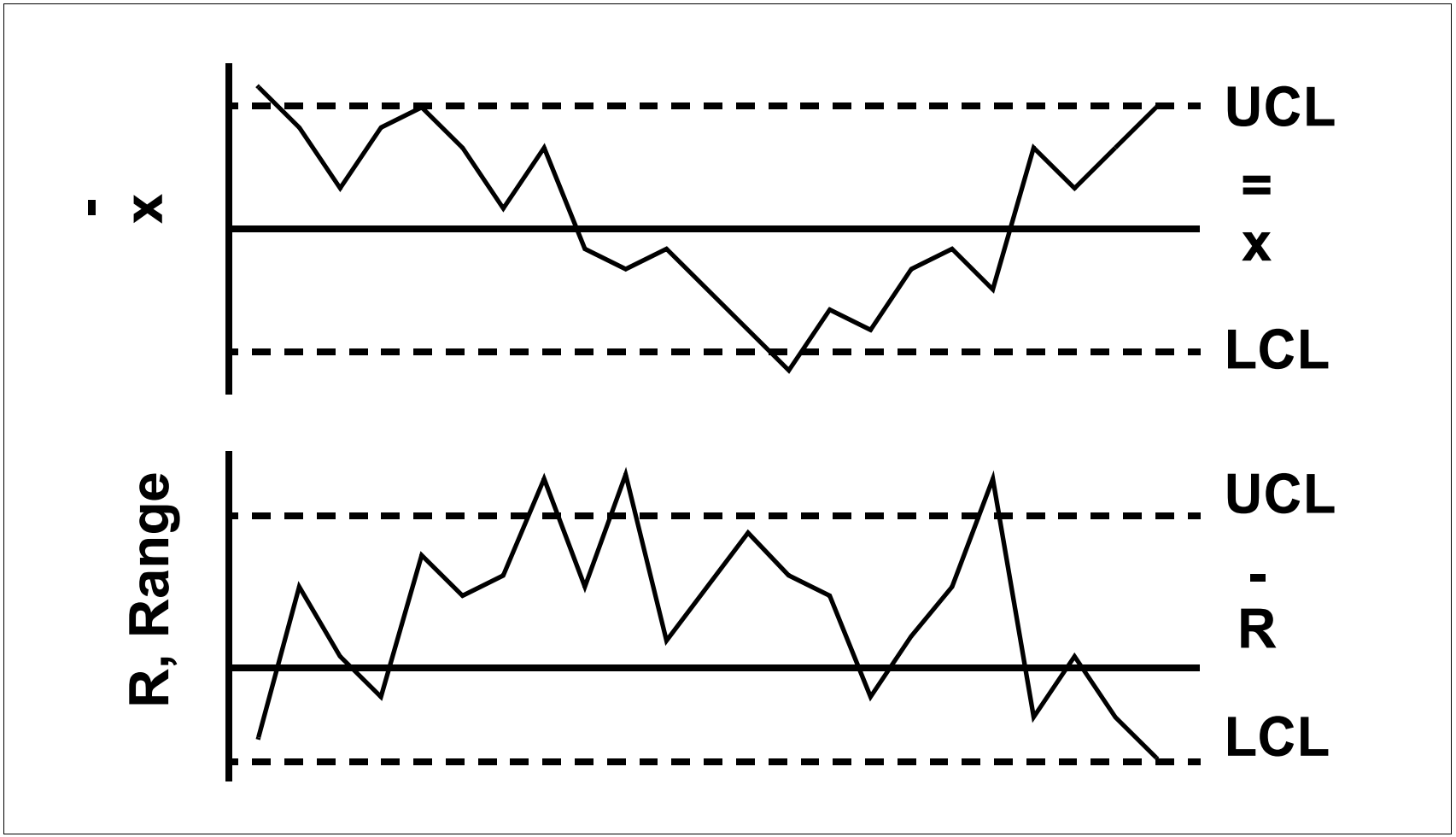
Put the limits 3 standard deviations from the mean

