

Use Cases and Nonfunctional Requirements

1 Requirements: the Interface between the Customer and the System Design

There are two equally important aspects in creating requirements.

- Understanding your customer and market.
- Understanding your own capabilities (as a company).

Failure of an engineering project can occur by either of these. A requirement is a *negotiation point* between the customer and the engineering team. The customer must agree that the requirement satisfies his objectives and the engineer must agree that the objective can be satisfied within the time and an agreed upon cost. This negotiation is under the influence of two manifestations of the *law of diminishing marginal utility* or *law of diminishing returns*. Figure 1 illustrates this law as it applies to both producers and consumers. Here, quality refers roughly to how strict the

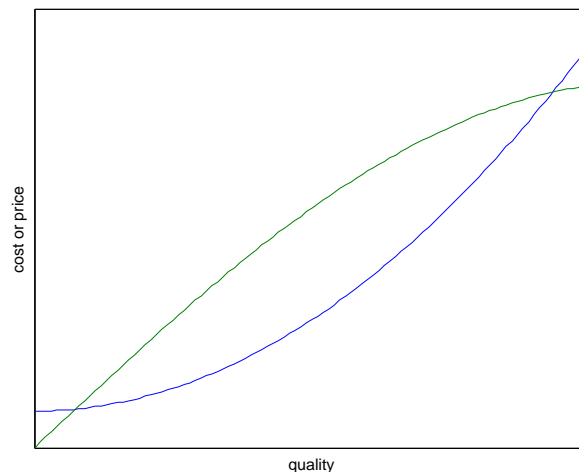


Figure 1. The valley shaped curve is the cost to produce as a function of the quality of the product representing the engineer's perspective. The hill shaped curve represents what the customer is willing to pay for a particular quality item.

requirements are or how many features a product has. For example, it could represent a weighted sum of a quietness metric, horsepower, fuel economy, and cornering ability of a car. For the consumer, the law of diminishing marginal utility means that beyond a certain point, he will always pay less for the next increment in product quality. For the producer, it means that the next increment of cost increases the quality of the product by a smaller degree. Bear in mind that quality is a complex, multi-dimensional quantity and this figure is only notional.

Customers are extremely complex systems and understanding them well can result in engineering success. Each customer as an individual has a different curve or surface. When you examine a market, you should take into consideration the size of the market and what will maximize your profits. Although there is probably a customer at any price level, the market might be very small. Note that the area near the middle of the figure has the highest difference between the price and the cost. This would imply maximum unit profit. If this curve represents your largest customer base, then it would be a very good choice for where to place the requirements. Note also that the curve crosses over in two places. The first crossover occurs when it is not profitable to sell. The second crossover occurs when the customer is not willing to buy. Sometimes, the curves are such that there is no area where profit is possible.

Your organization is a second very complex system responsible for the other curve. Oftentimes, you will not know what the cost is until later into the design process. Knowing these things as soon as possible would be a huge advantage

to companies. The rest of the systems engineering discipline will aid in this task, but you should keep this in mind as you make your requirements.

In this course, requirements are broken down into two categories, functional and non-functional. Use cases will be used to capture functional requirements and a separate requirements document will contain the non-functional requirements.

2 Use Cases

Use cases are written in plain text and with as few implementation specific details as possible. They are written in text in order to facilitate interaction with a customer. Use cases are units of behavior that are of value to the customer. Implementation details are deferred to other steps of the systems engineering process. This independence is good because it means that modification of the system design will not cascade into change of the use cases. A given use case should have many different valid implementations in principle. However, this is an abstraction, and you should understand from Homework 1 that abstractions are leaky. Since requirements have impacts on costs, and costs are dependent on implementation, use cases must depend on the implementation.

Here is an example use case for an ATM machine.

- This use case is valid only when a customer is in an active session. A withdrawal transaction first asks the customer to choose which account to withdraw from and then the amount of money. The ATM checks that it has enough cash available to satisfy the request. Then the request is sent to the bank system. If both of these steps are successful, then the ATM dispenses cash and provides a receipt.

3 Nonfunctional Requirement

Nonfunctional requirements are often in the form of constraints. They can be in plain text, or in the form of text mixed with mathematical equations. They are generally written at a level where customers can understand them. A list or outline should be sufficient for this class. In a large project, where requirements could number in the hundreds of thousands, sophisticated software is needed to manage them.

4 Exercises

1. Pick a family of products that you are familiar with. Give three use cases and seven requirements for this family of products.
2. Pick a particular product from that family. For two of the requirements, try to estimate the marginal cost to the producer. For example, you could plot the horsepower of cars against their price, doing your best to keep everything else equal. The slope of this plot near your particular product is an estimate of the marginal price. You might have to take a look at profit margins in order to figure out the marginal cost. Alternatively, you could try to estimate the cost based on what you know it takes to produce this feature. Answering this will require some research.
3. For one of the use cases, think about the marginal price that the customer is willing to pay for different functions. For example, the telecommunications industry is very good at providing functionality at an incremental price. There is the price of data plans or text messaging plans. Think about a behavioral feature that is infrequently implemented in the system of your choice, but could be desirable. For example, using your mobile phone like a credit card. Estimate what consumers would be willing to pay for that particular feature and how much it would cost to provide that functionality.
4. Extra Credit: For your group project, to try to get a better understanding of the customer, request a 15 minute interview of one person that is knowledgeable in the area. Ask questions and listen as much as possible. Write down what you learn.