University of Pittsburgh at Johnstown

Department of Electrical and Computer Engineering

COE/EE 1195

Engineering Practice (Design) and Professional Development

"Project Proposal" Course

PRIMER: Step 2 –

The Functional Requirements and Engineering Specifications

Revision Date: 2/3/2020

Background

This document provides the necessary background information to complete Functional Requirements and Engineering Specifications report. Prior to writing this document, students should have a generally agreed upon Functional Requirements, and the importance (weighting) of said functions. The students used a survey, faculty feedback, and/or additional means to determine the Customers wants and needs, and translated in to Functional Requirements. This included conversations with and vetting by University faculty, through several (formal and informal) proposal documents.

Grade Value

The FUNCTIONAL and ENGINEERING SPECIFICATIONS comprises 15% of the EE/COE 1195 grade. Considering the document will set the design targets / criteria of the Senior Project, the value of the FUNCTIONAL and ENGINEERING SPECIFICATIONS is very significant.

Functional / Engineering Spec (written)	Reviewed by Faculty
Revised Functional / Engineering Spec	7.5% EE/COE 1195 Instructor Grade +7.5% remaining COE/EE faculty grade
Functional / Engineering Spec (oral presentation)	5% (composite (average of all evaluators))

Guidance:

This documentation specifies, from a user's or operator's point of view, the products' functions and specifications. It should enumerate all inputs and outputs to the system and the relationship between them. Performance specifications should also be included. This document contains much the same information as is found in an owner's manual. It is not concerned, specifically, with the implementation of the function; rather, it defines the function from an external viewpoint. It could be the basis for an advertising brochure.

Functional Specifications are those elements of the performance that describe the product's desired behavior. Although the customers may not use technical terms, function is usually described as the flow of energy, information, and materials or as information about the operational steps and their sequence.

From the *Functional Specifications*, the *Engineering Specifications* are developed. Understanding the design problem is an essential foundation for designing a quality product, and ultimately translating customers' requirements into a technical description. The ability to write a good set of *Engineering Specifications* is proof that the design team understands the problem. *Engineering Specifications* consist of parameters of interest and targets for parameters. *Engineering Specifications* are a translation of the voice of the customer into the voice of the engineer. They serve as a vision of the ideal product and are used as criteria for design decisions.

There are many techniques used to generate *Engineering Specifications*. One of the best is called Quality Function Deployment (QFD), including the construction of a House of Quality (HoQ). The QFD method is organized to develop the major pieces of information necessary to understanding the problem:

1. Hearing the voice of the customers
2. Developing the specifications or goals for the product
   (i.e. the *Functional Specifications*)
3. Finding out how the specifications measure the customers' desires
   (the *Engineering Specifications*)
4. Determining how well the competition meets the goals
5. Developing numerical targets to work toward *(the Engineering Design Targets)*

The customers' requirements must be translated into measurable design targets for identified critical parameters. You cannot design a laptop that is "light" when the meaning of "light" is not clearly defined. "Product must be light" is more of a Functional Specification, while "Product must weigh less than one U.S. pound" is an Engineering Specification. The specifications must be published, before much time and resources are invested in the design effort.

The QFD technique (building a House of Quality (HoQ)) ensures that the problem is well understood. It is useful with all types of design problems and results in a clear set of customers' requirements, Functional Specifications, and associated Engineering Specifications. Submit a House of Quality Diagram and refer to it for the inputs and outputs. Depending on the size of your HoQ, sections may need isolated and magnified for discussion.

Finally, an often overlooked class of requirements is the class of those relating the product life cycle other than product use. It is important for the design team to ensure that requirements imposed by environmental concerns have been identified. Since the design process must consider the entire life cycle of the product, it is the design engineer's responsibility to establish the impact of the product on the environment during production, operation, and retirement. Thus, requirements for the disposal of wastes produced during manufacture (whether hazardous or not), as well as for the final disposition of the product, are the concern of the design engineer (you).

Report Content

The Functional and Engineering Specifications document should contain the following sections, at a minimum:

- Cover Page
- Problem Statement: Identify the problem that will be addressed
    - State reasons why the project was chosen and why it is worthwhile.
- Project Description
    - How does the solution Function, how does it work?
        - described with the aid of a sketch.
        - Include a flowchart / block diagram.
- Functional Requirements
    - Segue outlaying the important functional features incorporated in to the design, introducing your House of Quality (HoQ) diagram.
    - Include a description of each, answering WHAT and WHY
    - The basis for an advertising brochure
    - List or Table Form
- Engineering Specifications and Targets
    - Include a description of each, answering WHAT and WHY
    - There should be a clear connection between Functional Requirement and the corresponding Engineering Specification.
    - Each Engineering Specification has a unit (e.g. length, weight, time, concentration, etc.), can be measured, and will have a design target value.
    - Be reasonable and rationale with your Engineering Targets. No "pie-in-the-sky" targets! Have justification for your targets.
    - Show the correlation between the Engineering Specifications. Discuss tradeoffs and compromises (this is the roof of your HoQ)
    - List or Table Form
- Competition
    - What products / processes exist that perform the same or similar function?
    - How satisfied are customers satisfied now?
- House of Quality
    - May require "breakouts"
    - The Functional Requirements and Engineering Specifications and Competition sections should refer to the HoQ.
- Impact of the problem solution in a global, economic, environmental, and societal context.
    - Address with a with a 1-2 paragraph discussion, demonstrating your ability to recognize your ethical and professional responsibilities and your judgments, considering the impact of the engineering solution in global, economic, environmental, and societal contexts.
    - Discuss the entire life cycle of the product/project, and the impact of the product on the environment during production, operation, and retirement.
- Safety
    - Discuss Safety implications of your product (from manufacturing to user to disposal)
- Conclusion
- Appendices A/N

Add additional sections as warranted. For example, a sketch, flowchart, block diagram, etc. will likely be necessary, to supplement your description / specification (at least one of those).

Be sure to identify your HoQ (and each breakout), pictures, flowcharts, etc. as "Figures" in your document, and refer to items as "Figure #".

Proposal Format – Follow general guidelines for technical reports. For Example:

a) Formal writing guidelines used by your project sponsor (if applicable).
b) "UPJ Engineering Standards for Homework and Technical Reports".
c) "Rules for Writing Objective Formal Prose", see Appendix I.
d) "Mechanics of a Report", see Appendix II

ADDENDUM:

How to convey the FUNCTIONAL REQUIREMENTS – ENGINEERING SPECIFICATIONS – DESIGN TARGETS, in the Functional Requirements and Engineering Specifications Report.

Standardizing and Streamlining the presentation of Projects' design parameters (obtained from the House of Quality), please follow the format described within. Within the appropriate section of the formal written report, initiate the presentation of the design parameters via a LIST (of each Functional Requirements and each Engineering Specifications) (in written List or Bullet List form), **and include the necessary information (i.e., several sentences) to answer the WHAT and the WHY (additional details follow).** Subsequently, following these descriptive lists, include a TABLE SUMMARY (example provided as TABLE 1: *Functional Requirements and Engineering Specifications Summary*).

FUNCTIONAL REQUIREMENTS: Must answer WHAT and WHY. Elaborate on the Requirements, and explain WHY it is important. If customer requirements are too vague (e.g., product must be durable), flesh these out a little more in the customer's words. Consider a common Functional / Customer Requirement: Durable. What is "durability"? Does that mean you can jump up and down on it? Does it mean that it lasts more than a minute? For example, WHAT is durability, and WHY is it important?

ENGINEERING SPECIFICATIONS: Must also answer WHAT and WHY. Also, include a discussion on the Engineering Design Target (e.g. the "Delighted" target), and the Engineering Threshold Target (i.e., the "Disgusted" target). Note: DO USE THE textbook terms "DELIGHTED" and/or "DISGUSTED" in the written report. Elaborate on the Specification, and explain WHY the Specification is important. These specifications are the restatement of the design problem (i.e., the ENGINEERING FORMULATION) in terms of parameters that can be measured and have target values. These specifications are a translation of the voice of the customer into the voice of the engineer. Every effort must be made to find as many ways as possible to measure customers' requirements. If there are no measurable engineering parameters for customers' requirements, then the customer's requirement is not well understood. Each Engineering Specification should measure at least one customers' requirement at the strong relationship level. Ideally, **each Engineering Specification should measure multiple Functional Requirements.**

Succinctly, in the report, LIST each Functional Requirements and Engineering Specifications (in List or Bullet List form), and include the necessary information to answer the WHAT and the WHY. Following these descriptive lists, include a SUMMARY, in TABLE format:

Table 1: Functional Requirements and Engineering Specifications Summary

ENGINEERING SPECIFICATION • Related Functional Requirements	UNITS	DIRECTION ↑ ↓	DESIGN TARGET	DESIGN THRESHOLD
ENGINEERING SPECIFICATION 1 • Related Functional Requirement 1 • Related Functional Requirement 2 • List all measured Functional Requirements				
ENGINEERING SPECIFICATION 2				
ENGINEERING SPECIFICATION 3				

APPENDIX I: RULES FOR WRITING OBJECTIVE FORMAL PROSE

What to Avoid

1. Avoid contractions

Contractions render prose less formal.

