

Engineering Design Report Template

Joseph T. Foley and Vilhjálmur Páll Thorarensen

Short project description goes here

March 13, 2024

Advisors:

Jon Jonsson, Liason
Head of Research, Icelandic Company, ehf., Iceland

Helpful S. Leader, Advisor
Assistant Professor, Reykjavik University, Iceland

Smart T. Assistant, Teaching Assistant
MSc. Student, Reykjavik University, Iceland

Joseph T. Foley, EngineeringX Head Instructor
Assistant Professor, Reykjavik University, Iceland

Copyright © 2024 Joseph T. Foley and Vilhjálmur Páll Thorarensen 

This work is licensed under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>). You may copy and redistribute the material in any medium or format, provide appropriate credit, link to the license and indicate what changes you made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. You may not use the material for commercial purposes. If you remix, transform or build upon the material, you may not distribute the modified material. The images or other third party material in this thesis are included in the book's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the book's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

Contents

Contents	iii
List of Figures	iv
List of Tables	v
List of Symbols	v
1 Instructions	1
1.1 Introduction	1
1.2 Where to get the files	1
1.3 Files and Directories/Folders	1
1.4 LaTeX Template Instructions	2
1.4.1 Getting started:	2
1.4.2 Important Details	4
1.4.3 LaTeX Generated file extensions	4
2 Introduction	7
2.1 Stakeholder	7
2.2 Background	7
2.3 Goals	8
2.4 Prior Art	8
2.4.1 Cool System 1	8
2.4.2 Cool System 2	9
2.4.3 Cool System 3	9
2.5 Example Section	9
2.6 Data Management	9
3 Design	11
3.1 Requirements	11
3.2 Concepts	11

3.2.1	Concept 1: Time traveling robot	11
3.2.2	Concept 2	12
3.2.3	Concept 3	12
3.2.4	Concept 4	12
3.2.5	Analysis	12
3.3	Implementation	12
3.3.1	FR ₁ do something interesting	13
3.3.2	FR ₂ do something else	13
3.3.3	FR ₃ do something different	13
3.4	Summary	13
4	Analysis	15
4.1	DP ₁ rotating thing	15
4.2	DP ₂ gorobi api	15
4.3	DP ₃ financial risk method XXX	15
4.4	Stakeholder Feedback on Early Prorotypes	16
4.5	Integrated Prototype	16
5	Conclusion	17
5.1	Evaluation	17
5.2	Opportunities	17
5.3	Summary	17
	Bibliography	19
A	Interviews	21
A.1	Initial Stakeholder meeting	21
A.2	Design Review	21
A.3	Poster Session	21
A.4	Product Reveal Feedback	21
B	Code	23

List of Figures

2.1	RU Logo	9
-----	-------------------	---

List of Tables

2.1	Table of squared numbers	9
3.1	First level FR-DP mapping. [7]	12

List of Symbols

Symbol	Description	Value/Units
E	Energy	J
m	Mass	g
c	Speed of Light	$2.99 \times 10^9 \text{ m s}^{-2}$

Engineering Design Report Template

Joseph T. Foley and Vilhjálmur Páll Thorarensen

January 31, 2024

Abstract

The abstract follows the addresses and should give readers concise information about the content of the article and indicate the main results obtained and conclusions drawn. As the abstract is not part of the text it should be complete in itself; no table numbers, figure numbers, references or displayed mathematical expressions should be included. It should be suitable for direct inclusion in abstracting services and should not normally exceed 200 words. The abstract should generally be restricted to a single paragraph. Since contemporary information-retrieval systems rely heavily on the content of titles and abstracts to identify relevant articles in literature searches, great care should be taken in constructing both (from EDP Science's MATEC Web of Science LaTeX template).

Beal's "From Prototype to Paper in Six Easy Steps" suggests answering these questions: What is the problem and who/what does it affect? What is the general approach to fixing it? (What have others done?) What was your strategy to improve the situation? What were your specific accomplishments? Your success/failure is confirmed by quantitative results?

