Statistical Process Control Assessment
Instructor Guide

Note to Instructor

This assessment further gauges the participants' knowledge of Statistical Process Control and how it relates to MEMS fabrication as a result of having completed the SPC learning module and related activities.

This Assessment is part of the *Statistical Process Control Learning Module*, which covers the following:

- Statistical Process Control Knowledge Probe (KP) Pre-test
- Introduction to Statistical Process Control (PK)
- Control Chart Basics (PK)
- SPC Resistance Activity
- Activity (Advanced) – An MEMS Process Problem (Found in the SCME Systematic Approach to Problem Solving Learning Problem)
- **Final Assessment** (There are two assessments: Multiple choice and Short Answer)

This companion Instructor Guide (IG) contains both the questions and answers for the assessment questions.

SPC Final Assessment

This Assessment determines analyzes your understanding of Statistical Process Control and how it relates to MEMS fabrication after having completed the SPC learning module and its related activities.

There are 12 assessment questions below. Answer each to the best of your knowledge.

1. What are the two types of variation found in a manufacturing process?

   Answer:
   1. <u>Common Cause Variation</u> (other acceptable answers: Natural Cause, Inherent Variation)
   2. <u>Special Cause Variation</u> (other acceptable answers: Assignable Cause Variation)

2. Explain why understanding variation is particularly important in MEMS manufacturing.

   Answer: Microsystems deal in micrometers and nanometers. Because of the extremely small feature sizes (1 µm to 100 µm) and precise alignment (sometimes in the nano range), microsystems fabrication needs to be as close to "target" as possible from step to step, over hundreds of steps. There are so many steps involved in microsystems fabrication that when too much variation occurs at one step, it can affect other steps along the way. Therefore, technicians have to understand that a certain amount of variation is natural and to know what that variation is and to try to control it.

3. What are important factors in process control? (mark all that apply)
   a. Communication between operators, technicians, engineers, & management
   b. Plenty of historical data to set up your control chart
   c. Knowledge of Design of Experiments
   d. Eliminating process variation

4. Summarize the benefits and uses of Statistical Process Control.
   (Answers may include the following)
   - *Variation reduction is an important goal of Statistical Process Control.*
   - *All processes will have some form of natural variation that can never be eliminated but SPC can help to understand this natural variation.*
   - *SPC will also help to determine when a special cause variation is present.*
   - *SPC monitors process variation providing an assessment of ongoing process predictability.*
   - *SPC provides early information that may prevent deficiencies from occurring at all.*
   - *SPC can provide information on process capability by showing how consistently a process will produce a product within any ideal target range.*
   - *Understanding the process variations provides a deeper understanding of the product. With this improved understanding of what causes variation and how to control it, the designer is in an improved position to develop new, improved versions of the product and improved manufacturing processes.*

5. Given the following set of data, calculate the Centerline Value of a X-bar Chart.
   5.5, 7, 7.25, 4.9, 6.32, 5.74

   Answer: (5.5 + 7 + 7.25 + 4.9 + 6.32 + 5.74)/6 = 36.71/6 = 6.12

6. Using the data set above, calculate Upper Control Limit

Answer: Upper Control Limit = $\mu + 3\sigma$

$$\sigma = \sqrt{\sigma^2} = \sqrt{\frac{\sum_{i=1}^{n}(x_i-\mu)^2}{n-1}} = 0.82$$

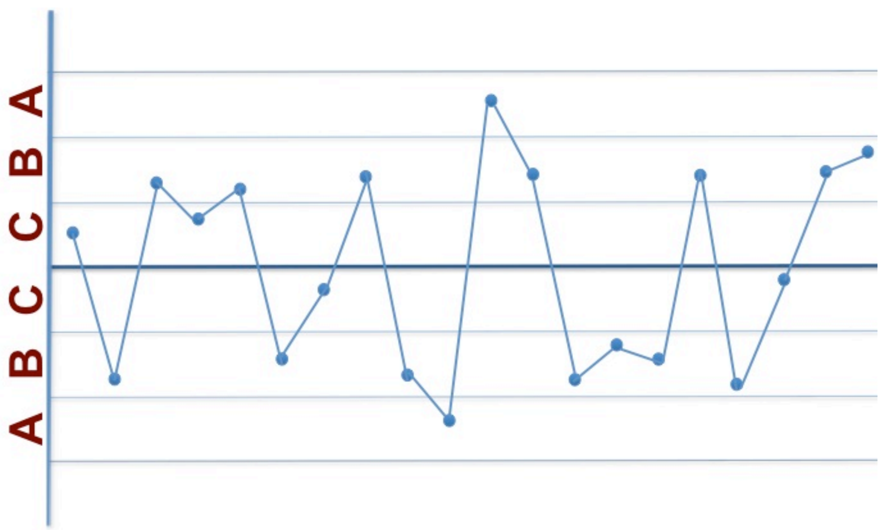
$$\textit{Upper Control Limit} = 6.12 + 3(0.82) = 8.59$$

