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Design Specification

For

Item Tracker

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Notes on This Document Template

This Document template is based on a compilation of sources from Government, Industry and Universities. In particular, materials from the CDC, VA, The University of Texas, Penn State University, and For Dummies have been liberally incorporated. Note that not all sections necessarily apply to your particular project. Also note that your project may require that you add additional sections to capture design specifications not explicitly included in this template. You should address customizations in cooperation with the course instructor.

Note that design specification requires an iterative collaborative process entailing information gathering, creative thinking, contextual assessment, with reference to requirements, constraints, design standards, affected constituencies, and stakeholders. You should NOT develop this document in isolation. Be sure to keep constituencies engaged and in the loop. You will need their final sign-off before you can begin complete this phase of the process.

If you have any questions, contact the course instructors for guidance.

# 1. Executive Summary

Typically, all the sentences in a design summary can be found in one form or another in the sections that follow. The purpose of the Executive Summary is to give the reader an overview of what the design need is and what design is being proposed to fill that need. Because of its content and location, this section is the most widely read section of the document. For that reason, the section should be well written and carefully proofread.

This document outlines the proposed system design for the new evaluation examination and verification platform referred hereafter as the Veterans Enterprise Management System (VEMS) as designed to accommodate the Office of Small and Disadvantaged Business Utilization (OSDBU) for the Department of Veteran’s Affairs (VA). This document is based on the VA-One technical reference standards and the (Document (SDD) template required as a PMAS deliverable for Milestone One of the ProPath project management methodology

## Purpose of this document

The purpose of this document is to describe in sufficient detail how the proposed system is to be constructed. The System Design Document translates the Requirement Specifications into a document from which the developers can create the actual system. It identifies the top-level system architecture, and identifies hardware, software, communication, and interface components.

Note, this section need not be very large. One or two paragraphs should suffice, as you only need to identify the specific product this document addresses.

## Design Scope

Here you should provide a short description of the system being constructed. Your description should include intended benefits, objectives, and goals. This section should at a minimum be one or two paragraphs in length, although at your option you may go longer than that. Do note that the main point of this section is to briefly describe the “size” of the project in terms of a bounded list of objectives and goals. You will provide a more detailed design description later. Here you should be concerned with describing the boundaries of the project (I.E. what you’re responsible for and what you’re not responsible for) as opposed to the details of what lies within those bounds. This section will be of particular interest to your sponsor and should be carefully negotiated, as in a very real sense; this section defines the criteria for deciding if your work is completed.

If there are previously existing design documents (E.G. a requirements specification of an earlier version of this product), they should be referenced here if this new product is to be a functional superset of the original.

## Intended Audience and Document Overview

Here you should describe the different kinds of readers you expect will be referring to this document. Examples of possible reader categories are project sponsors, project clients and users, project managers, marketing staff, and technical writers who will be preparing documentation for end users. You should also describe what sections of this document would be most useful for each of these groups of readers and suggest an order in which those sections should be read. Note that it’s save to presume that ALL readers will read section one of this document, as section one is intended to be both introductory and summative of major information common to the needs of all your readers.

## Definitions, Acronymns, and Abbreviations

This subsection should explicitly define ALL abbreviations, Acronyms, and specialized terms you use in this documents. You should focus especially on terms and abbreviations that are unique to the vernacular of your clients and/or sponsors. For a specification of a Galaxy Class starship, one might provide the following abbreviations in the following format:

ASRV Autonomous Survival and Recovery Vehicle

FTL Faster Than Light travel

RCS Reaction Control System (maneuvering thrusters)

SIF Structural Integrity Field

STL Slower Than Light travel

UFP United Federation of Planets

USS United Star Ship

WF Warp Factor (FTL speed measurement unit)

## Document Conventions

This subsection should define any special typographical conventions you use in the remainder of the document. For example, highlights of a certain color may have some significance (e.g. requirements inherited from the older Ambassador class starships might be highlighted in light green while requirements new to the Galaxy class might be highlighted in light yellow). Line graphs may follow some universal convention (e.g. dashed lines represent performance of existing Ambassador class starships and solid lines represent performance of new Galaxy class starships). Any such conventions should be defined in this section.

