<Blue text between angle brackets is for guidance and should not appear in the final document.

**Instructions**

This document is your template for performing a Design Concepts Evaluation and What-If Analysis.

**Document Purpose**

At this point of the project, all teams must have created multiple design concepts. The goal of this activity is to:

* Ensure design concepts are feasible given the provided resources.
* Confirm that the design concepts meet the project requirements.
* Identify a final design concept, using a quantifiable approach, to proceed with for detailed development.
* Ensure the final design concept achieves a high level of safety.

For the Design Concept Evaluation (Sections 1 to 3), see Appendix A for the requirements and marking rubric.

While this document is submitted as an individual assignment, working in a team is encouraged, especially for the What-If Analysis (Section 4).

Don’t forget to delete all the light blue text in your final version of the document.>

# Engineering Requirements

In this section, the constraints and engineering (functional/performance) requirements for the <name the project here> are listed in Tables 1 and 2, respectively.

<Concisely describe the constraints and functional/performance requirements of the design in the tables below.>

Table 1 Design constraints for the <name the project here>.

|  |  |
| --- | --- |
| Item # | Design Constraint |
| 1 | <constraint> |
| 2 | <constraint> |
| … |  |

Table 2 Functional/performance requirements for the <name the project here>.

|  |  |
| --- | --- |
| Item # | Functional/Performance Requirement |
| 1 | <requirement> |
| 2 | <requirement> |
| … |  |

# Developed Design Concepts

The following design concepts were derived by the design team through research and creative synthesis.

<In this section, you describe the multiple design concepts that your team conceived for the project. Typically, this would be five concepts or more, but not less than three.>

## 2.1 Concept #1

<Describe concept #1 in a few sentences. Include a sketch of the concept and make sure to refer to the figure in the text, e.g., “As shown in Figure 1, concept #1 is comprised of …” >

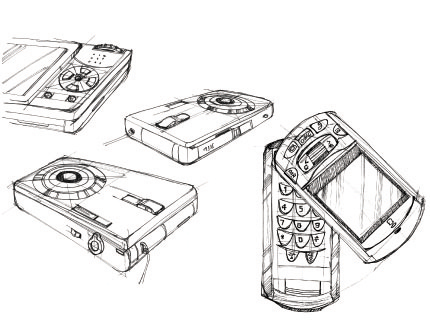
  
<Image source: product sketch by tengwan on DeviantArt>

Figure 1 Design sketch for Concept #1.

## 2.2 Concept #2

<Continue to list the remaining design concepts by expanding the subheading, giving a short description, and including a figure.>

# Concepts Evaluation

## 3.1 Feasibility Judgement

The design concepts presented in Section 2 were subjected to an initial feasibility judgment. The outcome of this activity is as follows.

<Categorize each of your design concepts according the following three judgements:>

* Concept(s) not feasible:  
  <Justify why the concept is not feasible (e.g., requires materials that are not permissible.>
* Concept(s) possible under the following condition:  
  <Describe what conditions would have to change for the concept to become feasible (e.g., if the team can identify suitable manufacturing method).>
* Concept(s) worth considering:  
  <List the concepts that are worth considering.>

## 3.2 Go/No-Go Screening

Go/No-Go screening was performed to ensure the design concepts that passed the feasibility judgement meet the engineering requirements. The evaluation is summarized in Table 3.

<List all remaining design concepts in the table below. In the table header, list the relevant criteria for the design solution, which can be (i) quantities (i.e., measurements or estimates, e.g., “Mass (kg) (<5kg)”), and (ii) binary questions (yes/no, e.g., “Material Availability (Yes/No)”.

