Amy Hissom

Homework #12 – Design for Six Sigma

TECH 50000 - Quality Standards

Friday, April 08, 2011

Chapter 12

Review Questions

2. What are the principle benefits of QFD?

QFD benefits companies through improved communication and teamwork between all constituencies in the production process, such as between marketing and design, between design and manufacturing, and between purchasing and suppliers. Product objectives are better understood and interpreted during the production process because all key design information is captured and synthesized. This approach helps to understand trade-offs in design and promote consensus among managers. . Use of QFD focuses on the drivers of customer satisfaction and dissatisfaction, making it a useful tool for competitive analysis of product quality by top management. Productivity as well as quality improvements generally follow QFD. QFD reduces the time for new product development. QFD allows companies to simulate the effects of new design ideas and concepts. Through this benefit, companies can reduce product development time and bring new products into the market sooner, thus gaining competitive advantage

5. Explain the difference between nominal dimensions and tolerances. How should tolerances be realistically set?

Manufacturing specifications consist of nominal dimensions and tolerances. Nominal refers to the ideal dimension or the target value that manufacturing seeks to meet; tolerance is the permissible variation, recognizing the difficulty of meeting a target consistently. Traditionally, tolerances are set by convention rather than scientifically. A designer might use the tolerances specified on previous designs or base a design decision on judgment from past experience. Setting inappropriate tolerances can be costly. All to often, tolerances fail to account for the impact of variation on product functionality, manufacturability, or economic consequences. A scientific approach to tolerance design uses the Taguchi loss function. As opposed to “goalpost” specifications, Taguchi suggests that no strict cut-off point divides good quality from poor quality. Rather, Taguchi assumes that losses can be approximated by a quadratic function so that larger deviations from target correspond to increasingly larger losses.

6. What is design failure mode and effects analysis (DFMEA)? Provide a simple example illustrating the concept.

The purpose of design failure mode and effects analysis (DFMEA) is to identify all the ways in which a failure can occur, to estimate the effect and seriousness of the failure, and to recommend corrective design actions. A DFMEA usually consists of specifying the following information for each design element or function:

Failure modes – These modes are ways in which each element or function can fail.

Effect of the failure on the customer – Such failure includes dissatisfaction, potential injury or other safety issue, downtime, repair requirements, and so on.

Severity, likelihood of occurrence, and detection rating – Severity might be measured on a scale of 1 to 10, where a “1” indicates that the failure is so minor that the customer probably would not notice it, and a “10” might mean that the customer might be in endangered.

Potential causes of failure – Often failure is the result of poor design. Design deficiencies can cause errors either in the field or in manufacturing and assembly.

Corrective actions or controls – These controls might include design changes, "mistake proofing", better user instructions, management responsibilities, and target completion dates.

A simple example illustrating the concept of a design failure mode and effects analysis (DFMEA) can be found in Figure 12.9 on page 607 of our textbook for an ordinary household light socket.

Problems

3. Bertha's Big Burritos conducted consumer surveys and focus groups and identified the most important customer expectations as follows:

- Tasty, moderately healthy food
- **Speedy service**
- **An easy-to-read menu board**
- **Accurate order filling**
- Perceived value

Develop a set of technical requirements to incorporate into the design of a new facility and a House of Quality relationship matrix to assess how well your requirements address these expectations. Refine your design as necessary, based on the initial assessment.

I am assuming that I am to rate these particular customer expectations based on what I think is most important as if I was the customer. I found a free house of quality Excel template to use for this problem. I hope that was ok. After reading this problem, I would think that a separate house of quality would be used for the speedy service, easy-to-read menu board, and accurate order filling. Therefore, using the other customer requirements, I constructed a partial house of quality based on the burrito alone. The following is the inserted Excel house of quality. It is included with the Excel sheet that is attached to this assignment and is as follows:

Customer Requirements	**Product features**	Price	Size	Calories	Sodium	% of Trans Fat	Competitor A	Competitor B	Competitor C	Selling Points
Taste/Flavor	3	5	1	1	1	5				
Visually Appealing	3	3	3	1	1	1				
Healthy/Nutritious	5	1	1	5	5	5				
Good Value	3	5	3	1	1	1				
Importance rating		44	26	34	34	46				

My ratings for each product feature based on each particular customer requirement are located in the green fields. These ratings are based on a scale of 1 to 5, with 5 being the most important and 1 being the least important. The numbers in the "Product Features" column are those I would think the company would base the importance of each feature based on my ratings. The importance ratings are computed using the "green fields" (my ratings) and the numbers in the "Product Features" column for each customer requirement. I was a little confused with this one, so I hope I was on the right track.

