UNIVERSITY OF CALIFORNIA
College of Engineering
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C. SPANOS **Special Issues in Semiconductor Manufacturing** **EECS 290H**
Fall 2005

PROBLEM SET No. 7
Due on Tuesday 15th of November 2005, <u>at the beginning</u> of the class

1. Two decision rules are given below. Assume they apply to a normally distributed quality characteristic. Further assume that the control chart has 3-sigma control limits.

   <u>Rule 1</u>: If one or more of the next seven samples yield values of the test statistic that fall outside the control limits, conclude that the process is out of control.

   <u>Rule 2</u>: If all of the next seven points fall on the same side of the center line, conclude that the process is out of control.

   What is the overall α-risk for each of these rules?

2. In the semiconductor industry, the production of microcircuits involves many steps. The wafer fabrication process typically builds these microcircuits on silicon wafers, and there are many microcircuits per wafer. Each production lot consists of between 16 and 48 wafers. Some processing steps treat each wafer separately, so that the batch size for that step is one wafer. It is usually necessary to estimate several components of variation: within-wafer, between wafer, between lot; and the total variation.
   a. Suppose that one wafer is randomly selected from each lot and that a single measurement on a critical dimension of interest is taken. Which components of variation could be estimated with these data? What type of control charts would you recommend?
   b. Suppose that each wafer is tested at five locations (say, the center and four points at the circumference). The average and range of these within-wafer measurements are x_{ww} and R_{ww}, respectively. What variability components are estimated using control charts based on these data?
   c. Suppose that one measurement point on each wafer is selected and that this measurement is recorded for five consecutive wafers. The average and range of these between-wafer measurements are x_{BW} and R_{BW}, respectively. What components of variability are estimated using control charts based on these data? Would it be necessary to run separate x and R charts for all five locations on the wafer?
   d. Consider the question in part (c). How would your answer change if the test sites on each wafer were randomly selected and varied from wafer to wafer?
   e. What type of control charts and rational subgroup scheme would you recommend to control the batch-to-batch variability?

3. Assume that the specs of the above problem are 1.95 - 2.15 μm.

   a) Construct a modified control chart with 3-sigma limits, assuming that if the actual process fraction nonconforming is as large as 5%, the process is unacceptable.

   b) If the actual process fraction nonconforming is as large as 5%, we would like the modified control chart to detect this out-of-control condition with probability 0.9. Construct the modified chart, and compare it to the chart obtained in part (a).

(More on next page, referring to material to be discussed on Tuesday 11/8/05)

4. Consider the data below (σ=2.0, n=5):

Sample Number	x	Sample Number	x
1	10.45	11	11.39
2	10.55	12	11.69
3	10.37	13	11.51
4	10.64	14	11.28
5	10.95	15	11.38
6	10.08	16	11.25
7	10.50	17	11.63
8	10.87	18	11.88
9	11.25	19	11.46
10	11.46	20	11.67

Suppose it is necessary to design the cumulative-sum control chart to detect a shift in the process mean of 1.3 units and that L(0) = 500. Design this cumulative-sum control chart

5. Suppose that in the previous problem the analyst wishes to find a cumulative-sum control chart that has $L(\Delta)<=4.0$. Does the chart designed in the last problem have this property? If not, design a new chart. What is L(0) for this cumulative-sum control chart?

6. Design a Cusum procedure with α=0.005, β=0.20, D=1, σ=3, and n=5. Set up both the V mask and the parameters K and H for the tabular scheme. Assume that the target value μo=50.