

HW # 1

Solution

1.1 The quality control before the 1980's was characterized by:

- The need to keep parts from reaching the customer, mostly through the use of mass inspection techniques.
- Employing the QC department as a policing function trying to catch bad parts before it goes out of the door.
- Constant “fire fighting”, frantically trying to solve each new problem as it would arise.
- The drive to meet the acceptable standard of productivity, often typified by work standard, and the acceptable level of quality, often articulated in terms of an “acceptable quality level” (AQL).

From the 1980's to the present, quality control has:

- Employed statistics to identify improved opportunities in the process.
- Emphasized the continual improvement in both quality and productivity.
- Begun to work side by side with manufacturing to produce a better product and enhance the company's competitive position.
- Begun to shift away from quality as primary a manufacturing based concept to quality as a design-based concept as well, i.e., pushing the quality efforts of the organizations farther upstream into engineering design.

1.8 Shewhart emphasized

- Economic operation of the process, the need to maintain the routine operation of the process if it is to be economical.
- The importance of consistency of process operation; the presence of only “chance” variation sources to insure the economic / routine operation of process.
- The use of statistics to recognize the presence of an inconsistent process, and removal of the root cause (s) of variation sources to improve the economic operation of the process.

1.24 Taguchi's most important contribution is his attention to quality as a design issue not just a manufacturing issue, and in particular, his concept of robust parameter design. By varying parameters through design of experiments to obtain a more robust / consistently functioning product rather than by tightening tolerances or using more expensive materials, quality as measured by performance in the field can be improved.

1.7 Shewart emphasized

Acceptance of the AQL concept

- Stifles creativity by removing incentives for improvement
- Allows scrap to be accepted as part of everyday business and planning
- Motivates the belief that there exists an economic tradeoff between improved quality by the continual reduction in defective material and the cost of doing so.

1.17 Rather than recommending the more expensive material, future experimentation should be done to exploit any non-linearities in the material quality – product

performance relationship, i.e., pursue the development of a more robustly performing product. This could improve output quality while using the same materials. Using a more expensive raw material is an example of developing a more robust product by “increasing the signal”, not reducing the transmission of the environmental noise through design.

1.20 Testing involves

- Using many products with same design to perform life tests to see how the design performs on average over a span of time.

Experimentation is concerned with:

- Comparing performance with regard to different levels of the parameters of a given design to seek the most attractive performance levels according to some pre-specified criteria. Experimentation is more useful in the design process because it yields more information on the product’s performance may change as the important design parameters are altered/adjusted.

HW # 2

2.1 Deming developed his 14 points to help companies realize their potential for better competitive position through continuous improvement. Deming saw the fires of quality improvement burn strongly for a short period of time in the 1940’s, but because quality and productivity improvement was not put on institutional basis within the organization it was always perceived of as someone else’s job. Deming through his 14 points, attempts to provide a clear roadmap for management so they might come to understand what needs to be done and who is responsible for making it happen. Deming learned through his disappointing experiences in the US during and immediately after WWII that without upper level management involvement and leadership it would be possible to put the concept of never ending improvement in place in a way which have a lasting impact on competitive position.

2.9 The loss function differs from the classical engineering specification in that it provides a variable measure of goodness and badness without regards to the design specification. In fact no design specification is necessary. The loss function simply measures in a quantitative way the loss incurred as a result of deviation from the nominal/target. Further , the loss function concept places emphasis on product performance in the field-use environment-and is very customer oriented.

2.12 The real cost of quality the loss incurred but often unobserved by the organization as a result of failing to pursue improvement/seek reduction in variation on a never ending basis. The cost of adhering to a product control mentally for quality control which for example, promises the mis-interpretation and enhances the mis-use of tolerances to the detriment of quality and productivity improvement. The real cost of quality include:

- Loss of competitive position in the marketplace because of an inability to reduce costs.
- Lost opportunity in form of lower efficiency/productivity resulting from failure to continue to seek and remove further sources of process variability.