Chapter 6 - Making Control Charts

Sample			X_{ij}				
1	2	7	6	4	4		
2	8	6	4	7	5		
3	7	1	6	5	3		
k	5	6	3	4	5		

$$= \quad \bar{X} = \sum_{i=1}^{k} \bar{X}_i / k \qquad \bar{\bar{R}} = \sum_{i=1}^{k} R_i / k$$

Chart Guidelines



Xbar Chart Details

$$\mu_{\bar{X}} \pm 3\sigma_{\bar{X}} = \bar{\bar{X}} \pm 3\sigma_{\bar{X}} \qquad \sigma_{\bar{X}} = \text{??}$$

Control Limits $= \bar{\bar{X}} \pm A_2\bar{R}$

R Chart Details

$\mu_R \pm 3\sigma_R$ $\bar{R} \pm 3\sigma_R$

Control Limits $UCL : D_4\bar{R}$ $LCL : D_3\bar{R}$

Control Charts (cont.)

Now we know how to construct control charts!!

We know to look for points beyond the limits -- is this enough?

How do we interpret the control charts??

Remember, our goal is to learn about the process -- we want to extract as much information as possible from the charts.

Interpreting Control Charts

- We will look for more than just points beyond the limits, i.e., extreme points.
- Behavior that suggests presence of special causes.
  - Trends / cyclic behavior
  - High proportion of points near / beyond the limits
  - Sudden shifts in level
  - In general, any non-random behavior

8 Rules for Chart Interpretation

- Test 1: Extreme points
- Test 2: 2 out of 3 points in zone A or beyond
- Test 3: 4 out of 5 points in zone B or beyond
- Test 4: Runs above / below the centerline
- Test 5: Linear trend
- Test 6: Oscillatory trend
- Test 7: Avoidance of zone C
- Test 8: Run in zone C

