NOTE – This template applies ONLY to the team project!

Do NOT use this for the mini-project.

Be sure to remove all of these notes / guidelines before you submit your report!

NOTE – This technical report serves to show that you have learned to use the Design Process as described in the book and taught in the lectures and class activities. The report must contain evidence of this in the form of artifacts! Another goal is to help students learn the tools typically used in report writing, such as Word and its automated features. Use of these features will make it much easier to generate a cleanly / properly formatted report. For MORE information on writing a technical report, please see “Tips for Writing a Technical Report” and the other support documents on LMS.

**Introduction to Engineering Design with Professional Development 1**

**Final Report for**

**<Descriptive Project Title>**

**Team: <team name>**

**Section <section number>**

**Instructors: <all instructor names>**

**Version 1.0**

**<Month, Date Year>**

**Prepared by**

**<Name (Year / Discipline)>**

**<Name (Year / Discipline)>**

**<Name (Year / Discipline)>**

**<Name (Year / Discipline)>**

**<Name (Year / Discipline)>**

**<Name (Year / Discipline)>**

**<Name (Year / Discipline)>**

Executive Summary

To Do: The Executive summary is a condensation of an entire report and must be short; try to keep it no more than one page. Focus on the objective(s) of project, the major points of your design and validation (what was done), the results and your recommendations. It is neither an introduction nor outline (table of contents) of the report. Hence, it should not contain phrases such as “This report presents …” and “Our main results are described in chapter 1”.

A busy executive may **only** read this page to decide whether to pass your report along to a staff member! It has to grab their attention and make them want to read the rest.

Write this part **last** so that it accurately reflects the content of your completed report.

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Note on the Table of Contents – let Word automate it for you – the page numbers will be correct!

Revision History

Table 1 - Revisions

|  |  |  |  |
| --- | --- | --- | --- |
| Version | Date | Name | Reason for Changes |
| 0.0 |  |  | Initial document. |
|  |  |  |  |
|  |  |  |  |

To do: take advantage of this! Update Table 1 as your team makes changes to this document. You don’t have to hide all the revisions until the one you declare as “final”. If you keep track, your team will know what portions of the report changed with each version, making it easier to assemble the document. When you save your file, be sure to include this same version number in the file name so that you can keep track of your work.

As shown above, be sure to label ALL TABLES.

# Introduction

To Do: This section should concisely address the following issues and point to an appropriate document or Appendix containing detailed information as needed:

* History behind the project
* Major end users’ needs and/or problem to be addressed (Present detailed customer requirements in an Appendix.)
* Justification for pursuing the project (worth for solving or improving)

This section also contains a summary of report sections.

# Project Objectives & Scope

To Do: This section contains the planned project objectives. Provide and describe a bullet list of the objectives for this semester. Focus on final outcomes, not intermediate steps. Do not include task assignments in this section. The objectives should be understandable by themselves. However, you can follow the objectives with a statement of scope to clarify what you planned to do (in scope), and what you planned to *not* do (out of scope). For example, “in scope” would be producing a single working prototype while “out of scope” would be mass producing the machine.

## Mission Statement

To Do: Include the mission statement your team created.

For the team report you should include the one created during that class activity.

## Customer Requirements

To Do: Capture and explain a summary of the overall customer requirements that you have collected. A table format will help organize this information as shown in the textbook. Identify which customer requirements you plan to address and which ones your team has excluded from the project. The customer data templates (detailed customer requirements) that your team created should go in an appendix. You **must** gather requirements beyond those of your team. Having additional requirements will help you create more alternate concepts. Use in-line citations to reference the individual customer requirements as needed.

A summary table of your overall customer requirements should be placed **here**, in the body of the text. Do NOT place this summary in the appendix. Be sure to prioritize your requirements in this table and provide a legend to indicate which requirements are the most important. Be sure to explain this summary of prioritized customer requirements in your text.

## Technical Specifications

Using the techniques found in your textbook (Ulrich & Eppinger) in the Product Specifications chapter, document what specifications you have assigned to the customer requirements. Be sure to show how each specification corresponds to one or more of the customer requirements. As you detail this information, you may “discover” new customer requirements that your actual customers did not think OK or failed to mention! Just add those requirements into your list.

# Assessment of Relevant Existing Technologies

To Do: Use material you gathered from the classroom activities. Make sure to provide correct in-text citations that refer readers to References. (See References also.) This is also the place to summarize your patent search.