For example, the goal of this template is to produce electronic output to be uploaded to Skemman that can be later printed out and bound into a professional looking textbook that fits on standard library shelves. It is important to note that A4 paper when bound requires taller shelf spacing, so the B5 paper format was chosen instead. When binding a book, the edges that face outward need to be very smooth to reduce contamination and dust from entering the book when it sits on a shelf; this is why traditionally a larger paper size is cut down to the book size. If your print house expects the stock to be A4, then make sure the rubook has the "a4paper" option. If they prefer to deal with preparation themselves from a B5 pdf, then the default "b5paper" option is correct. The template is optimized for lualatex, but should still work with pdflatex. (If you switch to Icelandic mode (IS option to ruthesis) then abstract will become Útdráttur) Thesis have been printed out in December 2023 that were successfully bound into B5 books by local printers.

Keywords: Keywords, separated, by, commas

Acknowledgments

So long, and thanks for all the fish.

Douglas Adams[1]

This work was funded by 2024 RANNIS grant “Survey of man-eating Minke whales” 1415550. Additional equipment was generously donated by the Icelandic Tourism Board. Just kidding!

Acknowledgements are important to acknowledge any people, funding, and companies that helped in the work in any significant way.

Chapter 1

Instructions

1.1 Introduction

These instructions detail how to prepare a final project report, master's thesis, or PhD dissertation for Reykjavik University. These instructions (unless otherwise stated) assume you are in the School of Science and Engineering or the School of Computer Science. If you are in another department, you should make sure that the template meets your specific requirements.

- Current maintainer: Joseph Timothy Foley. Questions, comments, complaints: <foley AT ru.is>

1.2 Where to get the files

Actively developed code: <https://github.com/ru-engineering/report-template>

Overleaf Template: COMING SOON.

1.3 Files and Directories/Folders

- `graphics-crop/`: is a place to put smaller versions of images to reduce the produced file size (and speed up printing)
- `graphics/`: contains the main graphics to generate this document.
- `covers/`: contains the official covers (from RU Communications) to be put on the outside of the finished book.

texlive-science texlive-generic-extra texlive-lang-european texlive-lang-german latex-xcolor texlive-pictures pgf texlive-bibtex-extra texlive-publishers chktex evince fonts-lmodern lmodern biber

3. Get a LaTeX Integrated Development Environment (recommended, but not required) <http://texstudio.sourceforge.net/> or <http://www.xmlmath.net/texmaker/> Some editors may include LaTeX support. If you want to learn a very powerful (but old-fashioned) editor <http://www.gnu.org/software/emacs/> Install the auctex package by: M-x list-packages, click on AUCTeX
4. Get a references manager (recommended, but not required) <http://jabref.sourceforge.net/> (You may have to install a Java JRE first.) The reference library is in `references.bib` by default. It is just a text file that can be edited, but be careful with the formatting. A common mistake is to forget “,” at the end of each piece of an entry/line.

If you are going to make glossaries or acronym lists, you will need a perl interpreter. Only windows usually needs this installed: <http://www.activestate.com/activeperl>
5. Get supporting programs for some tools. For glossaries under windows, you will need to install Perl <http://strawberryperl.com/> (it is already installed on the other platforms.)
6. Try building the `main.tex` file. If you get errors, there is something wrong with your LaTeX installation. Fix those first.
7. Rename the `main.tex` file with your information (optional). DEGREE-NAME-YEAR is the recommended scheme e.g. `msc-foley-2015.tex`. This is referred to as the "Main" file.
8. Set your UI to use `lualatex` as the processor. If you are typing commands in manually, this is by typing in `lualatex main.tex`
9. Open and read the options at the top of the previous file and set it up for your document. You will need to fill in the title and author at least.
10. Start editing all of the `.tex` files with your content.
11. Compile the document by running `lualatex` on the Main file, run the bibliography tool, then view the result.
12. When you print, make sure that the scale is 100%. If you allow it to resize when printing, the margins won't be right. If the margins aren't right, then the RU logo will not look right on the cover.