In the table, cross out the concepts that fail the Go/No-Go screening (i.e., they don’t meet a requirement)>

Table 3 Go/No-Go evaluation of design concepts.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Concept | Requirement #1 | Requirement #2 | Requirement #3 | Requirement #... |
| Name or # |  |  |  |  |
| … |  |  |  |  |
| … |  |  |  |  |

## 3.3 Decision Matrix

<Create a decision matrix to evaluate and rank the remaining concepts. You must include at least three concepts that passed the previous Feasibility Judgement and the Go/No-Go Screening. You can use the decision matrix template that is provided on eClass in the form of an MS Excel spreadsheet. If you use the template, copy the table from the spreadsheet into this document. You may include the table on a separate page in landscape orientation in this document if needed. Make sure to include ‘Rating’ and ‘Importance Weighting’ for the different criteria/quantities.>

The design concepts that remained after the previous Feasibility Judgement and the Go/No-Go Screening were compared and ranked against each other using the Decision Matrix as shown in Table 4. The Decision Matrix uses an importance weighting for the various criteria. The importance weighting is justified as follows:

<Include a list here in which you justify the importance weighting. For example:

* Since this is a safety-critical component, criterion ‘Safety’ was rated highest, giving it a rating of 40/100. ‘Safety’ was measured in the form of a Risk Level estimate.
* The project description identifies ‘Ease of Manufacturing’ as an important criterion for the design. Therefore, this criterion was given a rating of 40/100. ‘Ease of Manufacturing’ is an estimate ranging from ‘3-fully automated fabrication’, ‘2-some manual work required’, 1-fully manual fabrication’.
* The final design is expected to be compact, which is assessed herein using a weight and physical size estimate (mass in kg and volume in liters), respectively.

In the ‘Rating’ step of the Decision Matrix, assign negative numbers for negative attributes. For example, in the list above, Risk Level is a negative attribute (rated as a negative number) and Ease of Manufacturing is a positive attribute (rated as a positive number).

Conclude this section with a short statement highlighting the selected concept and give a brief outlook about the follow-up activities for this final design concept (e.g., prototyping and testing will be performed; additional analysis will be performed; the final design concept will be completed by selecting specific components).>

Table 4 Decision matrix for design concept selection.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Criteria | | |  |
|  |  |  |
| Max absolute value |  |  |  |
| Concepts |  |  |  |
|  |  |  |  |
|  |  |  |  |
| Rating |  |  |  |
| Concepts |  |  |  |
|  |  |  |  |
|  |  |  |  |
| Weighting |  |  |  | **Total** |
| Concepts |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

# Prevention Through Design – What-If Analysis

In engineering design, safety is paramount. Therefore, a What-If Analysis was completed for the final design concept, in order to identify safety concern early on in the design process and provide solutions increasing the safety of the design. The analysis was performed using the What-If Table shown in Table 5.

<Complete a What-If Analysis for your final design concept. Since this analysis is best performed by a team, you should complete this task as a group activity with your design team. It may be more appropriate to include the table for the What-If Analysis in landscape orientation on a separate page in this document. See Appendix B for the requirements and marking rubric.>

Table 5 What-If Analysis for final design concept.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Activity or Area of Concern** | **What If…** | **Cause(s)** | **Consequence** | **Risk Level** | **Existing Control Measure(s)** | **Recommendation(s)** | **Residual Risk Level** |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

# Appendix A - Design evaluation marking rubric

Table A1 Marking rubric for Assignment #6 ‘Design concept evaluation’.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Assessed Activity | Criteria for Scoring | Substandard (Score 1) | Acceptable (Score 2) | Exceptional (Score 3) | Mark |
| Section 1: Engineering requirements – Design Constraints (Table 1) | More than three design constraints listed | 🗶 | ✓ | ✓ |  |
| Five or more design constraints listed | 🗶 | 🗶 | ✓ |
| Section 1: Engineering requirements – Functional requirements (Table 2) | More than three engineering requirements listed | 🗶 | ✓ | ✓ |  |
| Five or more engineering requirements listed | 🗶 | 🗶 | ✓ |
| Section 2: Design concepts | At least three design concepts included | 🗶 | ✓ | ✓ |  |
| Four or more design concepts included | 🗶 | 🗶 | ✓ |
| Design concepts are briefly described | 🗶 | ✓ | ✓ |
| Descriptions address at least function and materials | 🗶 | ✓ | ✓ |
| Descriptions address more than just function and materials, e.g., also fabrication | 🗶 | 🗶 | ✓ |
| Sketches of all designs are shown | 🗶 | ✓ | ✓ |
| Sketches are neat and include some dimensions to give a sense of scale | ✓or 🗶 | 🗶 | ✓ |
| Section 3: Feasibility judgement | Design concepts are categorized in terms of feasibility | 🗶 | 🗶 | ✓ |  |
| Section 3: Go/No-Go screening (Table 3) | Design concepts are evaluated for at least three engineering requirements | 🗶 | ✓ | ✓ |  |
| Design concepts are evaluated for more than three engineering requirements | 🗶 | 🗶 | ✓ |
| Go/No-Go decision is indicated in the table | 🗶 | ✓ | ✓ |

