

MBARI Guidelines for Project Design Reviews and Requirements Documents

15th Nov 2002

Keith Raybould

Functional Requirements

Concept Reviews

Preliminary Design Reviews

Critical Design Reviews

Readiness Reviews

Guidelines for Holding Successful Design Reviews

1. Introduction

1.1 This document includes guidelines and recommendations for MBARI design reviews and for preparing Requirements Documents.

1.2 For design reviews, this document outlines at what stage in the project cycle the design reviews should be held together with what should be presented and who should attend the reviews. Also included is a section on general advice for conducting the design reviews to make them successful.

1.3 For Requirement Documents, this document outlines what should be included in the Requirements Document and provides a template for organizing the requirements. This is an area where everyone has prior different experience and there is no single right way. In particular everyone has different nomenclature for what is often the same or similar meaning. So here is an approach and a common set of terminology that MBARI can use so that we can work towards a common way of documenting and controlling Requirements.

Requirements Documents

1. Importance of Requirement Document. Requirements documents are essential for every project and should be one of the first tasks the project team undertakes. Without a first draft of the requirements document, design work should not be started.

2. Keeping Track of the Requirements. Requirements should be documented and at appropriate times new versions of the Requirement Document (RD) released. You should identify each release with a version number and a release date so that everyone in the team will be working off the same version of the Requirements.

3. Requirement Changes. Requirements change during the life of the project. You can expect this and even encourage it up to the Concept Design review. The first draft of the Requirements may include requirements that are impossible to meet, or are only “nice to have” but end up being design drivers. Until the design progresses, implications of some of the Requirements may not be well understood. Also in the early stage of the project new requirements may be identified and need to be added to the RD. The idea is that the Requirements should change up to the Preliminary Design Review (PDR) so that by the time you reach the PDR you have a realistic, high priority set of Requirements. After the PDR, the implications of requirement changes become more dramatic. So after the PDR, any new requirement must go through the project manager for evaluation on the impact on the project cost, schedule, performance before the new requirement is either accepted or rejected. This should speed up the process of getting the first system built and tested early, instead of experiencing set backs each time a new Requirement gets introduced randomly. Throughout the project, keep the Requirement Document up to date.

4. When are they needed?

- First draft of the RD should be completed before design work starts
- A well developed draft RD should be presented at the Concept Design Review
- A completed RD should be presented at the PDR
- After the PDR, any changes to the RD should be reviewed and approved or rejected by the project manager

5. What Should be Included in the Requirement Document?

5.1 A template for a Requirement Document is included here. The requirements are divided into:

- User/High Level Requirements (these are usually given by the end user)
- Derived Requirements (these are usually derived from the User/High Level requirements) (sometimes referred to as Level 2 or System Design Requirements)
- Environmental Requirements (depth, current etc)
- Operational/Maintenance Requirements
- Design Constraints (e.g. max weight, space limitations etc)
- Other Constraints (e.g. budget, schedule)
- Interfaces (to all other systems that the project unit interfaces to)

Notes:

a) The RD should list all of top level requirements that the project must meet to be successful (ask yourself: “if the product of the design could do only the functions that are listed on the RD would you be happy with the product?”)

b) It is valuable to prioritize the requirements early in the project, into at least “must haves” and “nice to haves” to allow design trade off decisions to be made

c) The interfaces may not be defined early in the project, but they should be at least identified

d) Concept of Operations (Use Scenarios)

Depending on the project it may be useful to develop Concept of Operations to help complete the Requirements particularly for command and control and for GUI's and offer the following advantages. They:

- use the customer's words and are from his/her perspective
- provide many concrete concepts and terms for designers to build from
- capture a narrative or sequence, not just discrete events
- keep the designers focused on what the users need

6. Who Should Attend the Requirements Review?

- project team
- all potential users and operators
- group supervisors

7. Good Requirements:

Guidelines for writing good requirements

- use a single sentence to describe each requirement. Avoid long paragraphs. Don't lump multiple requirements together
- each requirement should be verifiable (i.e. it can be tested)
- if you include a requirement that is a result of adopting a design approach, identify the requirement as “Design Derived”. Designers will then know that this requirement can readily be changed
- often starts with “xxxxx shall”

Requirements Document:

Project Title:

Project #

Prepared by:

Rev #	Date	Changes	Approved by

1. Scope of Project

(high level description of the project, context, purpose, scope)

2. Requirements

2.1 User/High Level Requirements

(recommend using one sentence per requirement)

2.2 Design Derived Requirements

(each of these requirements should be traceable back to the User/High Level Requirements)

