Quality Management Problems

Problem 1

An automatic filling machine is used to fill 2-litre bottles of cola. The machine's output is known to be approximately Normal with a mean of 2.0 litres and a standard deviation of 0.01 litre. Output is monitored using means of samples of five observations.

a) Determine the upper and lower control limits that will include roughly 95.5 percent of the sample means.
b) If the means for the six samples are 2.005, 2.001, 1.998, 2.002, 1.995, and 1.999, is the process in control?

Problem 2

Specification for the diameter of a metal shaft is much wider than the machine used to make the shafts is capable of. Consequently, the decision has been made to allow the cutting tool to wear a certain amount before replacement. The tool wears at the rate of 0.002 centimetre per metal shaft produced. The process has a natural variation, σ, of 0.01 centimetre and is Normally distributed. Specification for the diameter of the metal shafts is 15.0 to 15.2 centimetres. How many shafts can the process turn out before tool replacement becomes necessary (i.e., before the process makes an out-of-spec shaft)?

Problem 3

Six samples of five observations each have been taken of 80 kg concrete slabs produced by a machine, and the results are displayed below. Determine the UCL and LCL for sample mean and range and decide if the process is in control. Then suppose a new sample results in slab weights of 81.0, 81.0, 80.8, 80.6, and 80.5. Using the control limits identified earlier, does this new sample suggest the process is in control?

Sample					
1	**2**	**3**	**4**	**5**	**6**
79.2	80.5	79.6	78.9	80.5	79.7
78.8	78.7	79.4	79.4	79.6	80.6
80.0	81.0	80.4	79.7	80.4	80.5
78.4	80.4	80.3	79.4	80.8	80.0
81.0	80.1	80.8	80.6	78.8	81.1

Problem 4

The design specifications for the concrete slab in the previous problem is between 78 and 81 kg. Is the specification being met? Is the process capable?

Problem 5

A company has just negotiated a contract to produce a part for another company. In the process of manufacturing the part, the inside diameter of successive parts becomes smaller and smaller as the cutting tool wears. However, the specification is so wide relative to machine capability that it is possible to set the diameter initially at a large value and let the process run for a while before replacing the cutting tool.

The inside diameter decreases at an average rate of 0.001 cm per part, and the process has a standard deviation of 0.01 cm and the variability is approximately Normally distributed. After how many parts must the tool be replaced if the design specification is between 3 cm and 3.5 cm, and the initial setting is three standard deviations below the upper design specification?

Problem 6

When Polaroid reduced the number of quality inspectors and increased operator responsibility for statistical process control in its R2 plant (which made instant film cartridges with 10 films in each) in Waltham, Massachusetts, in 1985, it encountered an unexpected result. Instead of quality improving, it actually got worse. To identify the problem, Bud Rolfs, quality control manager, asked an operator from each shift to sample six observations of the critical characteristics of the product and report these to him. One important characteristic of instant films is the pod weight. A pod is a small capsule at the end of each film that contains chemicals. When the film is pulled out, the pod bursts and released the chemicals that will develop the film. Too much chemical overdevelops the film and too little underdevelops it.

a) Using the following three samples of six observations each (in grams) from the first day of the data collection period to develop a sample mean and sample range control chart for the pod weight. Is the process in control?
b) The first sample from the second day is 2.841, 2.802, 2.802, 2.806, 2.807, and 2.807. Is the process still in control?

Sample	Shift	1	2	3	4	5	6	Average
1	A	2.800	2.799	2.760	2.802	2.805	2.803	2.795
2	B	2.750	2.820	2.850	2.740	2.850	2.790	2.800
3	C	2.768	2.807	2.807	2.804	2.804	2.803	2.799

Problem 7

An appliance manufacturer wants to contract with a repair shop to handle authorized repairs. The company has set an acceptable range of repair time of 50 minutes to 90 minutes. Two firms have submitted bids for the work. In test trials, one firm had a mean repair time of 74 minutes with a standard deviation of 4.0 minutes, and the other firm had a mean repair time of 72 minutes with a standard deviation of 5.1 minutes. Which firm would you choose and why?

Problem 8

As part of an insurance company's training program, participants learn how to conduct a fast but effective analysis of clients' insurability. The goal is to have participants achieve a time less than 45 minutes. There is no minimum time but the quality of assessment should be acceptable. Test results for three participants were Armand, a mean of 38 minutes and a standard deviation of 3.0 minutes; Jerry, a mean of 37 minutes and a standard deviation of 2.5 minutes; and Melissa, a mean of 37.5 minutes and a standard deviation of 2.5 minutes. Which of the participants would you hire?

Problem 9

Output from a process contains 2% defective units. Defective units that go undetected into final assemblies cost $25 to replace. An inspection process, which would detect and remove all defectives, can be established to test these units. However, the inspector, who can test 20 units per hours, is paid $8 per hour, including benefits. Should an inspection station be established to test all units?
a) What is the cost to inspect each unit?
b) What is the benefit (or loss) from the inspection process?

Problem 10

There is a 3 percent error rate at a specific point in a production process. If an inspector is placed at this point, all the errors can be detected and eliminated. However, the inspector is paid $8 per hour and can inspect units in the process at the rate of 30 per hour. If no inspector is used and defects are allowed to pass this point, there is a cost of $10 per unit to correct the defect later on. Should an inspector be hired?