MILESTONE 3A (TEAM) – COVER PAGE

Team Number: Mon-11

Please list full names and MacID's of all *present* Team Members

Full Name:	**MacID:**
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Any student that is ***not*** present for their scheduled Lab-B session will not be given credit for completion of the worksheet and may be subject to a 10% deduction to their P-1 grade.

MILESTONE 3A (STAGE 1) – MATERIAL SELECTION: PROBLEM DEFINITION

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1. Copy-and-paste the title of your *assigned* scenario in the space below.

The Roof Generator

2. MPI selection
   → List one primary objective and one secondary objective in the table below
   → For each objective, list the MPI
   → Write a short justification for your selected objectives

	Objective	MPI-stiffness	MPI-strength	Justification for this objective
Primary	Minimize Volume	MPI = E	MPI = σ_y	Since houses are closely packed, the turbine should not collide with neighbouring objects. Thus, minimizing volume would minimize the overall size of the turbine. Also, volume is proportional to mass (v=m/p) -- so minimizing the volume would also ensure a low mass (so the average roof can withstand its weight).
Secondary	Minimize Cost	MPI = $\frac{E}{\rho C_m}$	MPI = $\frac{\sigma_y}{\rho Cm}$	Residential homeowners are looking to reduce their electricity bills. Therefore, minimizing the cost makes it easier and more affordable for the homeowners buying the turbines.

MILESTONE 3A (STAGE 3) – MATERIAL SELECTION: MATERIAL ALTERNATIVES AND FINAL SELECTION

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Document results of each team member's materials selection and ranking on the table below.

- All different types of steel (carbon steels, alloy steels, stainless steels) have very similar Young's moduli. **For this stage in Project 1, please group all variations of steels into one family as "steel"**. Please put **steel** in your material ranking list only once and indicate in a bracket which steels made the top ranks.

Consolidation of Individual Material Rankings					
	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
1: MPI = E	Tungsten alloys	Steels (medium carbon, low carbon, high carbon, low alloy, stainless)	Nickel alloys	CFRP	Copper alloys
2: MPI = σ_y	Low alloy steel	Tungsten alloys	Stainless steel	Titanium alloys	CFRP
3: MPI = $\frac{E}{\rho C_m}$	Steels (medium carbon>low carbon>high carbon> low alloy)	Bamboo	Aluminum alloys	Wood, typically along grain	Magnesium alloys
4: MPI = $\frac{\sigma_y}{\rho C_m}$	Steels (Medium Carbon, Low Carbon, High Carbon, Low Alloy, Stainless Steel)	Bamboo	Aluminum Alloy	Wood	Magnesium Alloy

As a team, fill out the table below and narrow down the possible materials for your assigned scenario by choosing the 3 materials which showed up the most across all MPI rankings in the table above.

- For this stage in Project 1, if **"steel"** is one of your three material finalists, please specify which steel your team chose to continue with, based on which showed up the most in your team's consolidated table.
- Remember to save the datasheets of all 3 material finalists

Narrowing Material Candidate List to 3 Finalists	
Material Finalist 1:	Low Alloy Steel
Material Finalist 2:	Tungsten Alloys
Material Finalist 3:	Bamboo

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As a team, compare material alternatives and make a final selection based on either a simple decision matrix or a weighted decision matrix (up to your team to decide)

→ As a team, consider *at least* 3 additional criteria that are relevant to your assigned scenario and discuss your 3 materials finalists for each criterion

- Feel free to pause at this stage and do some quick research on the materials finalists
- You may refer to the material finalists' datasheets for any relevant information that will enable your discussion.
- To help you come up with your additional criteria, below are some question prompts that you may consider. Please note that you are not limited to these suggestions, and they may or may not be relevant to your assigned scenario

Additional Criteria	**Possible question prompt**
Ease of access to material	Is the material easy to source in the country, are there tariffs due to international trade policy?
Chemical, weather and/or corrosion resistance	Will the material degrade over time (e.g. due to chemical resistance, corrosion resistance, fatigue resistance)?
Ease of maintenance	Consider maintenance if the part got damaged. Based on the material, is it easy to fix or will the entire part need replacement?

→ Remember that:

- Your MPI ranking takes into consideration both material and mechanical properties relevant to the objectives of your assigned scenario.
- Your additional considerations should not include previously evaluated objectives e.g. If minimizing the carbon footprint was either your primary or secondary objective, then it not be an additional criterion

→ Compare the material alternatives and make a final selection based on either a simple decision matrix or a weighted decision matrix (up to your team to decide)

- *Applies to a weighted decision matrix only:* choose a range for the weighting (e.g., 1 to 5) for each criterion. The higher the number on the weighting, the more important that criterion is.
- Choose a range for the score (e.g., 1 to 5) for each material on each criterion. Give each material a score based on how successfully it meets each criterion. The higher the score, the better the material is for that criterion.
- Add additional rows as needed.
- Add up the total score for each material alternative.

Fill one of the following templates only:

Simple Decision Matrix - Template			
	Material 1: *Low Alloy Steel*	*Material 2:* *Tungsten Alloy*	*Material 3:* *Bamboo*
Volume	4	5	1
Cost	5	1	4
Density	3	2	5
Strength	3	5	3
Sustainability	2	2	3
Weather Res.	3	4	2
TOTAL	20	19	18

Weighted Decision Matrix - Template							
	Weighting	*Material 1:*		*Material 2:*		*Material 3:*	
		Score	Total	Score	Total	Score	Total
Criterion 1	3	5	15				
Criterion 2	2						
Criterion 3	4						
…							

	TOTAL						

→ State your chosen material and justify your final selection

Justification	
Chosen Material:	Low Alloy Steel

Discuss and justify your final selection in the space below (based on the decision matrix results and any other relevant considerations).

We chose low alloy steel because it was the highest scoring material in our decision matrix and was a high-ranking material in all 4 of our MPIs. Our 2 main objectives were minimal volume and cost, which low alloy steel highly ranks in both. It is very cost effective for the average homeowner and will not collide with neighboring objects. Our additional criteria included minimal density to prevent roof collapse, which low alloy steel ranked fairly well in. Low alloy steel also ranked fairly well for strength and weather resistance, so the wind turbine will require minimal maintenance and will be long lasting.

Summary of Chosen Material's Properties

Material Name	Average value
Young's modulus E (GPa):	205
Yield strength σ_y (MPa):	1034.5
Tensile strength σ_{UTS} (MPa):	1249.5
Density ρ (kg/m^3):	7.8x10^3
Embodiment energy H_m (MJ/kg)	31.05
Specific carbon footprint CO_2 (kg/kg)	2.49