1.4.2 Important Details

- Make absolutely sure that your `references.bib` is in UTF-8. If it is another format (CP1251, etc) you may get weird problems with any accented characters. *Students have run into encoding issues in the past and it has taken a surprisingly long time to debug.*
- Make sure the rest of the files, particularly the `.tex` file are in UTF8 or are at least in the same encoding. If the files are in different encoding, you will discover errors with accented characters when you try to include them together. Watch out for line endings. Linux, Windows, and OSX all use different line endings in text files.
- You may wish `biber/biblatex` instead of `bibtex`. (The template may already do this.) Otherwise Icelandic characters may not work properly in your `references.bib` file. `TexMaker` and `TeXStudio` require a configuration change to do this.
- Be consistent about UPPER and lower case in naming files. Windows doesn't care (but some programs in Windows do). OSX sometimes cares. Linux always cares.
- When using this template with SVN, you will want to tell it to ignore the extensions listed in Appendix 1.4.3

1.4.3 LaTeX Generated file extensions

These are the files that \LaTeX generates when you run it. If you are using SVN or another version control system, you want to tell that system to ignore these files:

```
*-blx.bib
*.acr
*.acn
*.alg
*.aux
*.bak
*.bbl
*.bcf
*.blg
*.bst
*.dvi
*.glo
*.gl*
*.idx
```

```
*.ind  
*.ilg  
*.ist  
*.lo?  
*.mw  
*.nlo  
*.ntn  
*.out  
*.pdf  
*.ps  
*.rel  
*.run.xml  
*.sbl  
*.slg  
*.snm  
*.sym  
*.synctex.gz  
*.tcp  
*.thm  
*.tdo  
*.to?  
*.tmp  
*.tmpproj  
*.xwm  
.*  
._.DS_Store  
.*lock*  
auto  
Thumbs.db
```


Chapter 2

Introduction

The introduction starts with an expansion of the first half of the abstract where you introduce context, stakeholder, and the topic. The content and writing should be similar to the first half of the abstract, but go deeper: inspiration from Beal [2] and [3].

In this domain and topic, what opportunities could there be? (EngX Week 2, Chapter 3 [4])

Based upon the most promising opportunity, explain how it might be VRIN. (EngX Week 2, Chapter 3 [4])

Because you want to explore the VRIN opportunity, justify that it is worth doing with Real-Win-Worth it. (EngX Week 2, Chapter 3 [4])

2.1 Stakeholder

What is the problem and who/what does it affect? How much of an impact does this problem (or lack of a solution) have? Tell us as much as you can about the stakeholder: (Week 2 in EngX, Chapter 5 in [4]). Are there other stakeholders who might also be affected? Summarize the initial meeting with them and put details on the session into Appendix A.1. What did this group do on this topic before the project started? Did some attempts suggest areas to explore?

2.2 Background

Provide background about the subject matter. Think of this as a bit of a history lesson (e.g. How was Morse code developed? How is it used today?).

This is a place where there are usually many citations. It is suspicious when there is not. If you have specifications or related standards, these must be de-

scribed and cited also. As an example, you might cite the specific RoboSub competition website (and documents) if working on the lighting system for an AUV[5]

2.3 Goals

Write up the customer needs analysis here (Week 3 in EngX, Chapter 5 in [4]). In the end, narrow it down to 7 or fewer needs¹.

CN₁ Sort the fish

CN₂ Portion them quick

CN₃ Not get stuck

Develop a high-level strategy of how you will solve the stakeholder's problem by looking for how the needs can be collected together: Using Axiomatic Design theory, this is stated as a numbered list of Customer Needs(CN) [6]. The top level is CN₀.

