PROJECT ONE: MILESTONE 3A – COVER PAGE

Team Number: 26

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

Full Name:	MacID:
Jackson Lippert	lippertj
Sana Khan	Khans288
Sophia Workun	workus1
Ehsaan Khan	khane16
Emilia Pisic	pisice

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.

EWB Humanitarian Aid Mission

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 Cost	$MPI^{(cost)} = \frac{E}{\rho C_m}$	$MPI^{(cost)} = \frac{\sigma_y}{\rho C_m}$	The turbine is being installed in a third world country, limiting the type of material used. By using an inexpensive material that is widely accessible, it will allow for numerous blades to be produced.
Secondary	Minimize Mass	$MPI^{(mass)} = \frac{E}{\rho}$	$MPI^{(mass)} = \frac{\sigma_y}{\rho}$	The turbine needs to be easy to assemble and will be done so by local workers, thus needs to have relatively low mass. There may not be high end machinery and equipment thus many tasks may have to be done more hands-on and the mass can't be too high.

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

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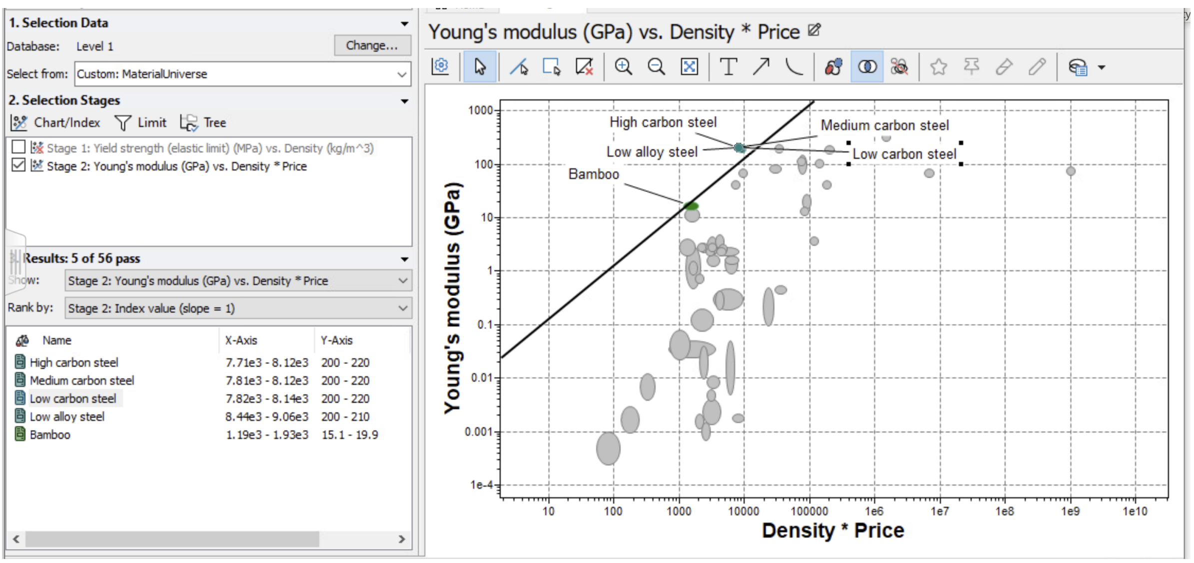
Copy-and-paste from the INDIVIDUAL worksheet

Full Name:	MacID:
Jackson Lippert	lippertj

Material Property Chart

Assigned MPI #1	Functional Constraint	Objective
$MPI^{(cost)} = \frac{E}{\rho C_m}$		
	d<d*	Minimize cost with respect to stiffness

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



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Copy-and-paste from the INDIVIDUAL worksheet

