Intro to the QFD (Quality Function Deployment) Method

This method is used to ensure that the design team has a complete understanding of the problem before potential solutions are generated. It will also serve to begin directing the team's thoughts to the generation of a large number of potential solutions to the problem. Several steps in the method will provide further input in down stream decision making. It will also help the team to develop the benchmarks by which the various design solutions may be measured. You may feel that these steps slow down or inhibit the design process, but the effort spent in generation of requirements, specification and targets will be returned multi-fold in terms of the quality of your eventual solution.

This document represents a general outline of the procedure. We will discuss the process in depth during class. You may also refer to the recommended text (Ulman).

Identify the Customer(s) or Stakeholders

We wish to ensure that it is the customer's requirements that drive the design process and not what the design engineer *thinks* the customer should want. A design which does not properly address customer needs and wants may poorly received in the marketplace.

First, generate a list of your customer (stakeholder) base. Remember that is the vast majority of cases, more than one customer will be identified. Customers obviously include the end-use consumer but can also include your own management, manufacturing division, sales staff, and service department. It may include governmental and regulatory bodies. Almost anyone who contacts your product will have some level of customer interest.

I suggest that you record and sort your customer base within a spreadsheet. We will include additional information to this spreadsheet as we move through the process.

Determine the Customer's Requirements

For each group within customer base, try to determine customer requirements. The idea is to create a list of all requirements that affect the design. Be sure to consider the requirements of each of the stakeholders you listed in the first step. I suggest that the team compile this list as a group to ensure that as many points of view as possible are considered. You will also need to perform outside research to determine these requirements. Market studies, literature searches, competition evaluation, interviews and questionnaires are all means that can be employed. Be as extensive as possible.

Requirements should be in the customer's words, e.g in "common" terms. For example, non-quantitative terms such as "safe", "compact in size", and "easy to use" are appropriate at this stage. The list should represent positive ideas, in other words, it should state what the design should be, not what it shouldn't be and not what is wrong with an existing design. Add the requirements list to the stakeholders spreadsheet.

See the end of this document for a list of types/categories of customer requirements. This list can be helpful when generating requirement for your project.

Determine Relative Importance of Requirements:

For each of the requirements generated, assign a weight factor specifying whether you feel the requirement is something the product MUST have, SHOULD have or would BE NICE if included. The "musts" are requirements which must be met in the design no matter what. Such requirements are often associated with standards, codes, legal requirements, spatial concerns or company requirements (for example, existing facilities must be used). Identify and mark these requirements within your list.

The remaining requirements ("should have" or "it would be nice if") are "wants". The relative importance of these should be determined. A common method for accomplishing this is to compare each want with each of the others. A table can be constructed to help perform this comparison, but the procedure is tedious. Once the relative comparison is made, they may be listed in order of importance.

It is common to use a 0-10 point scale. In this case the MUST's are assigned a value of 10 the WANTS may be scored between 7 and 9, the WOULD BE NICE from 4-6, and the non-critical from 0-3. By weighting the requirements, you will be better able to weight your engineering requirements and eventually your concepts. Record these weight factors in your spreadsheet.

Evaluate the competition (existing solutions):

This is usually referred to as *competitive benchmarking*. Existing designs are compared to the requirement list and a subjective evaluation of how well the design satisfies the requirement is made. Existing designs that do not meet the requirements that you determined indicate an area of opportunity. Designs that meet requirements well should be studied for ideas. Be careful, however, of patent infringement. Remember, a competing solution may not be a single device, it may involve multiple devices and/or operations.

Translate Customer Requirements into Measureable Engineering Requirements:

For each stakeholder requirement, define the engineering metrics to be used. For example, a customer requirement of "light weight" may have metrics of LBS or Kilograms. Doing this will help you in defining what we will call our "engineering requirements."

To accomplish this we will try to transform each customer requirement into an engineering requirement. These engineering requirements will be a set of measurable engineering specifications. By being measureable they may therefore be used to evaluate proposed design solutions. For example a requirement of "easy to attach" can be measured in (1) the number of steps in attachment (2) the time required to attach (3) the number of parts required (4) the number of tools require.

Make an effort to find as many measurable engineering specifications for each customer requirement as possible.

If you are unable to find an engineering specification for a customer requirement, it is an indication that the customer requirement is not well understood. Try breaking the customer requirement down into smaller parts or revisit the process of determining re

Set Engineering Targets:

In this step you will develop specific target values for the measurable engineering requirements. A target value represents a goal for your design and so that will be to evaluate the quality of your design solutions. You should first determine how well the competition meets the engineering requirements.

Really, two steps are involved here, (1) examine the competition for how well they meet the engineering specifications, and (2) establish the values that your product will meet. The first step will require you to revisit your competitive benchmarking and try to determine values met by the competition. If you can gain access to examine physical examples, that is the best process, but it may not always be possible. This will help you to develop your target values.

The advantage in setting these target goals early in the design process is that they will help guide you to the best possible solution. You will find that the best targets are specific values. Second best are target values set within some range. Shoot for the first. Record the target values associated with each engineering specification.

Product Design Specification:

At this point a comprehensive list of requirements can be developed which is referred to as the Product Design Specification. This specification should fully document, as unambiguously as possible, all the requirements that a product must fulfill together with any constraints that may affect it. A separate handout on the PDS exists on the course web site.

Types of customer requirements:

Functional performance

Flow of energy	(force, motion, hydraulics, electricity, etc.)
Flow of information	(ease of controlling, ability to sense product state)
Flow of materials	(motion of product or items being acted upon)
Operational steps	
Operational Sequence	

Human factor

- Appearance
- Force and motion control
- Ease of controlling and sensing state

Physical Requirements

- Available spatial envelope (size, how fits together, how fits with other system
- Physical properties (weight, conductivities)

Reliability

- Mean time between failures
- Safety (hazard assessment) (what happens when it does fail?)

Life-cycle concerns (other than use)

- Distribution (shipping) (size, weight, packaging concerns)
- Maintainability
- Diagnosability
- Repairability
- Cleanability
- Installability
- Retirement (design for disassembly)

Resource Concerns

- Time (product development restrictions)
- Cost (capital and production))
- Equipment (available resources)
- Standards (design restrictions)
- Environment (“green” concerns)

Manufacturing requirements

- Materials
- Quality
- Company capabilities