PROJECT ONE: MILESTONE 3A – COVER PAGE

Team Number: Tues-36

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

Full Name:	MacID:
Brian Tang	tangb17
Luigi Quattrociocchi	quattrl
Tuong Minh Doan	doant6
Rahul Mahesh	maheshr
Michael Shadoff	Shadoffm

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

Team Number: Tues-36

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

A Pioneer in Clean Energy

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 CO_2 footprint from production	$E/\rho CO_2$	$\sigma_y/\rho CO_2$	The primary goal in choosing a material should minimize damage to the environment while also, maximizing the strength and stiffens of the material. The best way to do this is to take in to account the C02 emissions caused by the turbines production. This is especially true considering that Sweden's main objective with this endeavor is to eliminate CO2 emissions by 2045
Secondary	Minimize Mass	E/ρ	σ_y/ρ	Minimizing the mass of each individual turbine allows for longer blades which in turn increases efficiency. The windmills would also be more stable and less likely to break when experiencing high wind pressure. Finally, maximizing efficiency is of greater importance than maximizing quantity of wind turbines produced, as Sweden has limited coastal areas that allow turbines to that should be utilized to their fullest potential, because of their higher windspeed.

MILESTONE 3A (STAGE 2) – MATERIAL SELECTION: MPI AND MATERIAL RANKING

Document the results of your materials selection and ranking on the following page.

→ Each team member is required to complete this on the *INDIVIDUAL* worksheet document, and then copy-and-paste to this document

We are asking that you submit your work on both worksheets**.** It does seem redundant, but there are valid reasons for this:

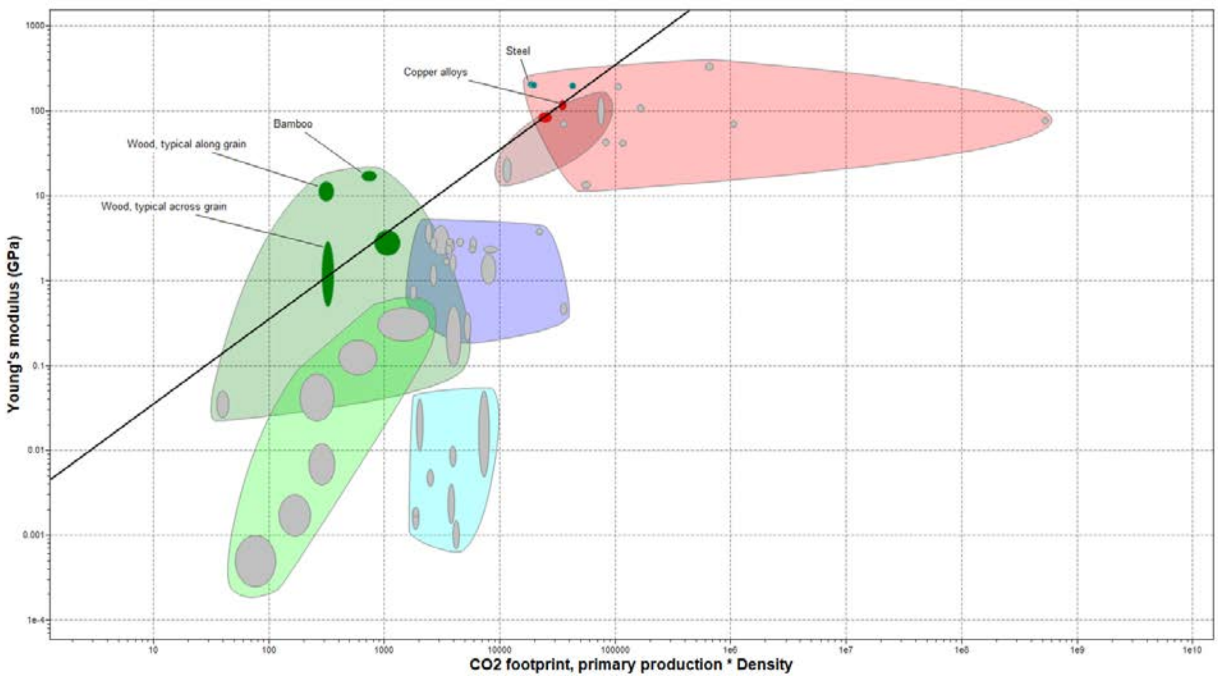
- Each team member needs to submit their summary of material property charts with the **Milestone Three-A Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone Three-A Team Worksheets** document allows you to readily access your team member's work
    - This will be especially helpful when completing ***Stage 3*** of the milestone

Team Number: Tues-36

Copy-and-paste from the INDIVIDUAL worksheet

Full Name:	MacID:
Brian Tang	tangb17
Rahul Mahesh	maheshr

Material Property Chart		
Assigned MPI #1	**Functional Constraint**	**Objective**
$E/\rho CO_2$	d < d*	Minimize CO_2 footprint from production
Insert a screenshot of the material property chart with MPI guideline. Please clearly label the top 5 materials with their name in the plot.		