Here is an example of a top level:

CN₀ A transfer bin for whole salmon, compatible with the SureTrack grader, cheaper and less prone to cracking due to skewing. The bin should be adaptable to a pure transfer task and be able to discharge anywhere along its path without accidental discharge. [7]

Which latent needs seem more interesting to explore?

2.4 Prior Art

What is the current state of the art in this topic? What are the products, tools, and/or techniques? How do they compare particularly focusing on the customer needs?

2.4.1 Cool System 1

This system from Cool Company is able to do cool things: BLaH blah blah. You can learn more about this particular product at CITATION.

¹Fewer is easier!



Figure 2.1: Reykjavík University Logo, used with permission.

x	x^2
1	1
2	4
3	9

Table 2.1: Table of squared numbers

2.4.2 Cool System 2

2.4.3 Cool System 3

Based upon this research, what are the critical metrics? End this section with a competitive bench marking chart [4, p.104]) What does the chart tell you about how you can do better or differentiate?

2.5 Example Section

There is an RU logo in Figure 2.1. This logo will scale according to the width of the text on the page. There is a helpful list of squared numbers in Table 2.1. This table is formatted in the style of a book, which is very different than the style one is used to in Excel.

2.6 Data Management

What data do you expect you need to collect electronically and how will you protect it following GDPR rules? (EngX Week 3) What regulations are relevant (cite them). If the data is leaked, what will you do?

Chapter 3

Design

Explain your design process. Hint: you will be employing elements from the textbook for Product Design and Development [4] and Axiomatic Design [8]. Give a one-page explanation of how the processes works assuming the reader isn't familiar with them but has an engineering education.

3.1 Requirements

You now have a list of customer needs and benchmark metrics from competitors. State assumptions, boundary Conditions, and/or constraints

The rest of this section uses elements from Kristján Gerhard's MSc Thesis [7]. Please remember to replace the citations and information for your paper. It is time to map the relevant customer needs into Functional Requirements based upon what you learned from the benchmark chart.

As usual, start with a top-level to encapsulate your general strategy of needed functionality and the implementation: The critical functionality for solving the problem is FR_0 : "Contain 25 kg of fish on SureTrack conveyor until release is triggered" Our tactic to implement this functionality is DP_0 : Gable-reinforced stainless-steel locking bin with bi-directional discharge [7].

3.2 Concepts

With these requirements in mind, we go back into creative mode and try to develop some possible concepts that might meet these requirements.

3.2.1 Concept 1: Time traveling robot

Describe the concept. How does it meet the Functional Requirements?

Table 3.1: First level FR-DP mapping. [7]

ID	Functional Requirement	Design Parameter
1	Contain product	Main weldment
2	Move product	Support system
3	Discharge product	Discharge system

Concept: terminator robot able to travel through time portal

DP₁ Robot arm with claw

DP₂ Gorobi solver

DP₃ 3D print material with viscosity of XX

Include a design decomposition (showing coupling) for each concept.

3.2.2 Concept 2

3.2.3 Concept 3

3.2.4 Concept 4

3.2.5 Analysis

Based upon the Product Design methods: matrix method (Exhibit 8-5) and concept-scoring matrix (Exhibit 8-7) [4] which concept is most promising.

Based upon the Axiomatic Design/CSD method: Independence Axiom: what is the coupling for each concept? (uncoupled, path-dependent, or coupled). Information Axiom: How reliably can each concept meet the requirements it is given? (does it require special preparation, high levels of maintenance, or may fail often?)

Looking at both of these methods, explain which concept will be investigated further.

3.3 Implementation

With this concept in mind refine the implementation to generate Table 3.1.: Update the Design Decomposition diagram and analyze the arrows.

From this diagram, chunk pieces together to make modules. Explain what those modules are and what they do.

Put Incidental Interaction graph and related discussion

3.3.1 FR_1 do something interesting

For each requirement, explain with calculations and data how the related DP will meet the requirement.. This means each FR needs to have an associated test or tests (which will be checked in the Analysis chapter) and each DP needs to have a target metric which should be quantitative. Put equations, data, sketches, drawings, CAD, and electrical schematics.