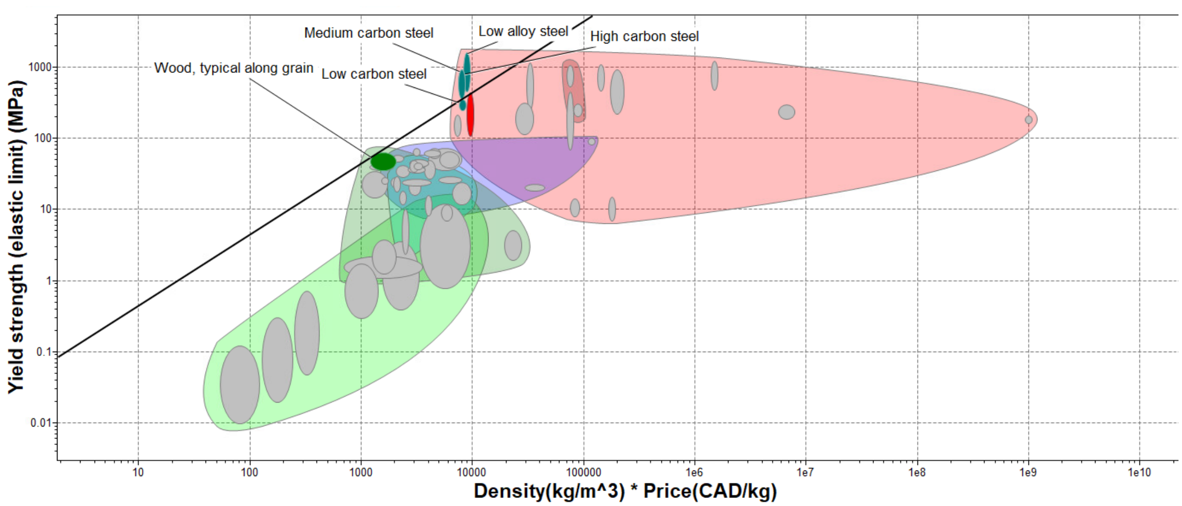
Full Name:	MacID:
Ehsaan Khan	khane16

Material Property Chart

Assigned MPI #2	Functional Constraint	Objective
	d<d*	Minimize Cost(strength)

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

$$MPI^{(cost)} = \frac{\sigma_y}{\rho C_m}$$



Show: Stage 2: Yield strength (elastic limit) (MPa) vs. Density(kg/m^3) * F

Rank by: Stage 2: Index value (slope = 1)

Name	X-Axis	Y-Axis	
Low alloy steel	8.44e3 - 9.06e3	469 - 1.6e3	0.0991
High carbon steel	7.71e3 - 8.12e3	433 - 924	0.0799
Medium carbon steel	7.81e3 - 8.12e3	376 - 929	0.0742
Low carbon steel	7.82e3 - 8.14e3	255 - 355	0.0377
Wood, typical along grain	1.2e3 - 2.01e3	36.3 - 62.3	0.0306

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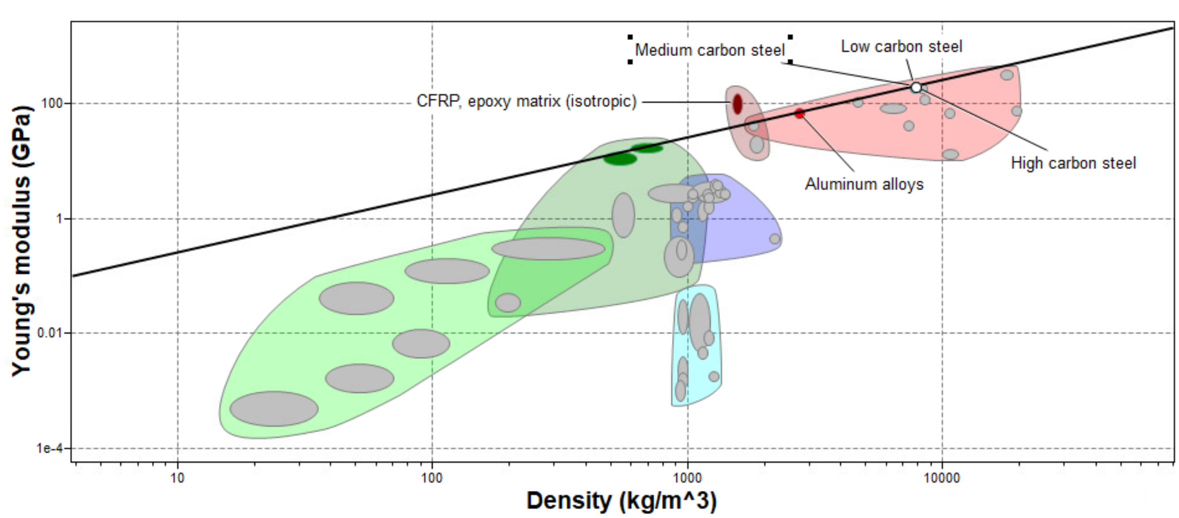
Copy-and-paste from the INDIVIDUAL worksheet