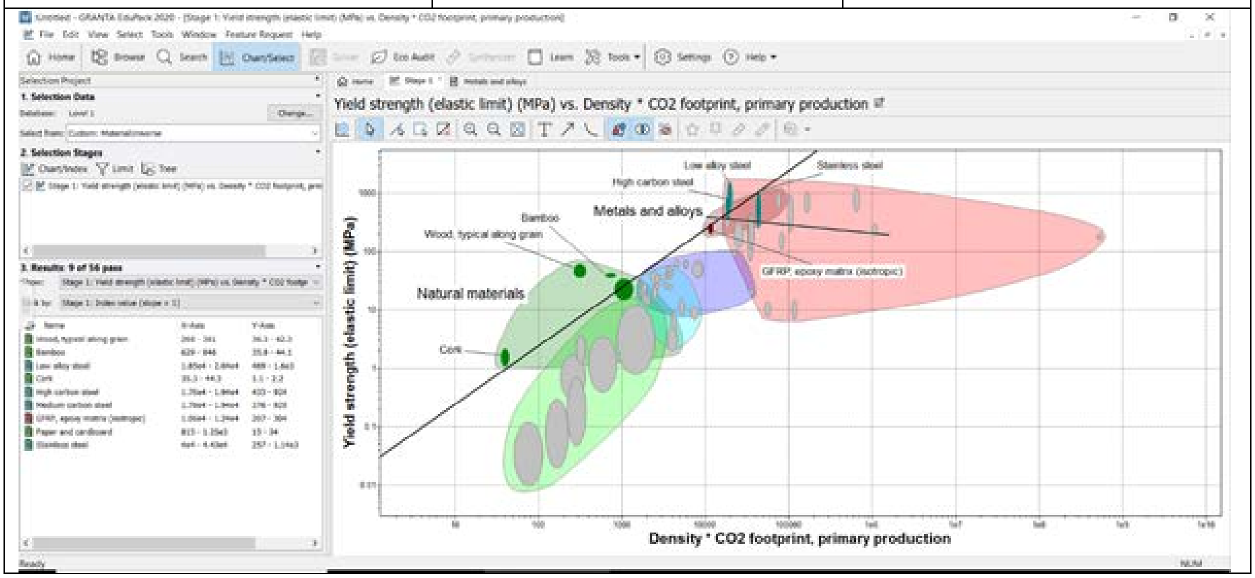


Team Number: | Tues-36

Copy-and-paste from the INDIVIDUAL worksheet

Full Name:	MacID:
Michael Shadoff	Shadoffm

Material Property Chart		
Assigned MPI #2	**Functional Constraint**	**Objective**
$\sigma_y/\rho CO_2$	d < d*	Minimize CO2 Emissions