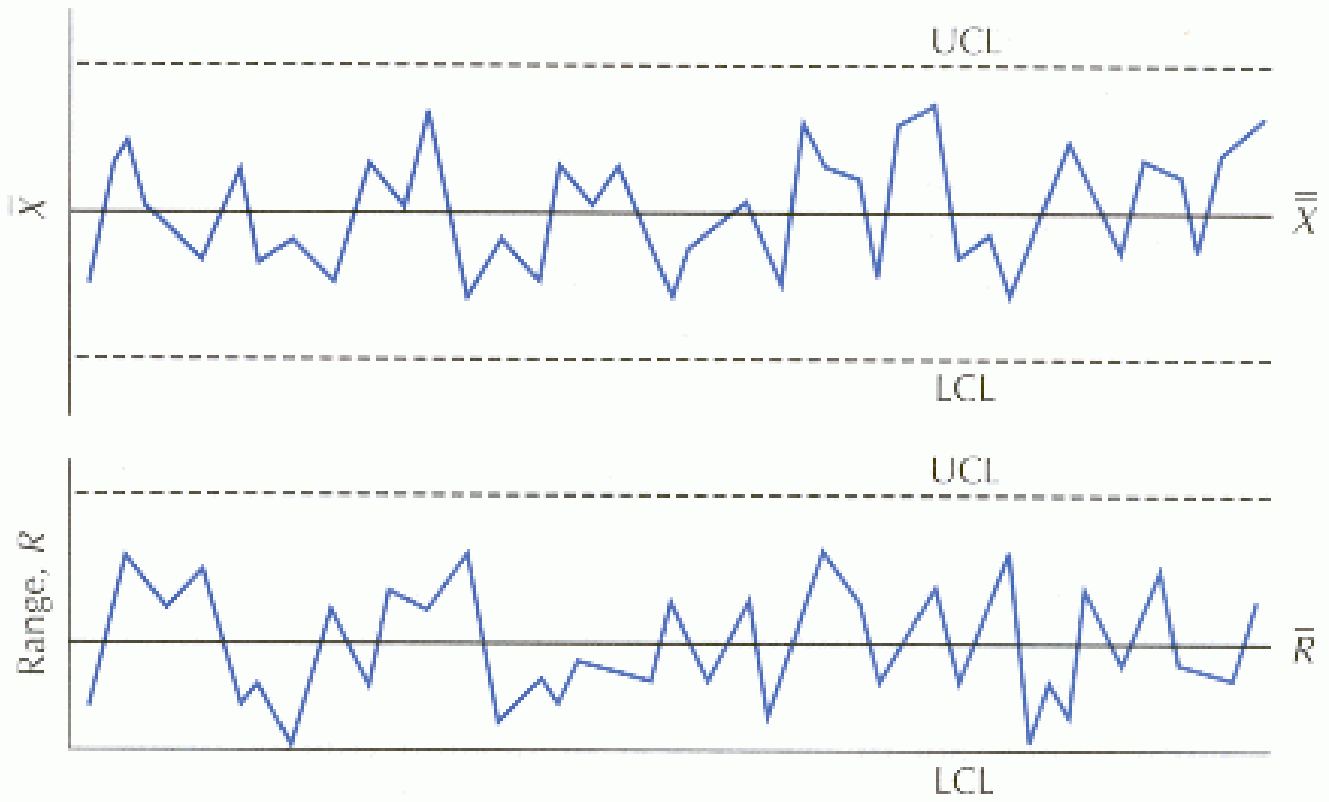


Figure 6.2 Appearance of a Process in Good Statistical Control

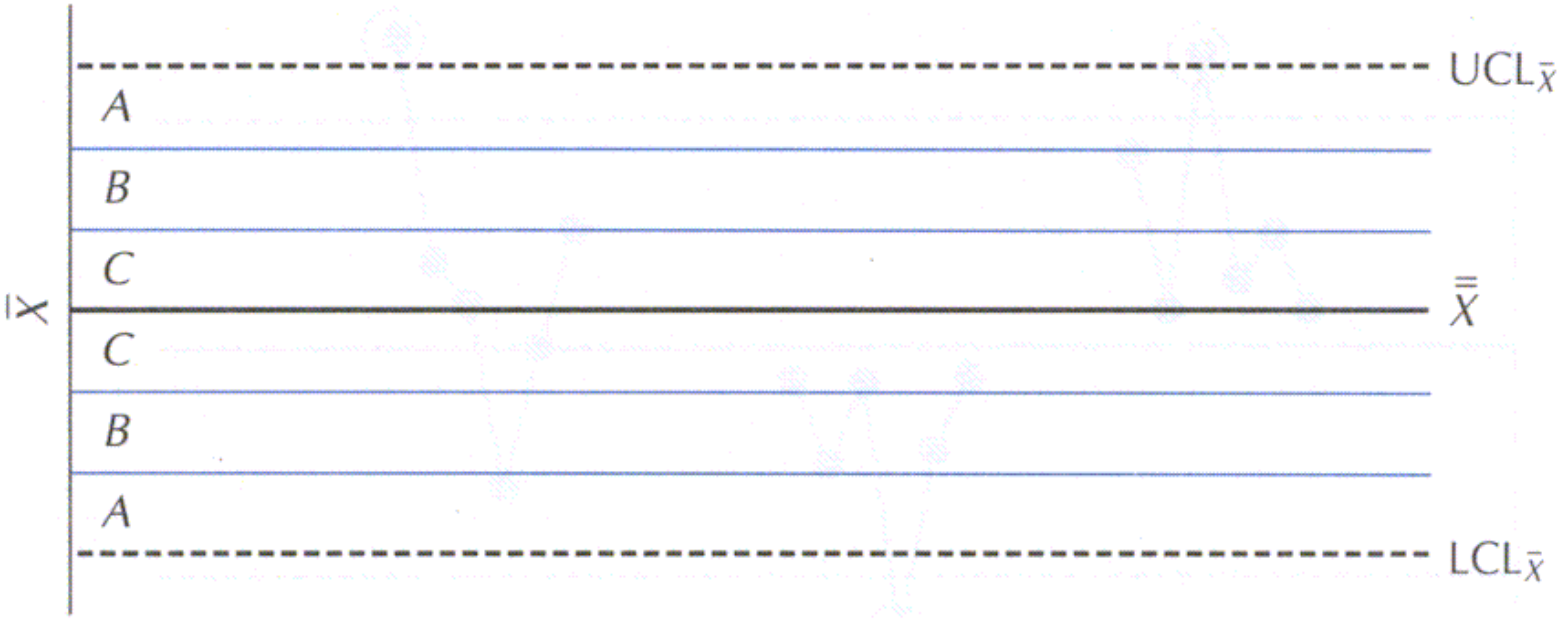