## References and Acknowledgments

This subsection should contain explicit references to any pre-existing material you make reference to in any part of this document. Examples of items one might reference are web pages, style guides, documents pertaining to earlier versions of the product considered in this document, contracts, professional society standards documents, etc. You should choose a consistent style for presenting your citations and references. We recommend the IEEE style, for which you can find ample documentation online.

# Problem Statement

In this section, your group will define the problem you are addressing, explain its significance, and discuss the impact of your solution (not how you are going to solve the problem, but what will happen if you solve the problem. **This document should not include specific technical details about your approach.**). Start with a general problem overview, background, etc., and then get progressively more detailed.

This section, sometimes called the “Introduction,” establishes the need for your design. In this section, you will make assertions about the problems that have created the need for the design you are proposing. Do not just make the assertions—rather, back up the assertions with evidence. That evidence generally will be reference listings from journal articles, books, briefings, or other sources. The evidence could also be surveys or testimonies of users.

In this section, you typically do not discuss the design solutions that you propose. Rather, you establish the problem so that when you discuss the proposed designs in the following sections, the reader is prepared.

## Historical Introduction

An overview of the general technical area you are researching, as well as any societal context impacting this project. (For example, many new products and business opportunities have resulted from significant legislation such as the American Disabilities Act of 1990. A project in this area that was impacted by this legislation should spend time discussing this.) At the end of the historical introduction, include a few sentences to tie this section into your project’s overall subject/purpose, basically answering the question, “So what?”

## Market Analysis and Relevant Art

Include a market analysis (i.e., Who would want to buy/use your product?) and an analysis of competitive products and relevant art (i.e., What other products like yours exist? How much are they? How is your product different?). If the product is a component of a larger system, provide a description of the larger system and how this product relates and interfaces to the larger system or systems. Diagrams, pictures, and charts are very appropriate for inclusion in this section, especially if they render clearly the relationships between the product and the larger context in which it is to exist.

## Alternative Approaches

Discuss alternative approaches to the design, including the relative advantages & disadvantages of each and the justification for the one selected. Provide evidence that the solution space has been appropriately explored and the best solution has been chosen to meet the stated requirements under the imposed constraints.

## Impact of Success

Describes how this product will be used if you are successful and the impact on the stakeholders and others. For example, if you build an audio amplifier for $10 that outputs 500W, how much of the market for audio amplifiers would you expect to capture?

Also, think about any broader changes that will occur if your product is successful. For example, Apple’s introduction of iTunes had a significant impact on market sales in traditional music stores. It also had a societal impact in that it helped reduce illegal music sharing: people could now buy individual songs instead of having to purchase an entire album. There is a temptation in this section to simply restate what you have already said using different wording. This section should contain NEW content and not reworded old content.

# Context of Design Solution

## Design Objectives

This section describes design objectives referenced in the rest of the document. Throughout this document, specific design elements and trade-offs are identified in the context of meeting these design objectives.

Often, a design has two to four specific objectives. Consider listing objectives as follows:

*(1) The designed toilet is the industry leader in flush performance,*

*(2) The designed toilet employs water saving technology,*

*(3) The designed toilet complies with existing standard “rough-in” dimensions, and  
(4) The designed toilet is resistant to harboring bacteria even after abrasive cleaning.*

A list may be appropriate here since readers often return to this section to review those objectives. Having the objective in a listing makes it easier to find. If your design objectives are complicated and depend on variables, consider placing them into a formal table, which would be introduced by name: Table 1, Table 2, and so forth.

In this section, you also present text that discusses more fully what you mean by the different design objectives. You might consider having a paragraph for each objective. For example:

*Flush performance refers to the ability to dispose of a mix of baby wipes, sponges, plastic balls, and water-filled latex sleeves without clogging. A secondary measure of flush performance is how well each flush cleans the toilet bowl and moves waste down the drain line. Top performers leave the bowl pristine and carry waste down the drain pipe without clogs.*

Note that if you have done a good job in the “Statement of Problem” section, then all the design objectives should make sense to the audience.