- Table continued on next page -

- Table continued from previous page –

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Assessed Activity | Criteria for Scoring | Substandard (Score 1) | Acceptable (Score 2) | Exceptional (Score 3) | Mark |
| Section 3: Decision matrix – Description of importance weightings | Importance weightings are justified for the selected criteria | 🗶 | 🗶 | ✓ |  |
| Section 3: Decision matrix – Matrix setup | DM includes at least three concepts and criteria | 🗶 | ✓ | ✓ |  |
| DM includes the following steps: input data, ‘Rating’, and ‘Weighting’, Summation | 🗶 | ✓ | ✓ |
| DM uses negative rating values for negative attributes | ✓or 🗶 | 🗶 | ✓ |
| Section 3: Conclusion | A statement is given for the final design concept along with a brief outlook about follow-up activities | 🗶 | 🗶 | ✓ |  |

# Appendix B - What-If Analysis marking rubric

Table B1 Marking rubric for Assignment #6 ‘What-If Analysis of Final Design Concept’.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Criteria | Scoring | | | |
|  | Substandard (Score 1) | Acceptable (Score 2) | Exceptional (Score 3) | Mark |
| Five or more activities or areas of concern are listed in the table (two can be repeated) | 🗶 | 🗶 | ✓ |  |
| At least three different activities or areas of concern are listed in the table (all must be different) | 🗶 | ✓ | ✓ |
| Five or more unique what if questions are provided (for a total of five rows in the What-If table) | 🗶 | 🗶 | ✓ |  |
| At least four unique what if questions are provided | 🗶 | ✓ | ✓ |
| Two probable or likely causes are provided for each what if question | 🗶 | 🗶 | ✓ |  |
| One probable or likely cause is provided for each what if question | 🗶 | ✓ | ✓ |
| Four or more existing control measures are identified within the What-If Table (and indicate if the control measure reduces L or C, or both) | 🗶 | 🗶 | ✓ |  |
| At least three existing control measures identified within the What-If Table (and indicate if the control measure reduces L or C, or both) | 🗶 | ✓ | ✓ |
| Ten recommendations identified and indicate if the recommended control measures reduces L or C, or both | 🗶 | 🗶 | ✓ |  |
| Between six and ten recommendations are identified and indicate if the recommended control measures reduces L or C, or both | 🗶 | ✓ | ✓ |

- Table continued on next page -

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|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Criteria | Scoring | | | |
|  | Substandard (Score 1) | Acceptable (Score 2) | Exceptional (Score 3) |  |
| Two or more What-If questions address consequences related to social impacts on workers, end users, and/or the public | 🗶 | 🗶 | ✓ |  |
| One What-If question addresses consequences related to social impacts on workers, end users, and/or the public | 🗶 | ✓ | ✓ |
| Two or more What-If question addresses consequences related to environmental impacts related to air, land, and/or water | 🗶 | 🗶 | ✓ |  |
| One What-If question addresses consequences related to environmental impacts related to air, land, and/or water | 🗶 | ✓ | ✓ |
| **Score** | \_\_\_\_ out of 24 | | | |

|  |  |
| --- | --- |
| **Total score for Concept Evaluation and What-If Analysis** | \_\_\_\_ out of 48 |