

Module 5:

Assessing and Achieving Stability Using Individuals Control Charts

Objectives

- ❑ **Recognize the limitations of attribute data**
- ❑ **Construct and interpret XmR control charts**
- ❑ **Assess process stability using individual data**
- ❑ **Differentiate between common and special causes**
- ❑ **Use control charts to set the aim in a process**

Control Chart Data for Individuals Charts

- **Periodically-collected measurement data**
 - **Subgroup size dependent on subgroup frequency**
 - **Inability to select subgroup size:**
 - **Makes logical subgroup size 1**
- **Attribute Data**
 - **Subgroup size $n = 1$**

Attribute Charts

- ❑ **When to use attribute charts**
- ❑ **Measurement data not feasible**
- ❑ **Systems approach**

Limitations of Attribute Data

- ❑ **Less informative than measurement data**
- ❑ **Ambiguity**
- ❑ **Less sensitive in detecting process changes**
- ❑ **Aggregate data**

How to Make Attribute Charts Useful

- **Data Collection**
 - ① **Focus**
 - ① **Rational sampling**
- **Operational definitions**

Focusing on the Right Data

		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday	
Equipment	Worker	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm
Machine 1	A	00X*	0X	000	0XX	000X XX*	0000 XXX	0000 X**	0XX	0000	00	0	XX*
	B	0XX*	000X X0	0000 00XX	000X X	0000 00XX *	0000 00X*	0000 0X	000X **	00XX *	0000 0	00X	000* XOX
Machine 2	C	00X	0X	00	*	0000 0	0000 00X	00	0*	00#	00+	#0	0
	D	00X	0X	00	000*	000* #	0000 0X	0*0	00#	00## +	0**	+00X	XXO

0 Surface scratches X Cracks # Improper shape * Incomplete + Others

(Ishikawa,1985)

Individual Values and Moving Range (XmR) Charts

- ❑ Subgroup size $n = 1$ (periodically collected measurement data or attribute data)
- ❑ Calculations similar to \bar{X} and R
- ❑ Ranges based on differences between successive data points
- ❑ Condition for using XmR charts for attributes data
 - Average count per area of opportunity must be greater than one.

XmR Chart: Construction Steps

1. Collect data
2. Record the data in the control chart form
3. Calculate the moving ranges
4. Calculate center line for the mR portion:

$$\overline{mR} = \frac{\sum mR}{k - 1}$$

5. Calculate the UCL_{mR} : $UCL_{mR} = 3.268 \overline{mR}$

6. Calculate center line for the X portion: $\overline{X} = \frac{\sum X_k}{k}$

XmR Chart: Construction Steps

7. Calculate the UNPL and LNPL (X portion):

$$\text{UNPL} = \bar{X} + 2.66 m\bar{R}$$

$$\text{LNPL} = \bar{X} - 2.66 m\bar{R}$$

8. Select the scales for the control chart

9. Plot the Xs and mRs

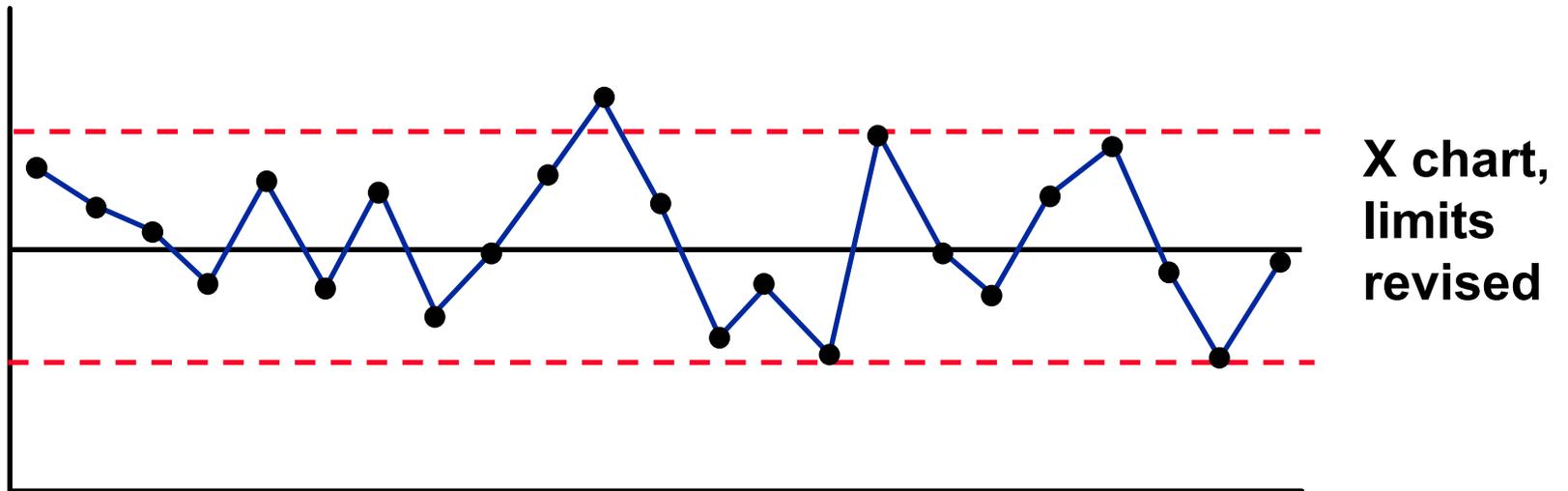
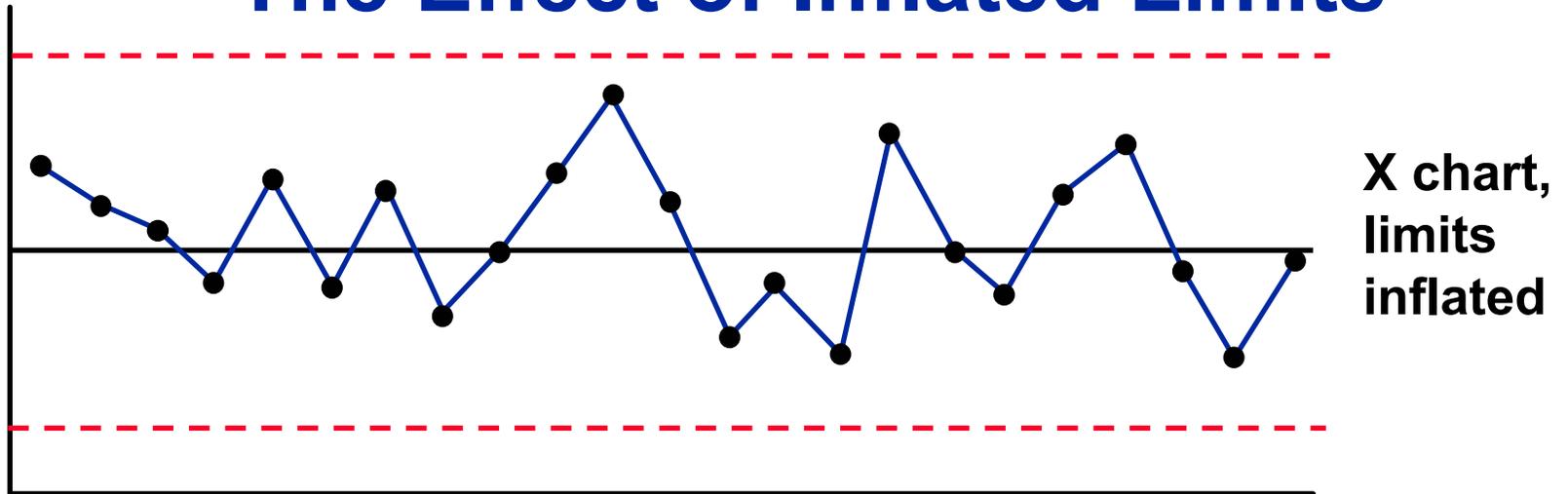
10. Draw the center lines and control limits on each chart

