

# MAE 241 Project Guidelines

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## Introduction

The Project is a requirement for the successful completion of MAE 241. You will work in teams to design, build, and test a product, using equipment and processes available in the Foundry and Student Design Center.

## Customer Needs

A customer has asked your team to re-design and customize a RC truck for racing and towing applications. Their list of needs includes the following:

- A new polymer body with Trine school pride
- One set of rims (if needed) and tires for racing
- One set of rims (if needed) and tires for towing
- A new aluminum bumper with hitch
- A new trailer to attach to hitch and tow a designated load
- New head lights and tail lights

The total allowable cost for purchasing materials is \$50. All purchased and in-stock materials used for prototyping need to be listed in the Bill of Materials.

## Iterative Prototypes:

- At least **three** design iterations should be conducted for the product
- Use stock materials in the Foundry and SDC before purchasing additional materials
- All manufactured components must be refined using secondary processing methods (e.g. milling, grinding, polishing, sanding, etc.)

**Design Iteration 1** can ONLY use *laser cutting* of cardstock, foamboard, or cardboard to check dimensions, tolerances, fitment, and geometry.

**Design Iteration 2** can use *3D printing* or *laser cutting* to assess prototype functionality.

**Design Iteration 3** can use all manufacturing and assembly methods to create the final design.

## Project Deliverables

For all reports, follow the instructions in the **MAE 241 Writing Guide** for formatting and technical writing guidelines.

### 1. MILESTONE 1 (DUE THURSDAY, JANUARY 30 END OF DAY)

For this milestone, you will need to complete the following:

- Set up the **Front Matter** (title page, table of contents, table of figures, list of tables). DO NOT do the abstract yet. Some of these sections may be blank, but the headings need to be in place.
- Complete the **Customer Needs and Requirements** section. The customer needs are provided to you; however, they need to be reiterated in your own words.
- Complete the global, social, economic, and environmental impact section.
- Complete the **Concept Generation** section for **Design Iteration 1**.
- Complete the **Concept Selection** section for **Design Iteration 1**.
- Complete the **Gantt Chart** using the provided template for the entire lifetime of the project. Submit it as a separate file to the “Gantt Chart” tab for the Milestone 1 submission in Moodle.

### 2. MILESTONE 2 (DUE THURSDAY, FEBRUARY 13 END OF DAY)

For this milestone, you will need to:

- Correct any errors from Milestone 1.
- Complete the **Detailed Design Discussion** section for **Design Iteration 1**.
- Complete the **Testing and Validation** section for **Design Iteration 1**.
- Complete the **Bill of Materials** for **Design Iteration 1** using the provided template. Submit it as a separate file to the “Bill of Materials” tab for the Milestone 2 submission in Moodle.

### 3. MILESTONE 3 (DUE THURSDAY, APRIL 3 END OF DAY)

For this milestone, you will need to:

- Correct any errors from Milestone 2.
- Complete the Concept Generation, Concept Selection, Detailed Design Discussion, and Testing and Validation sections for **Design Iteration 2**.
- For each section, discuss only the changes or additions made to that section from **Design Iteration 1**.
- Update the **Bill of Materials** for **Design Iteration 2**. Append any new parts to the BOM from Design Iteration 1. Submit it as a separate file to the “Updated Bill of Materials” tab for the Milestone 3 submission in Moodle.

#### 4. FINAL REPORT (DUE THURSDAY, APRIL 24 END OF DAY)

For the final report, you will need to:

- Correct any outstanding errors from Milestones 1, 2, and 3.
- Complete the Concept Generation, Concept Selection, Detailed Design Discussion, and Testing and Validation sections for **Design Iteration 3**.
- For each section, discuss only the changes or additions made to that section from **Design Iteration 2**.
- Complete the Conclusions, References, and Appendices sections.
- Update the **Final Bill of Materials** for **Design Iteration 3**. Append any new parts to the BOM from Design Iteration 2. The Final Bill of Materials will need to include all parts used for all design iterations. Submit it as a separate file to the “Final Bill of Materials” tab for the Final Report submission in Moodle.
- Update the **Final Gantt Chart**. Submit it as a separate file to the “Final Gantt Chart” tab for the Final Report submission in Moodle.