Figure 6.3 Control Chart Zones to Aid Chart Interpretation

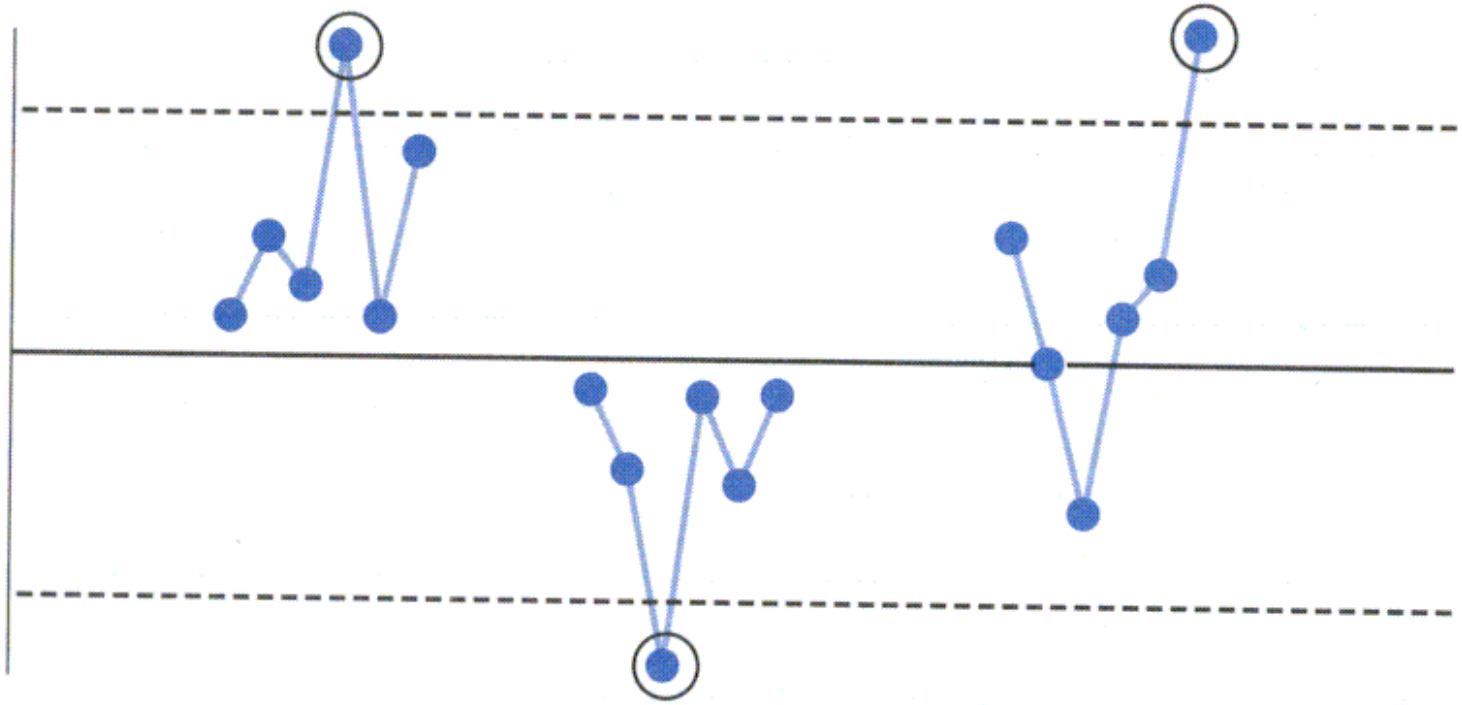


Figure 6.4 Examples of Test 1: Extreme Points