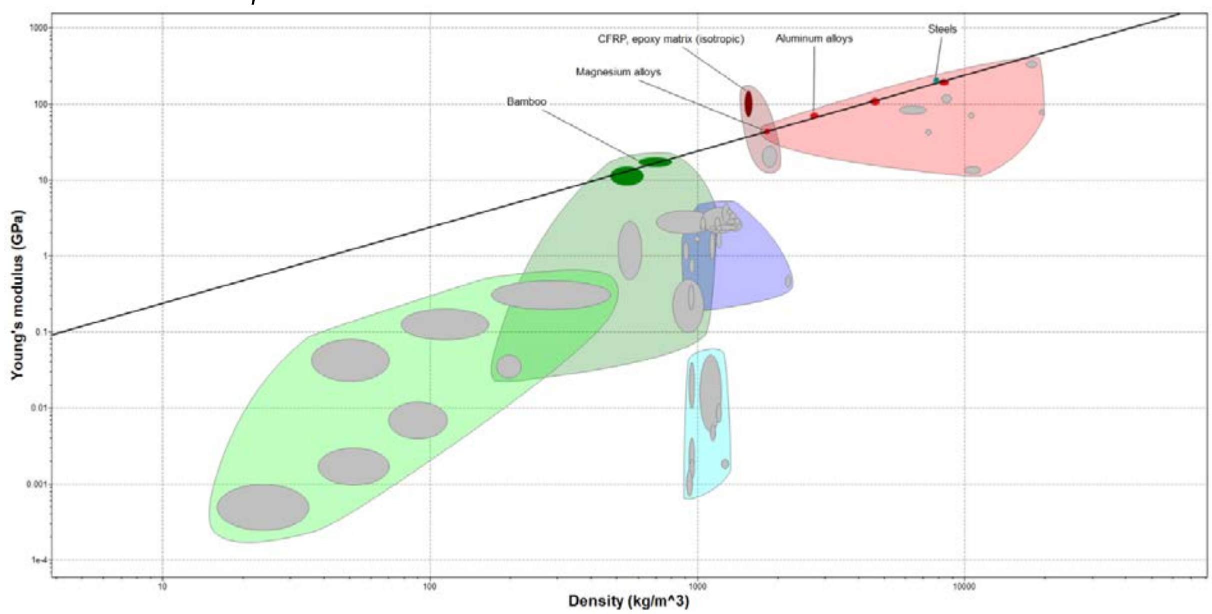
Team Number: Tues-36

Copy-and-paste from the INDIVIDUAL worksheet

Full Name:	MacID:
Luigi Quattrociocchi	quattrl

Material Property Chart		
Assigned MPI #3	**Functional Constraint**	**Objective**
E/ρ	d < d*	Minimize mass

Insert a screenshot of the material property chart with MPI guideline. Please clearly label the top 5 materials with their name in the plot.



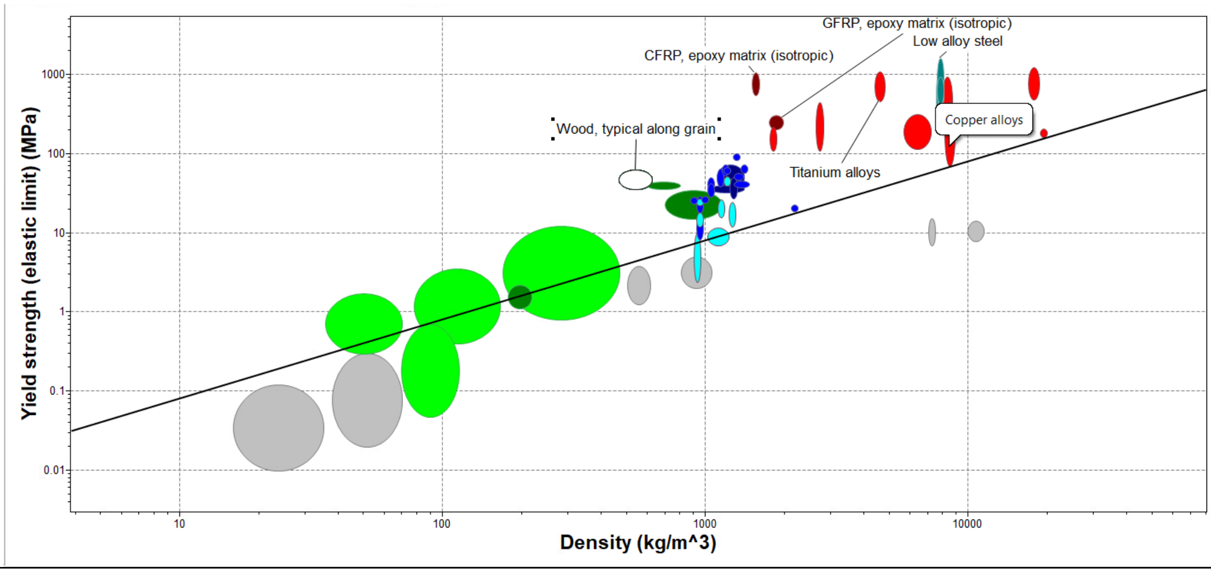
Team Number: Tues-36

Copy-and-paste from the INDIVIDUAL worksheet

Full Name:	MacID:
Tuong Minh Doan	Doant6

Material Property Chart		
Assigned MPI #4	**Functional Constraint**	**Objective**
σ_y/ρ	d<d*	Minimize mass

Insert a screenshot of the material property chart with MPI guideline. Please clearly label the top 5 materials with their name in the plot.