#### 5. CRITICAL DESIGN REVIEW PRESENTATION AND FINAL DEMONSTRATION

Please see the separate guidelines provided in Moodle for these two presentations.

## Grading Summary for Milestone 1

### Technical Writing:

Spelling/Grammar	/5
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Formatting	/5
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References	/5
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Front Matter	/5
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Customer Needs	/5
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Requirements Table	/15
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Justification for Requirements	/10
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Impact Statement	/5
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### Concept Generation for Iteration 1:

Concept Figures	/10
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Explanation of Concepts	/10
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### Concept Selection for Iteration 1:

Selection Matrices	/10
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Explanation of Selections	/10
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Gantt Chart	/5
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<b>TOTAL</b>	<b>/100</b>
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## Grading Summary for Milestone 2

### Technical Writing:

Spelling/Grammar	/5
Formatting	/5
References	/5

### Detailed Design for Iteration 1:

Engineering Drawings	/15
Explanation of Drawings	/10
Manufacturing Plans	/15
Explanation of Manufacturing Plans	/10
Bill of Materials	/10

### Testing and Validation for Iteration 1:

Fabricated Prototype (images)	/5
Explanation of Testing Process	/10
Explanation of Testing Results	/10

<b>TOTAL</b>	<b>/100</b>
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### **Grading Summary for Milestone 3**

#### Technical Writing:

Spelling/Grammar	/5
Formatting	/5
References	/5

#### Design Summary for Iteration 2:

Updated Concept Generation	/10
Updated Concept Selection	/10
Updated Engineering Drawings	/15
Updated Manufacturing Plans	/15
Updated Bill of Materials	/10

#### Testing and Validation for Iteration 2:

Second Prototype (images)	/5
Explanation of Testing Process	/10
Explanation of Testing Results	/10

<b>TOTAL</b>	<b>/100</b>
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## Grading Summary for Final Report

### Technical Writing:

Spelling/Grammar	/5
Formatting	/5
References	/5

Abstract /5

Conclusions /10

### Design Summary for Iteration 3:

Updated Concept Generation	/5
Updated Concept Selection	/5
Updated Engineering Drawings	/10
Updated Manufacturing Plans	/10
Final Bill of Materials	/10

### Testing and Validation for Iteration 3:

Final Prototype (images)	/5
Explanation of Testing Process	/10
Explanation of Testing Results	/10

Final Gantt Chart /5

**TOTAL /100**

In the pages to follow, a description is given for each section of the milestone reports. If you have any questions, please ask.

# Project Title

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Team Member Names

Date

This page should be a single page and include the following information:

- 1) Report name
- 2) ALL group member names
- 3) Date submitted (You could put the date the final report will be submitted)

The title page should NOT have a page number on it.



## **Abstract (or Executive Summary)**

The Abstract is placed after the title page and is placed on its own page (that means that you do not put anything else on this page except the abstract). The page numbering for the front matter is given in Roman numerals and starts with “i” on this page. The title page does not count as a page in the numbering.

The Abstract is a basic overview of the content and findings of the paper. As such, it is generally written last, after all the findings and work have been done. It should include the following:

- The problem you are addressing and why
- An overview of your proposed design, focusing on information that will be most important to your audience
- Final recommendations