For the competitors’ products that are reviewed, state how those products addressed the customer requirements and technical specifications you are trying to achieve. Use a table to help in summarizing this information. Be sure to include material discovered in books, on-line and from other resources as well. All sources must be referenced using in-line citations.

Table 2 - Competitive Benchmarking

|  |  |  |
| --- | --- | --- |
| Competitive Product | Title / Description | Relation to this project |
|  |  |  |
|  |  |  |

Be sure to include the patent numbers you reviewed during your patent search. For each patent, what did you learn from looking at it? How did it affect your design? Document this!

Where possible include a figure related to competitive products or patents to help show how they relate to your work. Images should be included here in the body of the paper and mentioned in the text. Always include proper citations for these!

Table 3 - Patent Research for Related Technologies

|  |  |  |
| --- | --- | --- |
| Patent Number | Title / Description | Relation to this project |
|  |  |  |
|  |  |  |

Table 3 - Patent Research for Related Technologies as seen above is an example of a properly labeled table! The caption is above the table itself, includes a number and a description of the table. Word will automate this for you, making it much easier!

# Professional and Societal Considerations

To Do: As part of your design process, your team must make informed judgments that consider the impact of engineering solutions in global, economic, environmental, and societal contexts. Using Table 4 - Engineering Solutions Impact below, describe how you considered this and provide your evaluation. Fill in the “Impact” column with Y or N (yes or no) based on whether your project has any impact in that category. Please fill this out for your overall project, not your individual sub-systems. After the table you may provide an expanded explanation if appropriate. Note that the impact may be positive or negative.

Our team applied the engineering design process to produce solutions that meet the specified needs with consideration for the topics found in Table 4 - Engineering Solutions Impact.

Table 4 - Engineering Solutions Impact

|  |  |  |
| --- | --- | --- |
| **Area of Impact** | **Impact** | **Description of Impact** |
| Public Health and Safety |  |  |
| Global |  |  |
| Cultural |  |  |
| Societal |  |  |
| Environmental |  |  |
| Economic |  |  |

INSTRUCTIONS FOR THE ABOVE TABLE:

For each area of impact above: Public health and safety; Global (e.g. weather, stock market volatility; wide spread social unrest, global energy costs, global interest rates… ) factors; Cultural factors (split out those considered); Social factors (split out those explicitly considered); Environmental factors; Economic factors. Briefly indicate (possibly quantify) which of these are important (or not) and why. Thus, it should be obvious that these items were indeed considered by your team. REMOVE these instructions when you are done!

# System Concept Development and Selection

To Do: Class activities helped the team generate a variety of alternate concepts that might address the customer requirements and meet the established technical specifications. Gather those here including the sketches of the concepts. Be sure to label the parts of your sketches and refer to those in the text as you explain the features or disadvantages of each. Neatly drawn and clearly scanned images of these initial / early sketches are acceptable for this report. These hand drawings should include proper annotations for the reader such as relevant dimensions, component labels, etc. For your final / selected concepts, computer generated/drawn images are most appropriate. These may be from any of the mechanical or electrical CAD tools (NX / PSpice / etc.) or even PowerPoint. Note that Microsoft Paint is ***not*** an appropriate tool.

This section focuses on the overall system and the team’s *design process* in deciding the overall functionality and design approach.

Here in the body of the report, be sure to include images, pictures, tables, figures, etc. along with the descriptions and explanations that will help the reader understand the overall product you are developing.

Include any overall system level mind maps or concept combination tables the team generated as you evaluated your options. Examples of these system level concept combination tables can be found in the textbook in Chapter 6, Concept Generation. Include the selection matrix or concept combination table(s) that explains how your team selected from among the available concepts.

Present the system concept that the team ultimately developed. Help the reader visualize the system concept by using appropriate drawings/diagrams, such as sketches, **CAD** models, system **schematics**, circuit **diagrams**, etc.. Be sure to label and refer to the items in the figures. Describe the significant criteria that led to concept selection, alternate concepts that were considered, and design trade-offs. Document the process you used for selecting the final system concept, e.g. concept selection matrix. Be sure to document how you arrived at the values in your matrix!

Software listings may be placed in an appendix but should be referred to here, in the body of the report. Be sure software listings are commented. Avoid formatting listings as multiple columns as it makes them more difficult to read – especially if they include good comments.

In this section, show sketches / models of the complete system. Do not just include the sketches – you must discuss and describe all of them and show the analysis (formulas, calculations, relevant facts / measurements, etc.) as well.

Now that the overall system has been described to the reader, the next section focuses on each subsystem in turn.