8. **The life of a cell phone battery is normally distributed with a mean of 750 days and standard deviation of 50 days.**

   a) **What fraction of batteries is expected to survive beyond 875 days?**

If, μ = 750 days and σ = 50 days, then to show the fraction of batteries that is expected to survive beyond 875 days:

$$P(x > 875) = 0.5000 - P(750 < x < 875)$$

$$z = \frac{x-\mu}{\sigma} = \frac{875-750}{50} = 2.5$$

So, using the z-chart, P(X>875) = 0.5000 – 0.4938 = 0.0062

So, **0.62%** should survive beyond 875 days.

I want to stress how I got "0.4938" from the z-chart, because I didn't in HW #10. To get this number, I went to the 0.00 column listed by 2.5 in the z-chart. The number listed there is 0.9938. I subtracted 0.5000 from 0.9938 to get 0.4938.

   b) **What fraction will survive fewer than 650 days?**

If, μ = 750 days and σ = 50 days, then to show the fraction of batteries that is expected to survive fewer than 650 days:

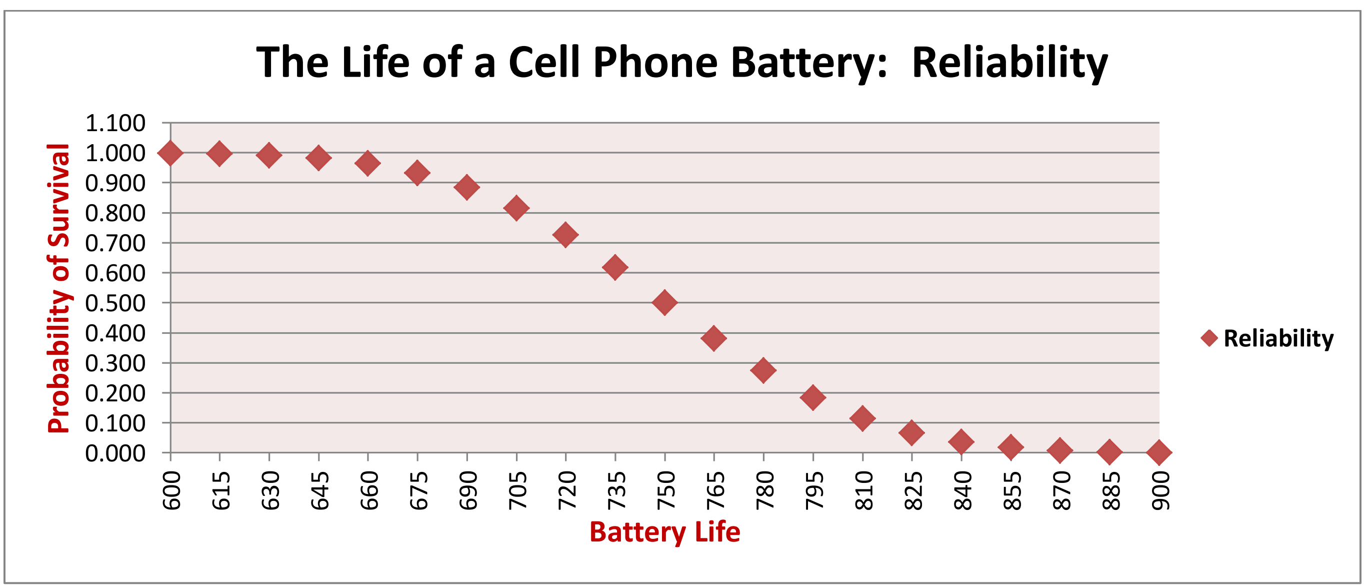
P(x<650) = 0.5000 – P (650 < x < 750)

$$z = \frac{x-\mu}{\sigma} = \frac{650-750}{50} = -2.0$$

$$P(x < 650) = 0.5000 - 0.4772 = 0.0228$$

So, **2.28%** should survive less than 650 days.

   c) **Sketch the reliability function.**



d) What length of warranty is needed so that no more than 1 0 percent of the batteries will be expected to fail during the warranty period?