3.3.2 FR_2 do something else

For each requirement, explain with calculations and data how the related DP will meet the requirement.. This means each FR needs to have an associated test or tests (which will be checked in the Analysis chapter) and each DP needs to have a target metric which should be quantitative. Put equations, data, sketches, drawings, CAD, and electrical schematics.

3.3.3 FR_3 do something different

For each requirement, explain with calculations and data how the related DP will meet the requirement.. This means each FR needs to have an associated test or tests (which will be checked in the Analysis chapter) and each DP needs to have a target metric which should be quantitative. Put equations, data, sketches, drawings, CAD, and electrical schematics.

3.4 Summary

Summarize the chapter and place a schematic of how all the modules fit together.

Chapter 4

Analysis

This chapter is all about testing how much of the prototype functionality. We use the words experiment and prototype interchangeably here. This is usually not an integrated prototype at week 12, but module test. In the three week period, you will be refining it into an early integrated prototype. See Chapter 14 of the textbook[4]

Start by answering: "What needed to be prototyped and why?"

4.1 DP₁ rotating thing

How did you setup your prototypes (see exhibit 14-14 in [4] to see how to make a test plan)? Include quantitative data from prototypes when you execute the plan. Analyze the results. How does this relate to the metrics/requirements? Include pictures/diagrams of prototype(s).

4.2 DP₂ gorobi api

How did you setup your prototypes (see exhibit 14-14 in [4] to see how to make a test plan)? Include quantitative data from prototypes when you execute the plan. Analyze the results. How does this relate to the metrics/requirements? Include pictures/diagrams of prototype(s).

4.3 DP₃ financial risk method XXX

How did you setup your prototypes (see exhibit 14-14 in [4] to see how to make a test plan)? Include quantitative data from prototypes when you execute the plan. Analyze the results. How does this relate to the metrics/requirements? Include pictures/diagrams of prototype(s).

4.4 Stakeholder Feedback on Early Prototypes

Show the 12 and 15 week prototypes to your stakeholder. What did they think about it: acceptable, needs improvement, feature requests, etc.

4.5 Integrated Prototype

Hopefully, by week 15 you will have the beginnings of a complete system. How did you setup your prototypes (see exhibit 14-14 in [4] to see how to make a test plan)? Include quantitative data from prototypes when you execute the plan. Analyze the results. How does this relate to the metrics/requirements? Include pictures/-diagrams of prototype(s).

Show the 15 week prototypes to your stakeholder. What did they think about it: acceptable, needs improvement, feature requests, etc.

Chapter 5

Conclusion

Write some transition text here to connect to the analysis chapter just finished.

5.1 Evaluation

Specific evaluation of each original goal/requirement (use ID number from requirements list). Remember to evaluate quantitatively whenever possible. Did you succeed or not? Justify your answer.

5.2 Opportunities

Looking back at the opportunities, how could the work you did be used to make progression on those opportunities? Which ones seem the most appropriate for investigation and how?

5.3 Summary

Restate your motivation and process. Remind the reader why this work is important. The abstract may help here. End with the most important result¹.

¹This is the only thing most people will remember.