2.3 Environmental Requirements

(eg. depth, current, temperature, etc)

2.4 Operational/ Maintenance Requirements

(eg. must be maintainable by staff with skill set xx, design should maximize use of commercial off-the-shelf (COTS) equipment)

2.5 Design Constraints

(eg. max. weight, space restrictions)

2.6 Other Constraints

(eg. budget, schedule, resources)

3. Interfaces

Concept Reviews

1. Aim of Concept Reviews

1.1 At the Concept Review, design options should be presented to experts in different fields (engineering, operations, consultants) to get feedback on various design options. The Concept Review should ensure that before you invest significant design resources you have selected the most promising design option and have not overlooked any obvious difficulties or design approaches.

1.2 At the Concept Review you will be aiming to:

- Select most promising design option (and variants around that design) that will be carried forward to the PDR
- Identify and document all of the Functional Requirements before starting detailed design work
- Identify and document all of the interfaces (these will be defined later)
- Identify high risk elements of the program and determine how best to mitigate these risks
- Make sure you have not missed any obvious solutions

2. When Should the Concept Review be Held?

2.1 You should hold the Concept Review before starting detailed design, undertaking complex analysis or starting development test programs. Even after the Concept review you may not know with a high degree of confidence whether the concept will meet all of the Functional Requirements. However, at this review you should be able to present a plan to demonstrate that by the time of the next review (PDR), you have mitigated all of the high risks.

3. What Should be Presented at the Concept Review?

- Draft Functional Requirements
- Brief outline showing that you understand the state of the art in this project related field, literature survey, published papers. Show what is different between what has been done before and the project Functional Requirements. You need to demonstrate that you have a clear understanding of what has been done before (outside the Institute) and how your project compares to these prior efforts
- Description of design concepts being considered
- System block diagram (if appropriate)
- System software architecture. Requirements of main architectural sub systems and interfaces between these sub systems
- Software demos to evaluate look and feel of produce, to prioritize features/ capabilities, to stimulate users to provide feedback to help development process

- Trade study comparing the performance of the design concept against the Functional Requirements. Ensure that the Functional Requirements are prioritized. You don't want to have a non essential feature driving the design
- More detailed description of the design features and the predicted performance of the preferred design option
- The high risk¹ elements of the preferred design concept and a plan for how the risks will be mitigated
- Preliminary integration, test and deployment plan
- What it will take in resources to complete the project from the time of this review to the completion (resources and schedule)

4. Who Should Attend?

- Project team
- Engineering/ science experts
- Users and operators
- Outside experts
- Group supervisors

5. Tips for a Successful Concept Review

- Recommend having brainstorming sessions for solving complex problems prior to holding the Concept Review
- Select the personnel for the review carefully
- Keep the group small as this will help interaction develop atmosphere where anyone can feel they can make suggestions
- Keep an open mind and avoid the mentality of "not invented here"
- The project manager or designee should take notes and actions
- If you have not done this before hold a dry run

¹ Risk here is defined as technical risk only. The consequences to the project of a high risk technical element going wrong could cause an increase in one or more of the following (a) time to complete (b) staff resources and (c) \$ costs

Preliminary Design Reviews (PDR)

1. For smaller projects a PDR may not be necessary and you can continue design through to the Critical Design Review (CDR). The aim of the PDR is to evaluate the variations on the design selected at the Concept Review so that between the PDR and the CDR your team are working on a single “Point” design.

2. Aim of the Preliminary Design Review

- Ensure that you have selected the best design approach for meeting the Functional Requirements, and that the selected design concept will meet all of the Functional Requirements, before starting the detailed design phase
- Ensure that the Functional Requirements have all been identified and carefully defined before you start detailed design.
- Demonstrate that all of the high risk elements are identified and the risks mitigated before starting the detailed design
- Presents a milestone at which the Functional Requirements will be under the formal control of the Project Manager

3. When Should the Preliminary Design Review be Held?

3.1 After the PDR you should be confident that the design will meet the Functional Requirements, but before you start the detailed design

4. What Should be Presented at the Preliminary Design Review?

- The Functional Requirements (at the end of this review the Functional Requirements should be completed and will be under some form of change control by the project manager)
- Detailed performance of the concept design, together with the engineering (bench-testing, analysis, layouts) that proves that the selected concept will meet all of the Functional Requirements
- How the high risk elements identified at the Concept Review have been mitigated
- A detailed integration, test and deployment plan that will include an outline of how you will demonstrate that the system will meet the Requirements.
- Definition of all of the interfaces
- What it will take in resources to complete the project from the time of this review to the completion (resources and schedule)

