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a. Assuming 10 observations are adequate for this purpose, determine the three-sigma control limits for dimples per camper top.

b. Suppose that the next camper top has 15 dimples. What can you say about the process now?

13. The production manager at Sunny Soda, Inc., is interested in tracking the quality of the company's 12-ounce bottle filling line. The bottles must be filled within the tolerances set for this product because the dietary information on the label shows 12 ounces as the serving size. The design standard for the product calls for a fill level of  $12.00 \pm 0.10$  ounces. The manager collected the following sample data (in fluid ounces per bottle) on the production process:

Sample	Observation			
	1	2	3	4
1	12.00	11.97	12.10	12.08
2	11.91	11.94	12.10	11.96
3	11.89	12.02	11.97	11.99
4	12.10	12.09	12.05	11.95
5	12.08	11.92	12.12	12.05
6	11.94	11.98	12.06	12.08
7	12.09	12.00	12.00	12.03
8	12.01	12.04	11.99	11.95
9	12.00	11.96	11.97	12.03
10	11.92	11.94	12.09	12.00
11	11.91	11.99	12.05	12.10
12	12.01	12.00	12.06	11.97
13	11.98	11.99	12.06	12.03
14	12.02	12.00	12.05	11.95
15	12.00	12.05	12.01	11.97

- a. Are the process average and range in statistical control?
- b. Is the process capable of meeting the design standard at four-sigma quality? Explain.

14. The Money Pit Mortgage Company is interested in monitoring the performance of the mortgage process. Fifteen samples of five completed mortgage transactions each were taken during a period when the process was believed to be in control. The times to complete the transactions were measured. The means and ranges of the mortgage process transaction times, measured in days, are as follows:

Sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Mean	17	14	8	17	12	13	15	16	13	14	16	9	11	9	12
Range	6	11	4	8	9	14	12	15	10	10	11	6	9	11	13

Subsequently, samples of size 5 were taken from the process every week for the next 10 weeks. The times were measured and the following results obtained:

Sample	16	17	18	19	20	21	22	23	24	25
Mean	11	14	9	15	17	19	13	22	20	18
Range	7	11	6	4	12	14	11	10	8	6

- a. Construct the control charts for the mean and the range, using the original 15 samples.
- b. On the control charts developed in part (a), plot the values from samples 16 through 25 and comment on whether the process is in control.
- c. In part (b), if you concluded that the process was out of control, would you attribute it to a drift in the mean, or an increase in the variability, or both? Explain your answer.

15. The Money Pit Mortgage Company of Problem 14 made some changes to the process and undertook a process capability study. The following data were obtained for 15 samples of size 5. Based on the individual observations, management estimated the process standard deviation to be 4.21 (days) for use in the process capability analysis. The lower and upper specification limits (in days) for the mortgage process times were 5 and 25.

Sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Mean	11	12	8	16	13	12	17	16	13	14	17	9	15	14	9
Range	9	13	4	11	10	9	8	15	14	11	6	6	12	10	11

- a. Calculate the process capability index and the process capability ratio values.
- b. Suppose management would be happy with three-sigma performance. What conclusions is management likely to draw from the capability analysis? Can valid conclusions about the process be drawn from the analysis?
- c. What remedial actions, if any, do you suggest that management take?

16. Webster Chemical Company produces mastics and caulking for the construction industry. The product is blended in large mixers and then pumped into tubes and capped. Management is concerned about whether the filling process for tubes of caulking is in statistical control. The process should be centered on eight ounces per tube. Several samples of eight tubes were taken, each tube was weighed, and the weights in Table 5.3 were obtained.

- a. Assume that only six samples are sufficient and develop the control charts for the mean and the range.
- b. Plot the observations on the control chart and comment on your findings.