Full Name:	MacID:
Sophia Workun	workus1

Material Property Chart		
Assigned MPI #3	**Functional Constraint**	**Objective**
$MPI^{(mass)} = \frac{E}{\rho}$	d<d*	Minimize mass(stiffness)



Results: 9 of 56 pass

Show: Pass all Stages

Rank by: Stage 1: Index value (slope = 1)

Name	Stage 1: Index, slope = 1
CFRP, epoxy matrix (isotropic)	0.0657
Medium carbon steel	0.0269
High carbon steel	0.0269
Low carbon steel	0.0269
Aluminum alloys	0.0264
Low alloy steel	0.0263
Stainless steel	0.0258
Bamboo	0.025
Wood, typical along grain	0.0211

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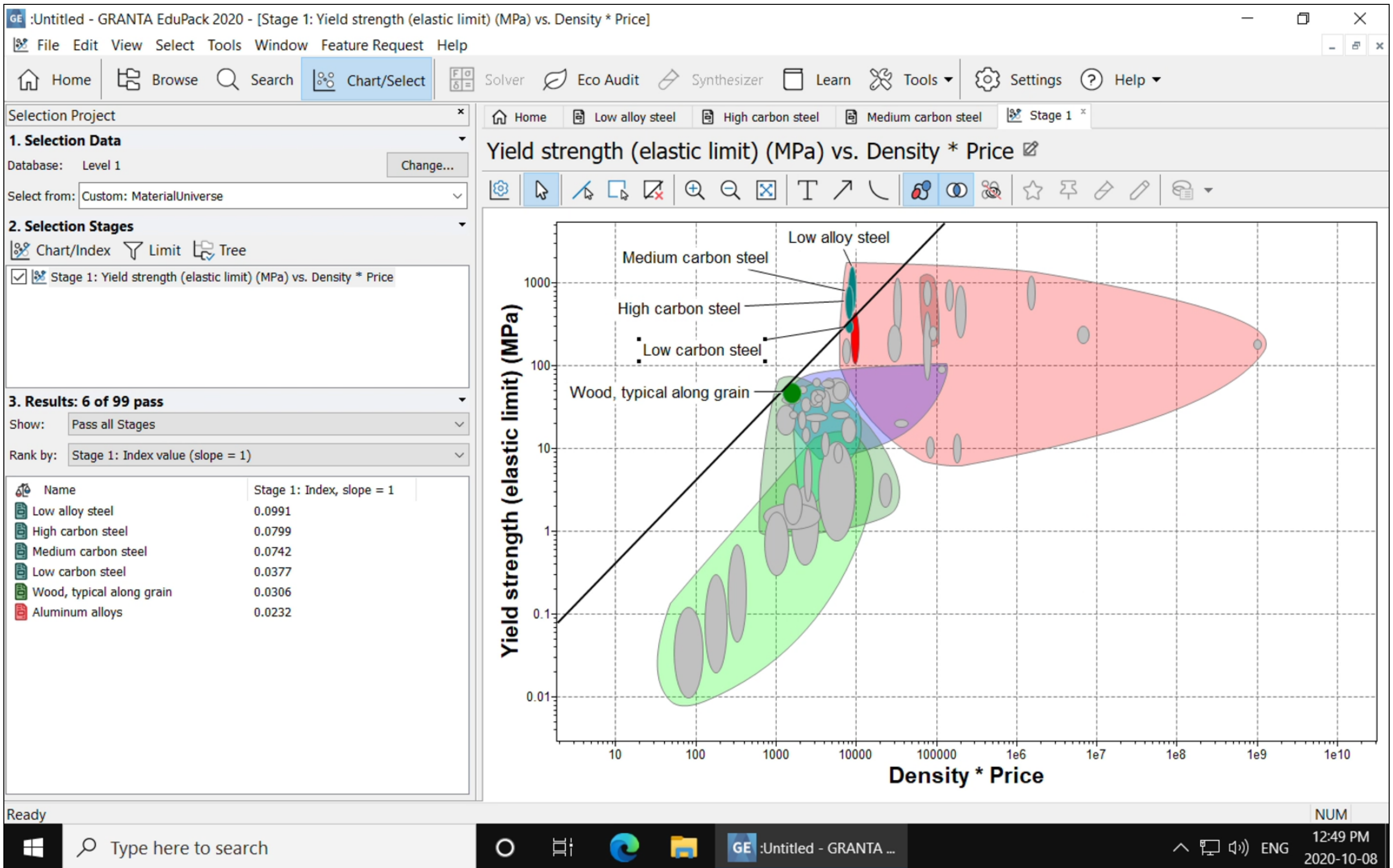
Copy-and-paste from the INDIVIDUAL worksheet