Bibliography

- [1] D. Adams, *So long, and thanks for all the fish*. Harmony Books, 1984.
- [2] J. Beal, *From prototype to paper in six easy steps*, Available upon request, Jun. 2016.
- [3] EDP Sciences. “MATEC web of conferences: Instructions for authors, latex template.” (2023), [Online]. Available: https://www.matec-conferences.org/doc_journal/instructions/macro/web-conf/macro-latex-web-conf.zip.
- [4] K. T. Ulrich, S. D. Eppinger, and M. C. Yang, *Product Design and Development*, 7th ed. McGraw Hill, 2020.
- [5] J. Guls, Ó. I. Bjarnason, Ó. Pétursson, S. Ö. Einarsson, and J. T. Foley, “Application of Axiomatic Design in designing autonomous underwater photography lighting,” in *10th International Conference on Axiomatic Design (ICAD)*, A. Liu, Ed., Sep. 21–23, Procedia CIRP, vol. 35, Xi’an, Shaanxi, China: Elsevier ScienceDirect, 2016, p. 6.
- [6] N. P. Suh, *The Principles of Design*. Oxford University Press, 1990.
- [7] K. Gerhard and J. T. Foley, “Redesign of the Suretrack grader transfer bin using Axiomatic Design,” in *10th International Conference on Axiomatic Design (ICAD)*, A. Liu, Ed., Sep. 21–23, Procedia CIRP, vol. 35, Xi’an, Shaanxi, China: Elsevier ScienceDirect, 2016, p. 6.
- [8] N. P. Suh, M. Cavique, and J. T. Foley, Eds., *Design Engineering and Science*. Springer Nature, 2021, ISBN: 978-3030492311.
- [9] A. Liu, Ed., *10th International Conference on Axiomatic Design (ICAD)*, vol. 35, Sep. 21–23, Procedia CIRP, Xi’an, Shaanxi, China: Elsevier ScienceDirect, 2016.

Appendix A

Interviews

A.1 Initial Stakeholder meeting

Remember to mention the name, location, date, and time of the meeting (EngX Week 3). Put questions and answers here.

A.2 Design Review

Week 12

A.3 Poster Session

Week 14

A.4 Product Reveal Feedback

Week 15

Appendix B

Code

You can put code in your document using the `listings` package, which is loaded. Be aware that the `listings` package does not put code in your document if you are in draft mode unless you give it the `final` option.

There is an example java (Listing B.1) and XML file (Listing B.2). Thanks to the `url` package, you can typeset OSX and unix paths like this: `/afs/rnd.ru.is/project/thesis-template`. Windows paths: `C:\windows\temp\`. Note: The `menukey` package has similar functionality but may cause problems.

If you are trying to include multiple different languages, you should go read the documentation and set these up as below. You will save yourself a lot of effort, especially if you have to fix anything.

Listing B.1: `Data_Bus.java`: Setting up the class.

```
1 package com.example.mycoolapp;

3 import android.app.Activity;
  import android.content.Intent;
5 import android.os.Bundle;
  import android.view.View;
7 import android.widget.Button;
  import android.widget.TextView;
9
  // I am creating a comment that is very very long to demonstrate how the line ↵
  ↵ wrapping system works. You should see a symbol to annotate that it has ↵
  ↵ been wrapped to the next line.
11 public class Data_Bus extends Activity {
    Button Next;
13    TextView textdisplay1, textdisplay2;
```

```

15  @Override
    protected void onCreate(Bundle savedInstanceState) {
17      // TODO Auto-generated method stub
        super.onCreate(savedInstanceState);
19      setContentView(R.layout.adc_databustest);
        Next = (Button) findViewById (R.id.checkButton);
21      textdisplay1 = (TextView) findViewById (R.id.tvTop);
        textdisplay2 = (TextView) findViewById (R.id.tvBottom);
23
    }
25 }

```

Listing B.2: AndroidManifest.xml: Configuration for the Android UI.

```

1  <?xml version="1.0" encoding="utf-8"?>
  <manifest xmlns:android="http://schemas.android.com/apk/res/android"
3     package="com.example.mycoolapp"
     android:versionCode="1"
5     android:versionName="1.0" >

7     <uses-sdk
        android:minSdkVersion="13"
9         android:targetSdkVersion="13" />

11    <application
        android:allowBackup="true"
13        android:icon="@drawable/ic_launcher"
        android:label="@string/app_name"
15        android:theme="@style/AppTheme" >

17        <activity
            android:name=".MainActivity"
19            android:label="@string/app_name" >
            <intent-filter>

```
