9 Engineering Design Report

Note: There is no accepted model for design documentation. You need to check what is specifically required in your case.

This chapter covers the basic general requirements:

- The purpose of an engineering design report
- Its readership
- The general characteristics of design documentation
- The *Summary*
- Development of a model
- Design calculations
- Checklist

Purpose of a Design Report

Design reports are used to communicate your solution of a design problem, usually to your boss or a colleague.

The design report is a critical component of the design process. An extremely competent or ingenious design solution cannot be communicated by drawings alone; it needs to be supported by comprehensive documentation.

Readership

The report should be written for another person of equal or greater competence than yourself.

General Characteristics of Design Documentation

1. The report should be **self-contained**, except for references to other specific documents (e.g. contracts, drawings, and standards).
2. **Your report must contain all of the information needed for someone to check how you arrived at your recommended solution.** While carrying out your design, you will have used analysis to demonstrate that your design will actually solve the problem. This needs to be clearly set out in your documentation.

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The Workbook

The workbook – either digital or hardcopy – is maintained throughout the process of designing your solution. All of your analysis will therefore be documented in your workbook as well as in your final report.

In the professional engineering workplace, a design workbook can become a legal issue, if for example a design has catastrophically failed. It therefore needs to be meticulously maintained.

Suggested Structure of Design Documentation

1. **Summary**
2. **Development of a Model**
3. **Design Calculations**

The Summary

Purpose of this section: The Summary should state precisely what the report is about and answer the following questions. *To make sure you don't solve the wrong problem, write up the first two before you start the design.*

1. **What problem does the report address?**
   - If the problem was defined in writing (assignment, tender or contract document), just refer to this briefly and accurately rather than restate the whole problem. Your reader will already know what you were supposed to be doing.
2. **What criteria were set for deciding on an adequate solution?**
   - You can make a sensible design recommendation only if you **understand the criteria that are to be used in judging the success of your design**, and obviously you must know this before you start designing. Again, if these were defined in writing, just refer to the original document.
   - Sometimes there are **other constraints** such as national standards that must be met. These should also be stated.
   - **If the criteria were incomplete or contradictory**, for example between the cost and durability of a new product, you need to decide the relative importance of the criteria to be used in making your decision. You need to explain this in a subsequent section.
3. **How did you model the problem?**
   Outline very briefly the factors influencing how you went about your design:
   - The analysis that was needed
   - How many different options were considered
   - The main factors influencing the design

   Note: If you are designing something that is routine, this section would be very short.
4. **What did you conclude?**
   State the following simply:
   - What you concluded. Refer to drawings or other details of your recommended solution.
   - If you considered various options, summarise why you chose your particular solution.

Development of a Model

Purpose of this section: The first step in an engineering design is to be able to conceptualise the problem in a way that allows standard methods of analysis to be used. This section should explain how you went about this.
The form of this section: You should use diagrams and equations as needed, but tie them into a logical presentation using text. Again, for a routine design, this section need not be very long.

This section would typically answer the following questions:

1. **What assumptions were needed?**
   - **Every analysis of a real system has some assumptions built into it** because the physical world does not behave in the way that engineers need to assume.
   - **Often these assumptions are taken for granted**.
   - **But sometimes you need to make unproven assumptions** to simplify the problem enough to be able to model it for analysis. This is acceptable provided that you **state what the assumptions are and that you check them later**.
   - **Your assumptions should therefore be stated clearly at the start of this section.**
2. **How was the problem modelled?**
   - You should now be able to represent the object or system by a simple conceptual model that is capable of being analysed. Use a diagram (e.g. stick, block, circuit and flow diagram) to show this and discuss it if needed.
3. **What analysis was used?**
   - **State the laws that you have applied.** You should state the relevant physical or other laws that you needed to apply. State them by name; you don't need to write them out or include any proofs.
   - **These laws will probably result in equations.** These should be written out in full, using well-defined variables (include a named list or label to your conceptual sketch).
   - **Simply state the method of analysis you used and make a reference to it.** Nearly always, the method of analysis used is standard and can be found in textbooks.
   - **If the analysis is repetitive** (because the solution has many components of the same type), you need to document all of this only once.

Design Calculations

Purpose of this section: This part proves that your design will work as it should; the section will consist mostly of small sketches and steps in solving equations.
Form of this section: Use subheadings to make it clear what each section is about and emphasise the important results, e.g. by underlining or boldfacing text.

- **Add numbers to your design** and then use conceptual modelling to show that the design will function as it should – i.e. that it will meet the design criteria stated at the beginning.
- **The numbers needed are those that would enable someone to actually make your design**. Include details of all components (material and dimensions of parts, electrical components and so on) plus all the physical properties you have used (e.g. strengths, elastic modulus, density, specific heats).

- **Your design report should contain only your final recommended solution**. In your workbooks, you may have needed to guess some of the numbers to carry out the analysis. If it subsequently turned out that your design did not meet the criteria for success, then you would have changed the guesses and tried again. You may also have tried out several different design options before finding one that worked. No matter how long they took you, **the details of the designs that did not work are irrelevant**. If they should be needed later, they can all be found in your workbook.
- **Where you looked at several very different design solutions**, you may want to include detailed results from the best of each to justify your final choice.
- **For repetitive designs, you may want to use a spreadsheet**. In that case, document one example calculation right through as above, and just show the results of the remaining components on a table (which must include enough of the intermediate results that it can be checked easily).

Checklist for a design report

- ☐ Is it written for another person of equal or greater competence than yourself?
- ☐ Is the report self-contained (except for references to such documents as standards, textbooks, contracts and so on)?
- ☐ Is all your analysis also contained in your workbook?
- ☐ Does it state the design problem?
- ☐ Does it describe the design criteria?
- ☐ Does it describe how you modelled the problem so that standard methods of analysis could be used?
- ☐ Does it state the assumptions you made?
- ☐ Do you tie up diagrams and equations with explanatory text into a logical presentation?
- ☐ Does it state the laws you applied and the method of analysis you used?
- ☐ Do you show that your design meets the design criteria?
- ☐ Would the numbers on your design enable someone to make it?
- ☐ Does it state your conclusions?
- ☐ Do you present only your final recommended solution?
- ☐ If you considered various design options, does it state why you chose your particular solution?