Analysis & Probability/Algebra: Quality Control (1)

Micron Technology, Inc

Job Description: Develop wafer level test strategies and test programs. Provide failure analysis reporting. Monitor device yields, failure rates, and repair rates. Interact with various engineering and product groups to optimize device yields and minimize costs.

Problem:

To create a method control chart for quality control, the following numbers were collected while monitoring a fabrication process.

What is the mean of the following set of numbers?

What is the standard deviation (STD)?

3.05
3.02
3.03
2.97
2.98
3.10
2.94
3.06

$$\text{STD} = \sqrt{\Sigma(\text{Xi} - \text{M1})2 \,/\, \text{n} - 1}$$

Where X_i is given numbers
M_1 is mean
n is number of values

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See problem for details.

Solution:

Mean (M_1) = sum (Σ) of readings ÷ # of readings

$M_1 = \Sigma \div n = (3.05 + 3.02 + 3.03 + 2.97 + 2.98 + 3.10 + 2.94 + 3.06) \div 8 = 24.15 \div 8 = 3.02$

Standard Deviation is a statistical measure of the range of variance or *deviation* from the average. It describes uniformity: the smaller the number, the more uniform the readings; the larger the number, the greater the deviation.

Deviation = difference between the reading (X) and the average of the readings (M_1) $\quad\quad$ Dev = $X - M_1$

Standard Deviation (STD) = square root of the mean(M_2) of the squares of the difference or *deviation* of each reading with the mean (M_1) of the readings (X_i)

$$STD = \sqrt{\Sigma(Xi - M1)2 / n - 1}$$

Reading X_i	**Deviation $X_i - M_1$**	**Squared Deviation $(X_i - M_1)^2$**
3.05	3.05 - 3.02 = **.03**	.0009
3.02	3.02 - 3.02 = **0**	0
3.03	3.03 - 3.02 = **.01**	.0001
2.97	2.97- 3.02 = **-.05**	.0025
2.98	2.98 - 3.02 = **-.04**	.0016
3.10	3.10 - 3.02 = **.08**	.0064
2.94	2.94 - 3.02 = **-.08**	.0064
3.06	3.06 - 3.02 = **.04**	.0016

$M_2 = (.0009 + 0 + .0001 + .0025 + .0016 + .0064 + .0064 + .0016) / n\text{-}1 = .0195 / 7 = .0028$

STD = $\sqrt{M_2}$ **= .053**

This means that on average, the readings varied only .053 (higher or lower) than the average of the readings.

Analysis & Probability/Algebra: Quality Control (2)

Micron Technology, Inc

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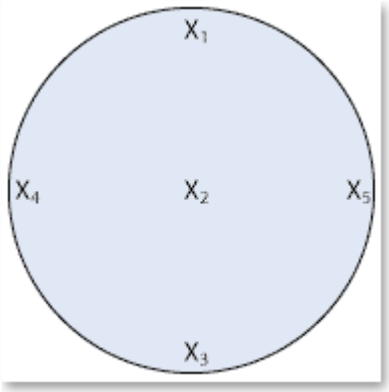
Problem:

The CTE (Center to Edge) range of the readings taken of the center of a wafer and various points on the edge of a wafer after Chemical Mechanical Planarization (CMP) must be calculated and compared with a critical value to determine if the process is accurate. The critical value is 1000.

Determine whether Process A and Process B are accurate (*absolute value is less than* 1000).

	X_1	X_2	X_3	X_4	X_5
Process A	22000	23500	21000	24000	21500
Process B	17000	19000	20000	21000	19700



$$CTE = \left[\frac{X_1 + X_3 + X_4 + X_5}{4} - X_2 \right]$$

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Problem:

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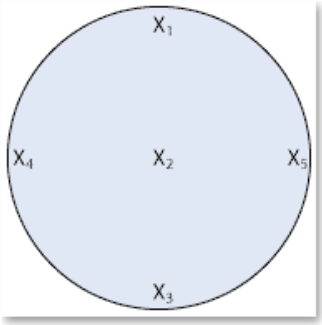
Determine whether Process A and Process B are accurate (*absolute value is less than* 1000).

	X_1	X_2	X_3	X_4	X_5
Process A	22000	23500	21000	24000	21500
Process B	17000	19000	20000	21000	19700

Solution:

The CTE range is calculated by finding the difference between the average or *mean* of the readings taken on the edge of the wafer with the reading taken in the center.



	X_1	X_2	X_3	X_4	X_5
Process A	22000	23500	21000	24000	21500
Process B	17000	19000	20000	21000	19700

$$CTE_A = \left[\frac{22000 + 21000 + 24000 + 21500}{4} - 23500 \right] = -1375$$

$$CTE_B = \left[\frac{17000 + 20000 + 21000 + 19700}{4} - 19000 \right] = 425$$

Process B is accurate because it has a CTE range less than the critical value of 1000.