## Design Assumptions

List any assumed factors (as opposed to known facts) that could affect the requirements stated in this requirements specification document. These could include third-party or commercial components that you plan to use or issues or constraints related to the development or operating environments. All of these assumptions should share the property that the project could be affected if they are incorrect, are not shared, or change. Also identify any dependencies the project has on external factors, such as software components that you intend to reuse from another project.

## Design Requirements

Include the relevant material from your requirements specification document. You may wish to divide this section into subsections matching the structure of your completed requirements document.

**YOU MUST IDENTIFY AND DISCUSS AT LEAST TEN FEASIBLE REQUIREMENTS DRIVING THE SPECIFICS OF YOUR DESIGN APPROACH.**

## Design Constraints

Include the relevant material from your requirements specification document. You may wish to divide this section into subsections matching the structure of your completed requirements document.

**YOU MUST IDENTIFY AND DISCUSS AT LEAST FIVE REALISTIC CONSTRAINTS UNDER WHICH YOUR DESIGN AND IMPLEMENTATION MUST OPERATE.**

## Design Standards

"A standard is a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose." - [ISO](http://www.iso.org/iso/home/standards.htm)

Your design will interface with other software/hardware/data/signals/connections. Operability and interoperability is made possible only through strict adherence to standards.

In this section, applicable design standards should be referred to by category and source (organization). Specific references to cited standards should appear again more completely in the technical approach sections discussed below.

**YOU MUST IDENTIFY, INCORPORATE, AND EMPHASIZE MEETING AT LEAST THREE APPLICABLE DESIGN STANDARDS IN VARIOUS ELEMENTS OF YOUR DESIGN.**

## Design Functionality

Summarize the major functions the product must perform. Organize the description to make them understandable to as many readers of your document as possible. At the very least, the readers should understand what functions are being provided, how they relate to one another, and how they relate to the problem product perspective earlier given. Again, pictures and diagrams are very appropriate. Top-level data flow diagrams or object-flow diagrams would be particularly effective. At a minimum, provide a bulleted list of ALL major functions the system will perform.

## User Characteristics

Identify the classes and characteristics of users you anticipate will use your product. Users should be classified by any taxonomy that makes sense for your project. Examples of taxonomic schemes include frequency of use, subset of product functionalities used, technical skill level, security or privilege levels, or product domain knowledge. Note that certain functionalities may appeal to only some user classes. You should also provide, if appropriate, a priority of importance of user classes. For example, you and your project sponsor may agree that the needs of certain classes of users are more important than the needs of other classes of users. Identify any such priorities here. Again, diagrams and charts are particularly useful.

## Operating Environment

Describe the environment in which the product will operate, including the hardware platform, operating system and versions, and any other components or applications with which it must be compatible. Discuss any environmental conditions, such as temperature, lighting, humidity/water resistance, atmospheric parameters, spatial parameters, electromagnetic interference, mechanical stresses that may impact the product. Again, diagrams and charts are particularly useful.

## User Documentation

List the user documentation components (such as user manuals, on-line help, and tutorials) that will be delivered along with the software. Identify any known user documentation delivery formats or standards.

# Technical Approach

This section discusses how you will realize the objectives presented in the previous section. Begin the approach section with a paragraph that provides a general overview of your design, thus providing continuity and flow of this section with the preceding sections. The approach section discusses, in great detail, the **hardware** and **software** subsystems used in your design to meet the requirements within the technical and practical design constraints of your project. The approach should follow a logical sequence.

## Hardware

For the hardware subsystems, you must discuss the different approaches to the key technological elements of your design and their **tradeoffs**. In discussing the tradeoffs of each technological approach, present enough **background theory** on each approach so that the reader becomes familiar enough with each approach to understand your **justification** for selecting a particular approach. To reiterate, for the major hardware subsystems in your design used to meet the technical and practical constraints of your design, you must present the theory behind the different technological approaches, the tradeoffs associated with each approach, and your justification for selecting a particular approach. You do not need tradeoffs for each approach if there is an obvious implementation that meets the constraint; however, you must still state how you met a constraint, even if there are no tradeoffs, and justify your decisions to meet the constraint.