## Table of Contents

Abstract (or Executive Summary) .....	i
Table of Figures .....	iii
List of Tables .....	iii
Customer Needs and Requirements .....	1
Design Summary (Design Iteration 1) .....	2
Concept Generation (Design Iteration 1) .....	2
Concept Selection (Design Iteration 1) .....	2
Detailed Design Discussion (Design Iteration 1) .....	3
Testing and Validation (Design Iteration 1) .....	4
Design Summary (Design Iteration 2) .....	5
Concept Generation (Design Iteration 2) .....	5
Concept Selection (Design Iteration 2) .....	5
Detailed Design Discussion (Design Iteration 2) .....	5
Testing and Validation (Design Iteration 2) .....	5
Design Summary (Design Iteration 3) .....	5
Concept Generation (Design Iteration 3) .....	5
Concept Selection (Design Iteration 3) .....	6
Detailed Design Discussion (Design Iteration 3) .....	6
Testing and Validation (Design Iteration 3) .....	6
Conclusion .....	6
References .....	6
Appendices .....	6

Table of Figures

Figure 1. Plan for manufacturing and assembling match plate.....**Error! Bookmark not defined.**

List of Tables

Table 1. Requirements ..... 1

Table 2. Selection Matrix for “Subsystem 1” (Replace Subsystem 1 with actual name of the subsystem)..... 3

Table 3. Explanation of flow chart elements. .... 3

Table 4. Bill of Materials for Design Iteration 1. .... 4

## Customer Needs and Requirements

The customer needs outline the problem to be addressed in the rest of the report. The customer needs for this semester have been provided to you, but usually you will need to speak with the customer to understand their requirements. Summarize and explain the provided customer needs in your own words. You should **not** directly copy what has been provided.

Once the customer needs are well explained, a subsection describing the technical requirements that match those needs will be presented. Remember that requirements need to be:

- 1) Measurable
- 2) Specific
- 3) Relatable back to customer needs (all customer needs should be accounted for)

Translate the customer needs into relevant technical requirements, which can be both quantitative and qualitative in a table (Table 1).

Table 1. Requirements

Need	Requirement	Unit	Value

Justification for Requirements:

In one or two paragraphs, summarize the requirements from Table 1 and **justify** the selection of the requirements (e.g., why did you select a specific value for that requirement?). Cite any references used.

## Global, Social, Economic, and Environmental Impact

In this section, you will need to research the global, social, economic, and environmental impact of the product to be developed. Write one to two paragraphs for each type of impact. Cite any external sources used.

## Design Summary (Design Iteration 1)

For each design iteration, you will have a Design Summary section. The design summary will have four subsections: **Concept Generation, Concept Selection, Detailed Design Discussion, and Testing and Validation.**

\*Make sure to start each Design Summary section with an introductory paragraph explaining what will be covered.

### Concept Generation (Design Iteration 1)

This subsection is used to explain the different concepts that were generated for consideration. It will be best to break your overall idea into subsystems, and generate concepts for each of those subsystems. For example, a car will have body, wheels, chassis, engine, and a number of other subsystems. **You MUST include all relevant subsystems for your overall design and each subsystem must have at least three viable concepts.** For each concept you should include:

- 1) A description of the concept
- 2) A figure of the concept. The figure can be hand drawn or computer generated. Select one format and be consistent. For example, hand draw all concepts or computer generate all concepts.
- 3) A reference IN THE TEXT to the figure BY NUMBER (e.g. ... as shown in Figure 3)

### Concept Selection (Design Iteration 1)

This subsection is used to fully document the reasoning behind the concepts that are selected for the subsystems. For EACH subsystem, you must include:

- 1) A selection matrix (see example Table 2).
- 2) A description of what parameters you used to develop your selection matrix.
- 3) A description of how you determined your weightings for the selection matrix.
- 4) A short recap of what concept was selected based on the selection matrix.

Remember that each figure and table in the report needs to be referenced by number in the text, have captions, and be fully described in the text.

Table 2. Selection Matrix for “Subsystem 1” (Replace Subsystem 1 with actual name of the subsystem)




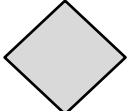

Selection Criteria	Weighting (%)	“Name of Concept 1”	“Name of Concept 2”	“Name of Concept 3”
“Criterion 1”	25			
“Criterion 2”	25			
“Criterion 3”	50			
<b>Total score</b>	100			
<b>Continue?</b>				

### Detailed Design Discussion (Design Iteration 1)

This subsection is used to fully explain the overall design and manufacturing plan for the selected concepts of each subsystem.