11. Draw the lines for zones A, B, and C

Interpretation - XmR Chart

- **mR Portion - use Rule 1 only**
- **X Portion - use Rules 1 - 4**

The Effect of Inflated Limits



Check for Inflated Limits

- If any point is outside UCL_{mR}
- If two-thirds or more of the mR s are below $m\bar{R}$

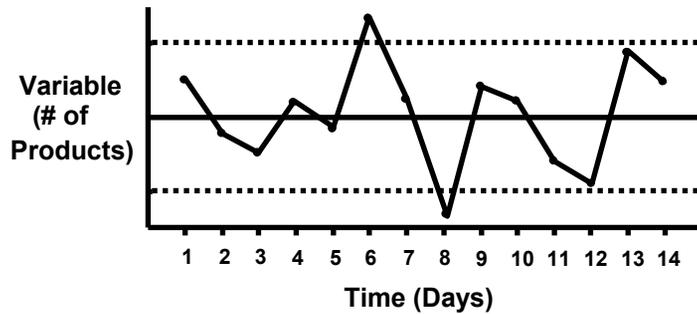
Revising Control Limits

- **1. Find and remove special causes**
- **2. Delete out-of-control ranges from computations**
- **3. Use the Median Range**

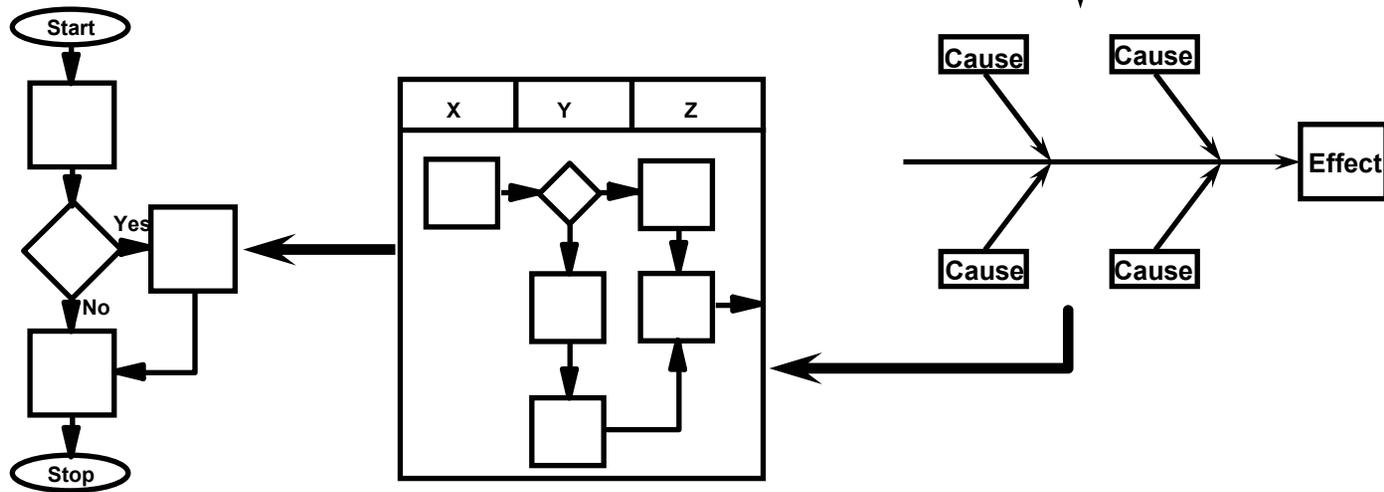
Setting the Process Aim

- ❑ **Use previously calculated limits**
- ❑ **Plot limits around desired average**
- ❑ **Move aimpoint and test**

Achieving Stability



Date	Time	Situation
6/15	1400	New employee



Maintaining Stability and Assessing Effectiveness of Changes

- **Maintaining stability**
- **Assessing effectiveness of changes**

Summary

- ❑ **Attribute data and its limitations**
- ❑ **Attribute and Periodically-collected measurement Data**
- ❑ **Construction and interpretation of XmR control charts**
- ❑ **Assessment of process stability**
- ❑ **Setting the process aim**