4. Who Should Attend?

- Project team
- Engineering/ science experts
- Users and operators

- Outside experts
- Group supervisors

Critical Design Reviews (CDR)

1. Aim of Critical Design Reviews

CDR's are excellent project milestones. They allow an opportunity to check:

- the manufacturability and tolerancing of the design, although I would recommend that this is done earlier, nearer the 50% design stage
- that the issues and concerns raised at the PDR have been adequately addressed
- interfaces are under formal control before the start of manufacture
- a variety of issues including assembly procedures, alignment procedures, control and operation, integration and testing, deployment, handling procedures, data management, evaluation of safety

2. When Should the Critical Design Review be Held?

2.1 The CDR should be held when design has used ~ 95% of the total design resources needed to complete the design, but before the start of fabrication. The remaining 5% design effort is left for addressing issues raised at the design review. Note that different parts of the system can go to CDR at different times **providing** interfaces between the part being reviewed at the CDR and other parts of the system that have not reached CDR, have their interfaces documented and under formal control and the project has evaluated the impact of a design change in the parts of the system that have not reached CDR.

3. What Should be Presented at the Critical Design Review?

- Project team response to the questions and actions raised at the PDR or at the Concept Review. Present which Concept Review or PDR suggestions were adopted, and for the suggestions that were not adopted, why not.
- Functional Requirements (no need to present these at the review, just have them distributed to the review team with the review material)
- Detailed description of the design with complete assembly and sub-assembly drawings, schematics, together with predictions of the performance of the design verified by analysis or development test programs
- Detailed definition of all interfaces
- Completed Integration and Test Plans showing how the system performance will be verified
- What it will take in resources to complete the project from the time of this review to the completion (resources and schedule)

4. Who Should Attend?

- Project team
- Engineering/ science experts
- Users and operators
- Group supervisors

- Machine shop personnel (if fabrication/machining involved) and Technicians
- Members of deployment team

Readiness Reviews

1. Aim of Readiness Reviews

A Readiness Review should be held before newly designed hardware or software is interfaced for use on Institute platforms (ROV, AUV, mooring etc). This will help identify interface and operation problems prior to deployment, so that issues can be resolved prior to ship time or deployment.

2. When Should a Readiness Review be Held?

- a few weeks before deployment on the ship and ROV, so that there is time to work on problems identified at the review

3. What Should be Presented/Discussed at the Readiness Review?

- Deployment plan including who is going to do what and who is responsible for what
- Detailed integration and test plans
- Interfaces to ship/ROV
- Handling arrangement
- Safety issues

4. Who Should Attend?

- Engineering Support Group (lead the review)
- Project team
- DMO and/or deployment team

Guidelines for Holding Successful Design Reviews

1. Prior to the Review:

- Ensure the documents are consistent and clear
- Send out the material to the reviewers at least 2 days before the review
- Hold a dry run if you have not done this before
- Ensure you invite the right individuals to the review, keep the group small so that you hold meaningful discussions. Interaction is important, so avoid it being a Pacific Forum type of presentation event. There are a few exceptions to this, namely, MOOS system level reviews and projects that involve multi-institutions.

2. During the Review

- Ensure that you start the review stating the aims of the review and how it will be conducted
- Plan for 50% presentations, and 50% open discussion. State before the meeting whether you want questions to be held during the presentations or held to the end of individual presentations
- Manage the meeting. Keep discussions focused. Know when to cut in and close out a discussion that is dragging on. This is a difficult balance because you want to encourage comments from the reviewers.
- Invite comment from the expert reviewers who are sitting quietly at appropriate times
- Either take notes and actions or have someone take notes for you. When you want to take an action to check or review some aspect of the design make a statement to that effect, and then move on
- Don't get too far into redesigning the project at the review. This is what should have happened before the meeting. Take an action item to investigate the suggestion after the meeting if it looks as though it may have merits.
- At later reviews such as the CDR, if anyone starts a discussion "why didn't you do it this way", politely state that the aim of the review is to "establish whether the current design meets the documented requirements". You do not want to open discussions on a radically different design approach at this stage in the project. This is what the earlier reviews are for, especially the Concept Reviews.

3. After the Review

- Send the comments and actions to everyone on the review team. This lets them know that their comments are being taken seriously. If you do not do this, the reviewers will start to feel that it was a waste of their time and the comments they made are being ignored
- Get the project team together and determine what you need to do to respond to the legitimate issues raised at the review. After you have the answers you may want to send a note to the review committee stating the outcome of your follow up work.
- Update your requirements, and move forward