- Lost opportunity in the form of all the benefits which are gained from predictable consistent, high quality process, e.g., imposed production management including scheduling inventory control, MRP, and increased flexibility/adaptability, enhanced environment for break through resulting from lower variability, more positive and participative employee attitudes.

2.14

Work standards have not been eliminated easily because:

- They have become institutionalized within the organization as a measure of productivity.
- They appear to provide some evaluation, in terms of comparison, of the workers, the machines and systems of manufacture.
- Eliminating the standards would relinquish some control that management has over workers.
- They are used in some situation as a part of wage incentive plans, which urge workers to work faster and reward them for production speed, not quality production.

Productivity would increase without work standards since all the system would be more directed toward the continual pursuit of improvement opportunities. Work standards tend to place a cap on further improvement, if the standard is being met, why try to do better? Rewards should be given for solving quality problems and finding more efficient methods of production, not for meeting or exceeding the numbers. Quality would certainly increase since production department would begin to take more responsibility for quality.

HW # 3

3.9

Machine 1 is better than Machine 2. This is because (from the frequency histogram) though both machines have nearly same mean, however machine 2 has higher standard deviation than machine 1.

3.10

a. 99.897% b. Nearly 100 %

3.15

a. 62.93% outside (or 37.07% inside) b. 98.02% inside (1.98 % outside)

5. Data is normally distributed

6. Data is not normally distributed

HW # 4

1

- $P(Z > 1.4) = 0.0808 > 0.025$ cannot reject the null hypothesis
- $P(Z < -3.42) = 0.00031 < 0.025$ reject the null hypothesis

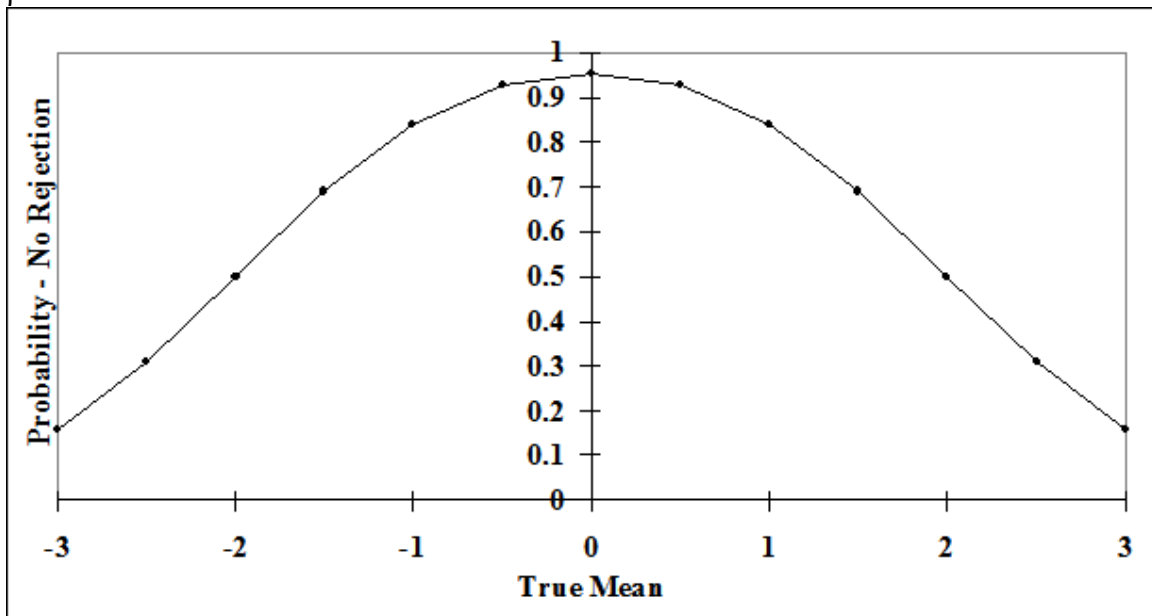
2

- $P(Z < -2.3) = 0.0107 > 0.01$ cannot reject the null hypothesis
- $P(Z > 1) = 0.1587 > 0.01$ cannot reject the null hypothesis