# Subsystem Analysis and Design

To Do: Divide your system concept into multiple subsystems and document each one. Be sure to introduce your subsystems and the figure - don't just start with the figure!

Figure 1 - Subsystem Diagram

The above, Figure 1 - Subsystem Diagram, is an example of a properly captioned figure. The caption is below the figure and includes a number and a descriptive title. Be sure to label ALL FIGURES!

The following Figure 2 - Hierarchical Subsystem Diagram, shows a more complex breakdown into subsystems. Use this when it is necessary to split apart a subsystem so that each student can be assigned to one.

Figure 2 - Hierarchical Subsystem Diagram

If your hierarchy diagram is large and/or complex enough you may wish to place it on a page by itself with the image rotated 90 degrees or with that page formatted to be “landscape” horizontal. This will let the diagram fill the page and easier to read.

This section is NOT a repeat of the System Concept Development and Selection material in the previous section. There you gave the overall system’s design. In this section, you are to document how you went through the complete design process for each individual subsystem.

**For each subsystem** be sure to include the design process steps used to work through each of the multiple concepts / approaches that were identified. Document the requirements and specifications for each subsystem and how you tested & verified each subsystem prior to final assembly / integration and testing.

Images, pictures, tables, figures, etc. along with their descriptions and explanations should help the reader understand **why** you made your various design decisions. Since they are part of your design explanation, they generally may be included here in the body of the report rather than the appendix. If there are a large number of these, you may elect to put the most important ones in the body of the report and the others in an appendix.

For the total product/project (i.e. when all the subsystems are assembled) be sure to indicate how you tested & verified that it meets your stated customer requirements.

Focus on the ***design***, not the fabrication.

NOTE – CAD is not a subsystem! Writing the report is not a subsystem! Development of a test setup that exercised the functions of the overall product / project IS a valid subsystem. As per the syllabus, each team member is to be responsible for a functional (technical) part of the project such that everyone gets to practice the full engineering design process. The entire team must ALSO participate in the preparation and writing of the report and associated presentation.

Examples of analysis techniques include:

* Technical / mathematical modeling / analysis
* Simulation
* Quick prototype / mockup and experimentation

Have a separate section per subsystem. Each person should have their own subsystem. Each person should describe the complete design process they followed for their subsystem.

## Subsystem 1

## Subsystem 2

## Subsystem 3

## Subsystem 4

## Subsystem 5

## Subsystem 6

## Subsystem 7

# Results and Discussion

## Results

To Do: Discuss the evaluation results in terms of the final design. Describe significant **technical** accomplishments compared to your objectives. If you did not meet all objectives, or if you accomplished something that was not in your plan, explain why. Please put your personal / professional development / project management accomplishments for the “Lessons Learned” appendix.

Be sure to include test results used to measure or calibrate your device. Document the test setup used to obtain your results, e.g. how the device was tested. You should show how your device performed vs. what your initial requirements & specifications were. Graphs or charts of key performance data can help the reader understand your project’s operation. A graph of power vs. RPM, for example, will show how your device converts rotary energy to power. Do you have enough data to be statistically meaningful? Many projects may work once, but getting them to repeatedly produce the same results can be a challenge – as was demonstrated in the mini project.

Report planned tests that were not performed as open issues. If uncertainties remain, they should be pointed out also. If your results were not completely successful, state why the chosen approach (concept) is not viable or limited. (Unsuccessful results are useful in eliminating unproductive effort by allowing future design teams to learn from your mistakes.)

Make recommendations for design changes or modifying requirements/specifications as needed. This is also the place to suggest future enhancements based on lessons learned from this project.

## Significant Technical Accomplishments

One of the greatest learning opportunities from this work is what did not work and why! This is your chance to demonstrate what you learned. Describe any particularly challenging technical elements of the project and how you met those challenges.

For example, you may have learned to use new tools or processes to fabricate your project. You may have used modeling or simulation tools covered in other courses and learned how to apply those to an actual project. Your team may have learned the pros and cons of cost cutting during a development project.

# Conclusions

To Do: Bring together, concisely, the technical conclusions to be drawn. Your conclusions must be supported by the material presented in the previous sections. Recommend next steps if appropriate. If your project were continued by your team or another team, what would you suggest they investigate / do / improve / etc?