7. Fill in the blank: The control limits are based upon the assumption that the historical data is distributed __________________________.

   Answer: Normally

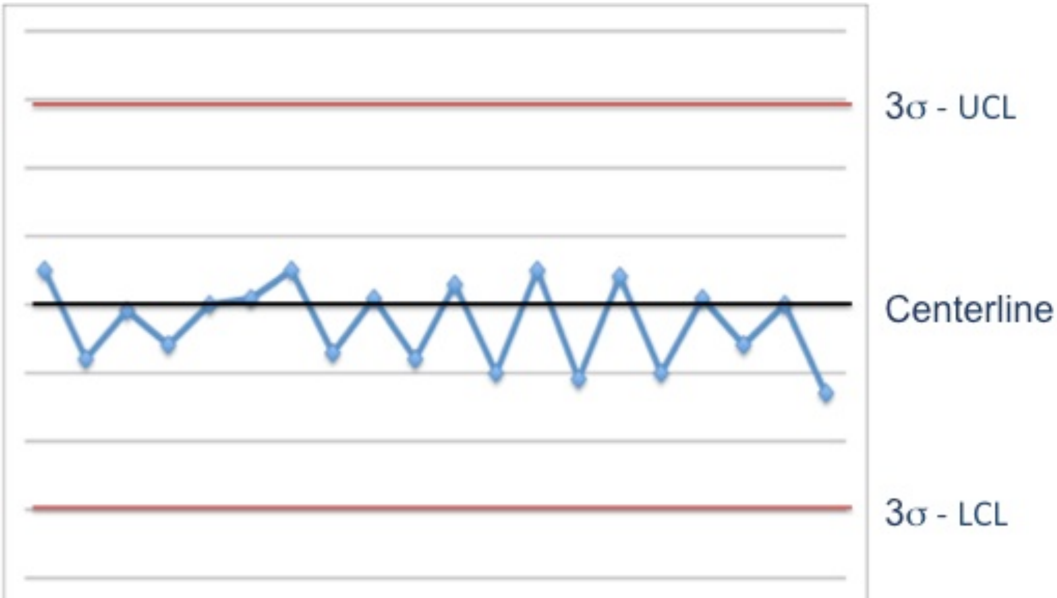
8. Is the following process "in control"? If not, state the rule that supports your answer.

   Answer: No, the process is NOT in Control. It breaks Rule 3: Four out of five successive numbers in a zone B or beyond. This would be four out of five successive points outside $\mu \pm 1\sigma$ *zone.*



9. Is this process in Control? If not, state the rule that supports your answer.

   Answer: This process is cycling to where the behavior is a predictable pattern – one point above the mean, the next point below the mean. The process should be checked.



10. What do you do when your process is out of control or is experiencing a trend, cycle, or shift?

    Answer: Complete your companies Out of Control Action Plan (OCAP) or equivalent.

11. Explain what is happening with the process if your process is violating Rule 8 of the Shewhart Rules.

    Answer: Rule 8 is violated when fifteen successive points fall within +/- 1 standard deviation only, to either side of the centerline. This is actually a good thing. The process is very close to the target value or centerline and there is a possibility that the process' natural variation has decreased. This could indicate that the control limits should be re-calculated.

12. What is the difference between specification limits and control limits?

    Answer: Control limits are calculated based on historical process data. They are used to indicate a process' inherent variation and to detect special cause variation, which destroys process predictability, and to detect and prevent process problems before they occur.

    Specification limits are the boundaries at which a product is said to be acceptable or not acceptable, not defective or defective based on the customer's criteria.