3

$X_{lo} = 110.8$ & $X_{hi} = 189.2$

β risk = 0.83



HW # 6

6.5

a. R chart – in control

X chart – not in control

Sample	Rule violation
4	2/3 in zone A or beyond
10	Extreme point
12	2/3 in zone A or beyond
18	2/3 in zone A or beyond, extreme point,
19	4/5 in zone B or beyond
20	2/3 in zone A or beyond, 4/5 in zone B or beyond

b. Sample size = 5

6.13

i - 4, ii - 2, iii - 6 or 7, iv - 9, v - 1, vi - 3 (Most likely answers)

6.14

i - 8, ii - 7, iii - 1, iv - 8, v - 6, vi - 5 (Most likely answers)

6.16

R-Chart

$\bar{R} = 16.97$, $LCL = 0$, $UCL = 35.89$

Xbar-Chart

$\bar{X} = 47.79$, LCL = 38, UCL = 57.58

R-Chart

No out of control points

Xbar-chart shows signal

33, 34, 35 – run of eight or more above or below centerline

34, 35 - 4/5 in zone B or beyond

6.17

R-Chart

$\bar{R} = 16.40$, LCL = 0, UCL = 34.69

Xbar-Chart

$\bar{X} = 49.56$, LCL = 40.10, UCL = 59.02

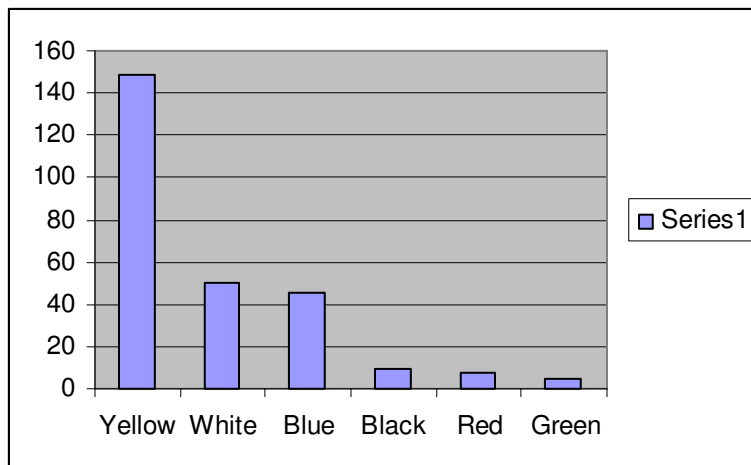
Xbar chart

No signals

R chart

39 – 43 all run of eight below centerline

6.24



HW # 7

9.4

a.

R-Chart

$\bar{R} = 0.06250$, LCL = 0, UCL = 0.13188

Xbar-Chart

$\bar{X} = 4.51005$, LCL = 4.47340, UCL = 4.54611

Xbar chart

No signals

b. 91.9%,

c. 93.72%

9.8

Supplier 3 is preferred because it has least variability, Centering can improve $CP_k = 2$

9.18

Crate depth = 8.11463

Problem # 4

a. $Lo = 29.31$, $k = 0.4667$, $m = 34.7857$

b. 29.6

c. upper specification = 40.77 and lower specification = 28.81

d. 51.5

e. 33.5

HW # 8

11.7

$\bar{X} = 4.99$, $\bar{R} = 0.40$

X-chart

LCL = 3.940

UCL = 6.040

Rm Chart

LCL = 0

UCL = 1.307

Signals on Rm Chart

5, 7, 17, 18, 36, 37-extreme points

41-44 run below center line.

11.14

a

$\bar{X} = 0.2375$

$S_x = 1.1650$

b

$A_1 = 0.49 \dots A_{40} = -0.990$

$V_1 = 1.185 \dots V_{40} = 0.796$

c

A-Chart

CL = 0.2375, LCL = -0.9280 and UCL = 1.4025

V-Chart

CL = 0.9798, LCL = 0.2295 and UCL = 1.7312

Problem # 3

Standardized cusum chart