# References

To Do: The references must list all published information sources, including electronic documents that are directly quoted or used to support your discussion or equation. Your textbook and the various resources posted on LMS are examples of materials that should be referenced when used. **All images / graphics / diagrams / figures / tables / etc. found on websites and used in your document MUST be referenced to avoid plagiarism issues.**

**All references must be cited at the appropriate points within the report text.** Please use either IEEE style or APA for these. As an example, the following are APA style formats:

Single author: (Author’sLastName, Year)

Two authors: (Author’sLastName1 & Author’sLastName2, Year)

Three or more authors (*FirstAuthor’sLastName*, et al., *Year*)

This list of references uses the alphabetical order. For more information on APA style citations, visit:

[**http://www.rpi.edu/dept/llc/writecenter/web/apa.html#references**](http://www.rpi.edu/dept/llc/writecenter/web/apa.html#references)

For IEEE style references, visit: **http://www.ieee.org/documents/ieeecitationref.pdf**

A sample APA style format for a web document citation is:

*Author*, *Title*, [cited *Date*]. Available from World Wide Web: <*URL*>

The author is either a person or corporate body. For more information, see:

<http://www.collectionscanada.ca/iso/tc46sc9/standard/690-2e.htm>

Do NOT use footnotes for references. DO reference EACH of the specific pages of a book or website that you used.

Use APA or IEEE style for the references only! Follow this template for all other formatting.

# Appendix A: Selection of Team Project

To Do: Include the material from your Milestone 1 report indicating the process followed in the selection of this specific team project.

This section should NOT focus on the design of the project, but instead must focus on how/why you selected the project described in this report.

# Appendix B: Customer Requirements and Technical Specifications

To Do: Present the complete set of customer requirements obtained and the technical specification you created for them. Include the individual customer data templates your team developed. Organize the requirements according to appropriate types and prioritize these. Be sure to sort your prioritized list so that the most important ones appear first in the list. We recommend that you assign a unique ID to each requirement so that you can refer to them in the body of your report. If your project focused on a subset of the customer requirements, present them as either “in scope” or “out of scope”. Include your table of interpreted customer needs in this appendix. Include your list of customers & stakeholders.

Include the prioritized table of customer requirements with their corresponding technical specifications in the **main body** of the report. Put the table that summarizes those details in the body of the report so that you can describe it there.

In this section put the multiple **detailed** customer requirements.

# Appendix C: Gantt Chart

**Be sure to check that it is readable after you insert it! Check the formatting!**

You may rotate the diagram 90 degrees, if needed, to make it readable. Include comments on how you used / applied the chart – did it help or not, why, in what ways, etc.

Please do NOT provide the Gantt Chart as a separate file / document. DO ask for help on how to embed it within this report. It CAN split across 2-3 pages if you repeat the task list on each page. Set the time span in the Excel-based Gantt Chart tool to 7 days rather than 1 to help compress the chart.

# Appendix D: Expense Report

To Do: Summarize your expenses / manufacturing expenses as a table.

Note that Word was used to label this table. If you do that, Word will keep track of the numbering for you! In the body of your report you can then make reference to this table as you explain these expenses. Be sure to total your rows and columns!

Include the table but then consider and comment on how your project may have been improved by either spending additional funding or by reallocating your expenses!

Table 5 - Project Expenses

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Item | Quantity | Unit Price | Subtotal | Shipping |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Total |  |  |  | |

The project expenses table should have a fairly complete list of all significant parts. Smaller parts, like nuts and bolts, can be grouped into “misc hardware” or similar category.

# Appendix E: Team Members and Their Contributions

To Do: Include a subsection for each of your team members. Each team member is to write their own subsection describing / detailing their technical and other contributions to the project.

Omit subsections for teams with fewer members.

## Team Member 1

## Team Member 2

## Team Member 3

## Team Member 4

## Team Member 5

## Team Member 6

## Team Member 7

# Appendix F: Statement of Work

To Do: Include a copy of your team’s statement of work. This helps future readers to understand the scope of your project as initially planned.

# Appendix G: Professional Development - Lessons Learned

To Do: From a professional development viewpoint, summarize your lessons learned from the team project experience and how your project planning and execution was impacted by those lessons. What did you plan to do differently? How did that work out? To what extent was that successful for the team? For things that did not work, offer reasons why they did not and what might have been done to avoid / prevent / fix those.

Be sure to include comments for the professional development, project planning, and teamwork aspects of the project not the technical ones.

One approach for reflecting on this is to use the “KPT” approach:

* K – Keep – these things worked and you would use/do them again
* P – Problem – these things did not work out well and might be avoided in the future
* T – Try – these things may be worth attempting in the future

# Appendix H: User Manual

To Do: Present the procedure to operate your prototype. Assume that the reader is not one of your instructors or part of your team and has never seen the device operated.

Make sure to include all safety related instructions.