Full Name:	MacID:
Sana Khan	khans288

Material Property Chart

Assigned MPI #4	Functional Constraint	Objective
$MPI^{(mass)} = \frac{\sigma_y}{\rho}$	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.



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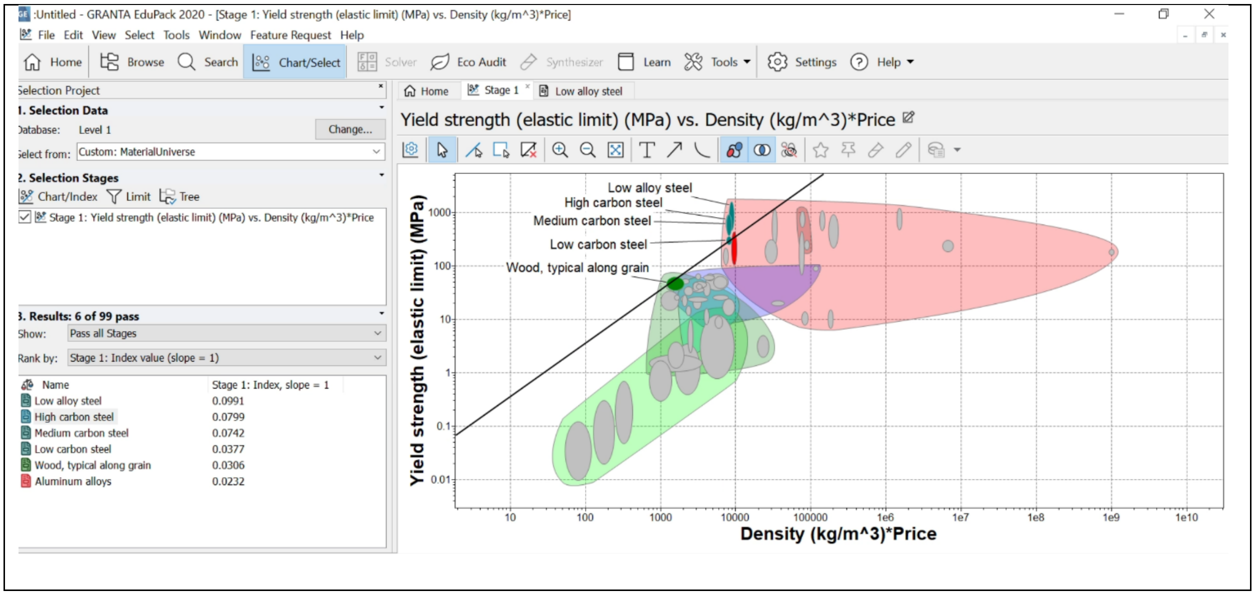
Copy-and-paste from the INDIVIDUAL worksheet