1. Explain how the selected overall design will satisfy the requirements from the Customer Needs and Requirements section.
2. Include engineering drawings of the selected concept for each subsystem. **Engineering drawings must include dimensions with units and relevant tolerances.** Explain the contents of each drawing (e.g. What are the major features? How does the component fit into the whole prototype?)
3. Use a flowchart to describe your manufacturing process (see example plan for manufacturing a match plate for sand casting in Figure 1). Provide an explanation of the plan in the main text. Table 3 includes the different elements used in the flow chart.

Table 3. Explanation of flow chart elements.

Symbol					
Name	Start/End	Input/Output	Process	Decision	Connection
Function	An oval represents a start or end point.	A parallelogram indicates an input or output.	A rectangle signifies a specific action.	A diamond is used to make binary decisions.	Lines are used to show relationships between the shapes.

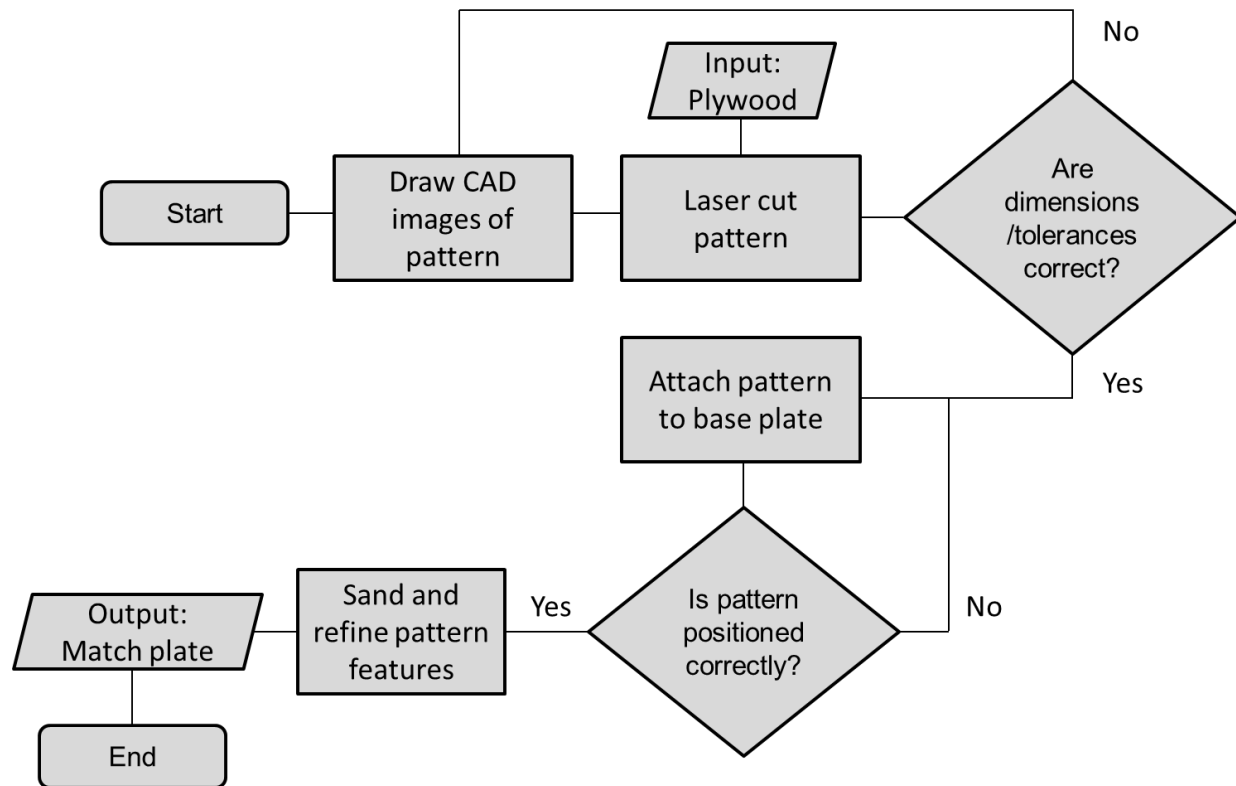


Figure 1. Plan for manufacturing and assembling match plate.

