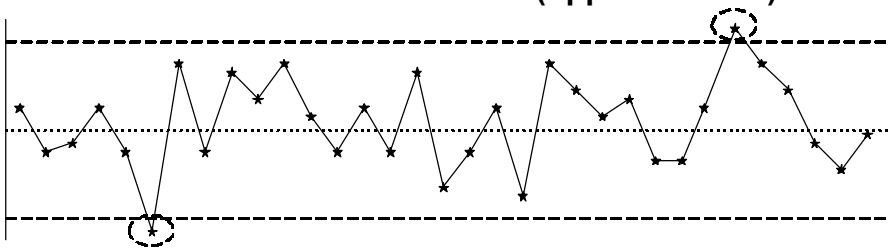
Essentials of Statistical Process Control
Using and Analyzing Control Charts for Variables

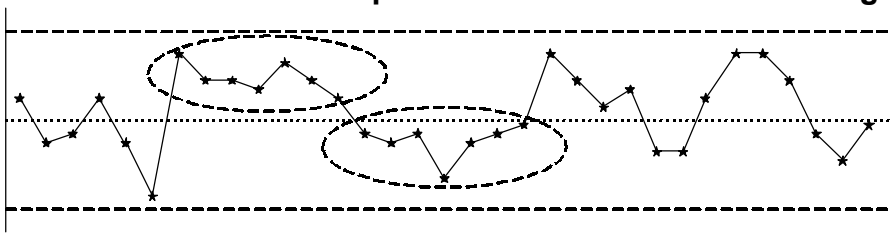
1. **Use the previously created Control Charts (see Control Charts for Variables) with the Average and the Upper and Lower Control limits marked on them.**
2. **Measure 5 samples every hour and calculate:**
   - **The average of the 5 measurements ($\overline{X}$).**
   - **The range of the 5 measurements (R).**
3. **Plot $\overline{X}$ and R on the relevant Control Chart during the production run.**
4. **Interpret the Range Control Chart first, look for any of the following patterns:**

a. Points outside the control limits (upper of lower)



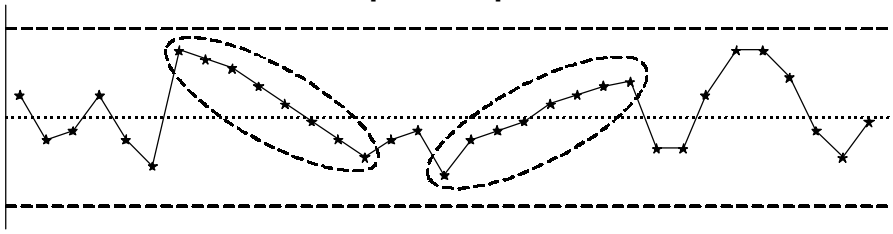
Points outside the control limits show 'special cause' has occurred and 'out-of-control' parts were made.

b. Run of 7 consecutive points above or below the average line



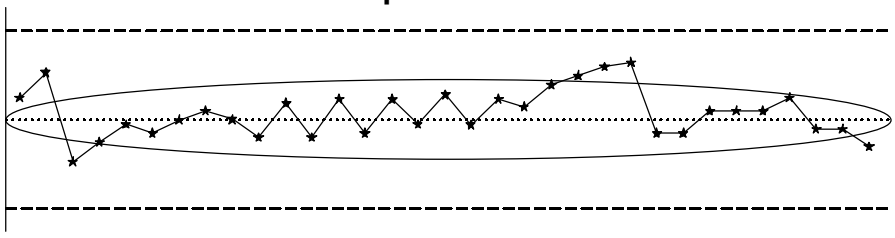
There is a step change in the process. Check for new materials or similar changes.

c. Run of 7 consecutive points upward or downward



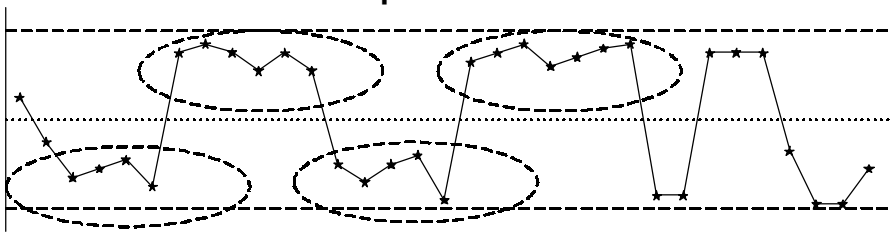
The process is drifting upwards or downwards. Check for tool wear or similar gradual changes

d. Pattern with 2/3 of the points in the middle 1/3 of the control limits



The process is too consistent, check and recalculate the Control Limits.

e. Pattern with 2/3 of the points in the outer 2/3 of the control limits



The process may have internal variations. Are two tools being used and has the output been mixed up?

5. **If any of the patterns are present, then the process is out of control for the range. Investigate for special causes and correct as required.**
6. **If the Range Control Chart is in order then interpret the Average Control Chart:**

   Look for the same patterns in the Average Control Chart as in the Range Control Chart:

   - **Points outside the control limits (upper of lower)**
   - **Run of 7 consecutive points above or below the average line**
   - **Run of 7 consecutive points upward or downward**
   - **Pattern with 2/3 of the points in the middle 1/3 of the control limits**
   - **Pattern with 2/3 of the points in the outer 2/3 of the control limits**
7. **If any of the patterns are present, then the process is out of control for the average. Investigate for special causes and correct as required.**
8. **Important Points for using Control Charts**

   - **Operators should carry out the measurements and record them on the chart themselves - this is not to be done by 'Quality Control', it is an operator task.**
   - **Operators should join the recorded and calculated points together with a straight line to the previous result.**
   - **Operators should always initial and date the Control Chart when they make the measurements.**
   - **Operators should always record significant events (materials batch changes, operator changes, colour changes, etc.) on the Control Chart - it makes finding the special causes easier to find and rectify.**
   - **Control Charts are working documents, not works of art.**
   - **Unless the Control Chart indicates one of the above patterns, the process should never be adjusted by the operator. Parts are being produced in tolerance and the process is in control - there is no need for adjustment.**
   - ***Hint:* To drive this home, make adjusting the machine without a Control Chart warning a disciplinary offence.**
   - **Do not be in a rush to adjust the machine - always study the process carefully before making any adjustments to the machine.**
   - **Control Charts provide a 'common language' for operators, managers and reporting. They are the glue that holds the analysis together.**
   - **Control Charts can be used to detect 'special causes' these can be fixed or eliminated by local action.**
   - **The detection and elimination of 'common causes' (the reason for the Upper and Lower Control Limits) is generally much more difficult. Eliminating 'common cause' generally requires management action and possibly a large investment in the process.**