X_w = Length of warranty and $P(x < x_w) = 0.10$

If I am right in using the z-chart: 0.10 on the z-chart is -1.28. So, Z = -1.28. To solve for x:

$$z = \frac{x - 750}{50} = -1.28$$

-1.28 x 50 = -64

-64 + 750 = 686

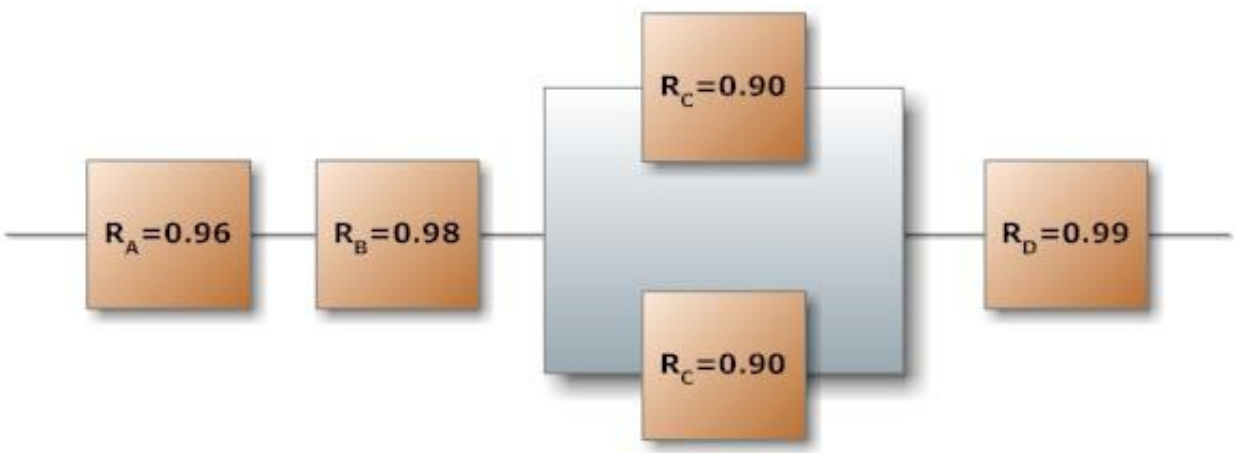
$$z = \frac{686 - 750}{50} = -1.28$$

686 – 750 = -64

-64 / 50 = -1.28

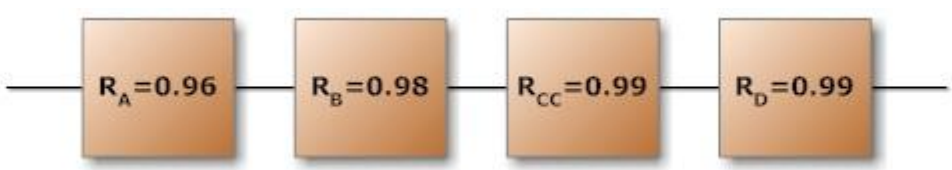
Therefore, X_w = **686** warranty days

13. An electronic missile guidance system consists of the following components: Components A, B, C, and D have reliabilities of 0.96, 0.98, 0.90, and 0.99 respectively (see the following diagram). What is the reliability of the entire system?



First we must compute the reliability of the parallel subsystem C:

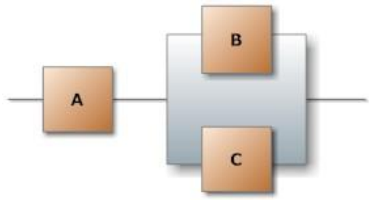
$R_C = 1 - (1 - 0.90)^2 = 0.99$



Using the calculation above for the two Cs combined; we can now compute the reliability of the entire system using the equivalent parallel system shown above as follows:

R_S = (0.96) (0.98) (0.99) (0.99) = 0.922

14. A manufacturer of MP3 players purchases major electronic components as modules. The reliability of components differ by supplier (see the following diagram). Suppose that the configuration of the major components given by:

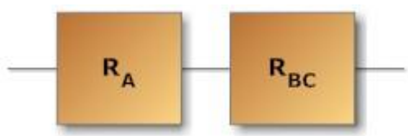


The components can be purchased from three different suppliers. The reliabilities of the components are as follows:

Component	Supplier 1	Supplier 2	Supplier 3
A	.97	.92	.95
B	.85	.90	.90
C	.95	.93	.88

Transportation and purchasing considerations require that only one supplier be chosen. Which one should be selected if the MP3 player is to have the highest possible reliability?

For this system, each supplier would be computed separately based on the diagram above but first by computing the reliability of the series system BC. The equivalent parallel system is shown below:



Therefore:

Supplier 1	**Supplier 2**	**Supplier 2**
$R_A = 0.97$	$R_A = 0.92$	$R_A = 0.95$
$R_{BC} = 1 - (1 - 0.85)(1 - 0.95) = 0.9925$	$R_{BC} = 1 - (1 - 0.90)(1 - 0.93) = 0.993$	$R_{BC} = 1 - (1 - 0.90)(1 - 0.88) = 0.988$
$R_S = (0.97)(0.9925) =$ **0.963**	$R_S = (0.92)(0.993) =$ **0.914**	$R_S = (0.95)(0.988) =$ **0.939**

Supplier 1 should be chosen since its entire system is the most reliable.