4. Include a Bill of Materials (BOM) that accounts for all materials used for the prototype. Use the template shown in Table 4 and provided in Moodle.

Table 4. Bill of Materials for Design Iteration 1.

Part #	Part Description	Link	Quantity	Size	Material	In Stock? (Yes/No)	Price (each)	Estimated cost	Shipping Cost	Total Cost (If part is in stock, then enter 0)
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
							Totals:			

### Testing and Validation (Design Iteration 1)

Fabricate a prototype of your design for testing. Testing is used to validate your design against the technical requirements. To that end, you must include the following for EACH test setup that you use:

- An explanation of the test setup
- The requirements that are to be validated by that test
- The results of the test, and if they are negative, what needs to happen next
- A discussion of requirements that still need to be met

### Design Summary (Design Iteration 2)

The second design iteration needs to include all the same subsections as in Design Iteration 1. However, you will focus on changes that need to be made as a result of testing from the first design iteration and any additional aspects of the design not yet addressed.

### Concept Generation (Design Iteration 2)

Include only major concept changes that you need to make in response to things learned during the previous design iteration.

### Concept Selection (Design Iteration 2)

For each new set of concepts generated, you must generate an updated selection matrix.

### Detailed Design Discussion (Design Iteration 2)

Update the engineering drawings for the new selected concepts. The dimensional tolerances will need to be changed according to the equipment used for fabricating the second prototype. Update the manufacturing plans based on the equipment used for fabricating the second prototype. Update the Bill of Materials from Design Iteration 1 to include all materials used for Design Iteration 2.

### Testing and Validation (Design Iteration 2)

Explain the testing process for the second prototype, as similar to Design Iteration 1.

### Design Summary (Design Iteration 3)

The third design iteration needs to include all the same subsections as in Design Iterations 1 and 2. However, you will focus on the changes that need to be made as a result of testing from the second design iteration and any additional aspects of the design not yet addressed.

### Concept Generation (Design Iteration 3)

Include only major concept changes that you need to make in response to things learned during the previous design iteration.



### Concept Selection (Design Iteration 3)

For each new set of concepts generated, you must include an updated selection matrix.

### Detailed Design Discussion (Design Iteration 3)

Update the engineering drawings for the new selected concepts. The dimensional tolerances will need to be changed according to the equipment used for fabricating the final prototype. Update the manufacturing plans based on the equipment used for fabricating the final prototype. Update the Bill of Materials from Design Iteration 1 and 2 to include all materials used for Design Iteration 3.

### Testing and Validation (Design Iteration 3)

Explain the testing process for the final prototype, as similar to Design Iterations 1 and 2.

### Conclusion

The conclusion section provides a brief recap of the overall findings for the project. A few points to remember are:

1. No new information should be introduced in the conclusion. Think of it as a condensed version of your most important findings for a very busy boss.
2. State clearly whether or not you have achieved your aim. If you have not achieved your aim, state why and what future advancements might make it possible to achieve your aim.
3. Discuss what modifications you would make to your design if you had more time and money.
4. While a design report in industry would not necessarily contain what you have learned, although it might, this is the one place where we make room for academia. Part of the academic purpose of this section is for you to reflect on your work. What do you know now that you wish you would have known at the start of the project? What advice would you give to future MAE 241 students?

### References

See the section on Citing Sources in Your Report in the Writing Guide for more information on correctly citing your references. Again, a bibliography is **NOT** sufficient, you must give the citations in the text.

### Appendices

Appendices can be added to provide additional information that the reader may find useful. For example, data sheets for instruments, computer code, or other supplemental material. Equations and calculations can also be included in the appendices.