2. Avoid the use of the personal "I"

Note that qualifiers such as "I think" are especially irrelevant. However, the personal "I" can and must be used in certain types of letters, such as job application letters. It is also acceptable in oral presentations, but over-use will make the writer or speaker sound egotistical.

3. Avoid rhetorical questions

A rhetorical question is one in which the writer states the questions and then answers it. This use wastes words and violates the principle of economy in writing.

4. Avoid the use of the second person "you"

The English language fails to distinguish between "you" (singular) and "you" (plural). Consequently, the use of "you" in formal prose is vague. This pronoun form should only be used to give instructions or to make requests, and even then, it should be used sparingly. Especially avoid the construction "you know" in both oral and written presentations.

5. Avoid clichés

While all writing cannot be original, at least avoid obvious clichés like "A penny saved is a penny earned".

6. Avoid slang, technical "jargon", "media" words, "globbledgook" and "federal-ese"
    a. *Slang* reduces the level of formality in your writing. It is also subject to misunderstanding since there are no fixed meanings for most slang expressions.
    b. *Media words* are overused and trendy. The greatest offender of the present decade is "lifestyle", a terrible word.
    c. *Gobbledygook* is a mélange of jargon words often employed to bury actual meaning. Usually the author is unable or unwilling to state what is meant clearly and so loads up the sentence with unclear words and grammar. The result is often unreadable prose.
    d. *Federal-ese* is the language of government bureaucrats. Like gobbledygook, it obscures meaning.

What to do **WRITE WITH A PURPOSE!**

1. Use active voice

Use third person active voice. This will make your writing far more interesting and vigorous. Active voice gives your writing "life".

Example: Passive
The autopsy was seen by twelve students.
Active
Twelve students saw the autopsy.

Note: When the subject performs the action, you are using active voice.

2. Use possessives correctly

Learn the rules governing the formation of possessives.
Use 's for singular possessive
Use s' for plural possessive

Example: child's (singular possessive)
children's (plural possessive)
woman's (singular possessive)
women's (plural possessive)

The one exception to the possessive rule is the form "its" to show possession.
Note: It's – it is Since you have been instructed to avoid contractions in objective, formal prose, "it's" is always wrong.

3. Use the right word

Learn to distinguish between the spellings of words that are pronounced the same way but are spelled differently and have different meanings:

Example: sight – vision; the ability to see
cite – to state a source, as in to "cite" a reference
site – a location

4. Use parallel structure

Parallel structures give your writing balance and a sense of order. This is particularly true in a series of related statements. Arrange your sentence so that its parts are grammatically equal. Faulty parallelism occurs when the related ideas in a sentence are not grammatically balanced.

Example of Faulty parallel structure:
Computer programs are available which perform calculations, record-keeping and some do word processing.

Example of Correct parallel structure:
Computer programs are available which perform calculations, record-keeping and word processing.

APPENDIX II: MECHANICS OF THE FINAL REPORT

Typing

Final Reports should be typed (1.5 or double spaced) on one side of standard letter size sheets (nominal 8 ½ x 11 in). The paper should be white and of good quality and weight. Pages of the report, including appendices, if any, should be numbered consecutively centered at the bottom of each sheet.

Illustrations

Graphs, charts, sketches, line drawings, and diagrams should be created with the appropriate computer software (Visio, Word, PSpice, etc.) and they should be in the body of the report as close as possible to the reference statement. Captions should be included to describe the illustration.

Headings and Numbering

Headings and sub-headings should appear throughout the text of the report to divide into logical parts and to emphasize the major topics. These headings will assist the reader in following the trend of thought and informing a mental picture of the points of chief importance.

Formulas and equations should be numbered consecutively throughout the report, including the appendices, irrespective of any divisions in the text.

Tables should be numbered consecutively throughout the report, including the appendices.

All illustrations should be consecutively numbered throughout the report including the appendices. Illustrations are properly referred to as “figures”.

Mathematics

Type formulas and equations used in the report. A list of all symbols used in the report should appear at the beginning. The distinction between capital and small letters should be apparent. Explain what each symbol stands for and the unit in which it is expressed. If an equation or formula must be arrived at by a lengthy derivation, it is preferable that the derivation be accomplished in the appendix. Proper reference to the appendix is imperative in this case.

Drawings

All drawings, which are considered an essential part of the project, should be included with the final report. The drawings should be of sufficient detail that any related manufacturer could build the product from the drawing alone.

Language

Spelling, punctuation, paragraphing and other mechanical details of correctly written English are essential to a good report.

Computer Programs

Any computer programs, which are considered significant to the project, should be documented. Be certain to include the revision number of the software and date of release.