For example, many projects contain a microcontroller. You do not have to provide tradeoffs on the microcontroller choice if a generic microcontroller is sufficient; in this case choosing a microcontroller that you are familiar with (and saying that this is why you chose it) is fine. However, if you need a particular feature in the microcontroller (power consumption, some particular on-chip peripheral, etc), then detailed tradeoffs should be given.

Another example: Many projects are battery operated. You must include current draw equations that show that your battery choice meets your operating time specification. At the most basic level, this is simply the current draw of your system divided into the mA hour rating of the battery to get the number of hours that it will run. Most battery-operated projects, though, have a sleep mode and an active mode, and so your equations must show these two contributions. If your active mode has significantly different current draw depending on what the system is doing, then you must sub-divide your active mode into the percentage of time spent doing each task.

## Software

Your software section must include the following:

 A few “optimistic” and “pessimistic” usage cases, along with a model data flow for a couple of representative cases.

 A model diagram that shows how the user interacts with your system

 A flow chart that shows the basic top-level state machine for your software

 A discussion of the data types and data storage with which your software interacts

You do not have to present an object model or an object-oriented view of your design; however, you may do this if you are comfortable with this approach.

The approach section must present a **complete** picture of how your project meets all of the technical and practical constraints, as well as the operation of the hardware and software subsystems to provide the functionality needed for your project.

# Appendix: Test and Evaluation Master Plan and Report

The **Test and Evaluation Master Plan** **or TEMP** outlines the plan for testing, analysis, and validation of: *achieving* each requirement, *conforming* to each constraint, and *complying* with each standard. In this section, the team shall describe the test and analysis method for each requirement, constraint, and standard. The test and evaluation methods should follow industry standards and best practices whenever possible. In cases when an alternate method is used, the method should follow mathematical or physical principles, engineering best practices, or common sense. In some cases, the TEMP may be useful in identifying requirements that were improperly specified.

The **TEMP Report**, which is an execution of the TEMP, documents the actual testing and evaluation activities and serves to validate the requirements, constraints, and standards per the design specification.

**Definition of terms:**

*Test*: the act of inspecting or measuring a particular property or capability of the system.

*Evaluation*: the act of analyzing the results of a test to determine if a particular design requirement, constraint, or standard is satisfied.

*Threshold*: the minimal performance level for the design to satisfy a particular requirement, constraint, or standard.

*Objective*: the performance level goal, that is better than the performance Threshold value. In some cases, the sponsor pays a bonus when the design exceeds the Threshold Objective.

A test method may be direct observation under appropriate conditions, such as when a subsystem is present or the system is in a particular state of operation. In other cases, the test method may be by indirect observation, such as when a voltage measurement is converted to a scale representing temperature. In some cases, a test result must be analyzed to calculate the quantity used to validate a requirement, constraint, or standard. Regardless of the manner of test and evaluation, engineering standards and best practices should be used where appropriate.

The TEMP must include statements of the requirements (section 3.3), the constraints (section 3.4), and the standards (section 3.5) and, for each of these, include the description of the test method, the analysis method, the performance threshold, and the performance objective. The TEMP Report lists the test date, location, time, conditions, results and any notes pertaining to deviations from the TEMP. For purposes of this practicum, it is understood that testing for compliance with some requirements, some constraints and likely *most standards* may exceed the capabilities and resources available. In such cases, the team should clearly identify how such testing would be performed if resources were available, or identify an outside service provider that could be contracted for compliance testing relative to a particular standard.