*If you are in a team of 5, please copy and paste the above on a new page

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

Team Number: Tues-36

Consolidation of Individual Material Rankings					
	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
	Material Name	Material Name	Material Name	Material Name	Material Name
MPI 1 $E/\rho CO_2$	Wood, typical along grain	Bamboo	Steel	Wood, typical across grain	Copper Alloys
MPI 2 $\sigma y/\rho CO2$	Wood, typical along grain	Bamboo	Steel	Cork	GFRP, epoxy matrix (isotropic)
MPI 3 E/ρ	CFRP, epoxy matrix (isotropic)	Steels	Aluminum alloys	Bamboo	Magnesium alloys
MPI 4 σ_y/ρ	CFRP, epoxy matrix (isotropic)	Titanium alloys	GFRP, epoxy matrix (isotropic)	Steel	Wood, typical along grain

Narrowing Material Candidate List to 3 Finalists	
Material Finalist 1:	Steel
Material Finalist 2:	CFRP, epoxy matrix (isotropic)
Material Finalist 3:	Wood, typical along grain

Team Number: Tues-36

Compare Material Alternatives and Make a Final Selection using a Decision Matrix

→ As a team, establish a weighting factor for each criterion:

- Move row-by-row
  - If *Criteria 1* is preferred over *Criteria 2*, assign a 1. Otherwise, assign 0
  - If *Criteria 1* is preferred over *Criteria 3*, assign a 1. Otherwise, assign 0
- Add additional rows/columns as needed

Criteria Ranking						
	Cost	Young's modulus	CO2 emissions	density	Fatigue Strength	**Weight factor**
Cost	1	0	0	0	0	1
Young's Modulus	1	1	0	0	1	3
CO2 emissions	1	1	1	1	1	5
Density	1	1	0	1	1	4
Fatigue Strength	1	0	0	0	1	2

→ As a team, evaluate your materials against each criterion using your weighting

- Add additional rows as needed

Decision Matrix							
	Weight factor	*Steel*		*CFRP, epoxy matrix (isotropic)*		*Wood, typical along grain*	
		Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating
CO2 Emissions	5	7	**35**	2	**10**	10	**50**
Density	4	3	**12**	7	**28**	9	**36**
Young's Modulus	3	10	**30**	8	**24**	1	**3**

Fatigue Strength	2	10	**20**	8	**16**	1	**2**
Cost	1	10	**10**	1	**1**	8	**8**
TOTAL		40	**107**	26	**79**	29	**99**

Team Number: Tues-36

→ List your chosen material and justify your selection

Justification	
List Chosen Material:	Steel
Steel was chosen as the best material for several reasons, the first of which being that it was the best material according to the decision matrix, both weighted and unweighted. Additionally, many of the other materials under consideration have critical flaws, making them difficult to use within the constraints of the project. The CFRP epoxy matrix, for instance, has a very high carbon footprint and it would be environmentally damaging to produce, so it would be an unreasonable choice for an eco-friendly objective. Wood is also flawed, as it would be very prone to warping due to moisture or splitting under high stress. It would also be difficult to carve wooden wind turbines blades, because of their physical structure. Steel was also a material that appeared in all the MPI charts showing its versatility and suitability of steel. When analysing other materials such as wood or CFRP it becomes clear that they only excel in one area. CFRP is rated highly under both the mass MPI's but it has little to no presence under the CO2 emissions MPI because of its high CO2 emissions. Wood was the opposite strengths and weaknesses, showing how each of the other materials fail for this specific project, despite both receiving high scores in the decision matrices. Overall, Steel was the best material for the job as it works well in the setting of a wind turbine blade, and it has a low carbon emission.	

Summary of Chosen Material's Properties

Material Name: Steel	Average value:
Young's modulus E (GPa):	210 GPa : 200 - 220 GPa
Yield Strength σ_y (MPa):	295 MPa : 255 - 335 MPa
Tensile strength σ_{UTS} (MPa):	456 MPa : 379 - 532 MPa
Density ρ (kg/m^3):	7.81e3 kg/m^3 : 7.8e3 - 7.82e3 kg/m^3
Embodiment Energy H_m (MJ/kg)	30.8 MJ/kg : 29.3 - 32.3 MJ/kg
Specific carbon footprint CO_2 (kg/kg)	2.33 kg/kg : 2.21 - 2.44 kg/kg