***Example Contents of the TEMP Document***

**Summary Tables of Test Plan *–*** *Each row should have a corresponding description of the test and evaluation methods.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Requirement | Test Method | Evaluation Method | Threshold | Objective |
| 1.1 |  |  |  |  |
| 1.2 |  |  |  |  |
| 2.1 |  |  |  |  |
| ⁞ |  |  |  |  |
|  |  |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Constraint | Test Method | Evaluation Method | Threshold | Objective |
| 1.1 |  |  |  |  |
| 1.2 |  |  |  |  |
| 2.1 |  |  |  |  |
| ⁞ |  |  |  |  |
|  |  |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Standard | Test Method | Evaluation Method | Threshold | Objective |
| 1.1 |  |  |  |  |
| 1.2 |  |  |  |  |
| 2.1 |  |  |  |  |
| ⁞ |  |  |  |  |
|  |  |  |  |  |

**Summary Tables of Test Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Requirement | Test Date | Test and Evaluation Location | Result | Notes | Date Passed (Accepted) |
| 1.1 |  |  |  |  |  |
| 1.2 |  |  |  |  |  |
| 2.1 |  |  |  |  |  |
| ⁞ |  |  |  |  |  |
|  |  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Constraint | Test Date | Test and Evaluation Location | Result | Notes | Date Passed (Accepted) |
| 1.1 |  |  |  |  |  |
| 1.2 |  |  |  |  |  |
| 2.1 |  |  |  |  |  |
| ⁞ |  |  |  |  |  |
|  |  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Standard | Test Date | Test and Evaluation Location | Result | Notes | Date Passed (Accepted) |
| 1.1 |  |  |  |  |  |
| 1.2 |  |  |  |  |  |
| 2.1 |  |  |  |  |  |
| ⁞ |  |  |  |  |  |
|  |  |  |  |  |  |

**Test and Evaluation Methods**

Testing of requirements is to validate the system’s achievement of a capability or level of performance. Testing of constraints is to verify that the system’s properties, capabilities or levels of performance conform to limits set by of the constraints. Testing to standards is to verify that the system’s capabilities, function or levels of performance comply with industry standards.

The following examples illustrate simple approaches for writing descriptions of test and evaluation methods to verify achievement of a requirement, to verify the system conforms to constraints, and to verify the system complies with standards.

***Requirements (verification of achievement)***

Requirement 1.1 will be tested at Facility X which hosts equipment Z and test chamber Y. The test method is as follows: Subsystem J will be monitored using a P test meter at standard temperature and standard pressure for H hours of continuous operation. Specialized test equipment and test fixtures are not required. The results will be evaluated by direct observation of the tests. The threshold is U units and the objective is V units.

Requirement 2.1 will be tested at Facility X which hosts equipment Z and test chamber Y. The test method is as follows: Subsystem J will be monitored using a P test meter at standard temperature and standard pressure for H hours of continuous operation. A specialized test connector Fitting K is required and the results will be evaluated by indirect observation. The Value at test port A will be processed using a discrete Fourier transform and frequency domain analysis. The threshold is U units and the objective is V units.

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***Constraints (verification of conformity)***

Constraint 1.1 will be tested at Facility Y which hosts Windows- and Linux-based laptops, desktops and workstations. The test method is as follows: Graphical User Interface (GUI) software for subsystem H will be compiled on OS D without error or warnings. Each of the GUI features will be demonstrated following Use Cases A, B, C as described below. The threshold is zero run-time errors. The objective is zero run-time errors.

Constraint 1.2 will be tested at Facility Y which hosts Windows- and Linux-based laptops, desktops and workstations. The test method is as follows: Following successful demonstration of Requirement 2.1.1, Algorithm W will be tested using the Graphical User Interface (GUI) software for subsystem H. Each of the GUI fields values will be compared against the expected values following Use Cases A, B, C as described below. The threshold is accuracy of +/-X units. The objective is +/-X/2 units.

…

***Standards (verification of compliance)***

Standard 1.1 will be verified in accordance to IEEE Standard 102.11C dated Sep. 2016. The tests will occur at Facility X which hosts equipment Z and test chamber Y. Specialized test equipment and test fixtures are not required. The results will be evaluated by direct observation of the tests. The threshold is U units and the objective is V units.

Standard 1.2 will be tested for compliance with IEEE 802.11 a/b/g/n/ac at the Interoperability Laboratory at the University of New Hampshire. The cost of this test service will be $X, and will be completed along with a compliance report within Y weeks.

# Appendix: Résumés of Team Members

The following pages present one-page résumés of the team members.