Full Name:	MacID:
Emilia Pisic	pisice

Material Property Chart		
Assigned MPI #5	**Functional Constraint**	**Objective**
$MPI^{(mass)} = \frac{\sigma_y}{\rho}$	d < d*	Minimize mass


:Untitled - GRANTA EduPack 2020 - [Stage 1: Yield strength (elastic limit) (MPa) vs. Density (kg/m^3)*Price]
File Edit View Select Tools Window Feature Request Help
Home Browse Search Chart/Select Solver Eco Audit Synthesizer Learn Tools Settings Help
Selection Project
1. Selection Data
Database: Level 1
Change...
Select from: Custom: MaterialUniverse
2. Selection Stages
Chart/Index Limit Tree
Stage 1: Yield strength (elastic limit) (MPa) vs. Density (kg/m^3)*Price
3. Results: 6 of 99 pass
Show: Pass all Stages
Rank by: Stage 1: Index value (slope = 1)
Name
Stage 1: Index, slope = 1
Low alloy steel 0.0991
High carbon steel 0.0799
Medium carbon steel 0.0742
Low carbon steel 0.0377
Wood, typical along grain 0.0306
Aluminum alloys 0.0232
Home Stage 1 Low alloy steel
Yield strength (elastic limit) (MPa) vs. Density (kg/m^3)*Price
Low alloy steel
High carbon steel
Medium carbon steel
Low carbon steel
Wood, typical along grain
Yield strength (elastic limit) (MPa)
1000
100
10
1
0.1
0.01
10
100
1000
10000
100000
1e6
1e7
1e8
1e9
1e10
Density (kg/m^3)*Price

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

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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	High carbon steel	Medium carbon steel	Low carbon steel	Low alloy steel	Bamboo
MPI 2	Low Alloy Steel	High Carbon Steel	Medium Carbon Steel	Low Carbon Steel	Wood, typical along grain
MPI 3	CFRP, epoxy matrix	Medium carbon steel	High carbon steel	Low carbon steel	Aluminum alloys
MPI 4	Low Alloy steel	High carbon steel	Medium carbon steel	Low carbon steel	Wood, typical along grain
MPI 5	Low alloy steel	High Carbon steel	Medium Carbon Steel	Low Carbon Steel	Wood, typical along grain

Narrowing Material Candidate List to 3 Finalists	
Material Finalist 1:	Medium carbon steel
Material Finalist 2:	High carbon steel
Material Finalist 3:	Low carbon steel

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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

	Lightweight	*Cheap*	*Strength*	Stiffness	Carbon footprint	**Weight factor**
Lightweight	1	0	0	1	0	2
Cheap	1	1	1	1	1	5
Strength	1	0	1	1	1	4
Stiffness	0	0	0	1	1	2
Carbon Footprint	0	0	0	0	1	1

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

- Add additional rows as needed

Decision Matrix							
	Weigh t factor	*Medium carbon steel*		*High carbon steel*		*Low carbon steel*	
		Ratin g	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating
Lightweight	2	3	**6**	3	**6**	3	**6**
Cheap	5	3	**15**	3	**15**	3	**15**
Strength	4	2	**8**	3	**12**	1	**4**
Stiffness	2	3	**6**	3	**6**	3	**6**
Carbon footprint	1	2	**2**	2	**2**	3	**3**
TOTAL			**37**		**41**		**34**

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→ List your chosen material and justify your selection

Justification	
List Chosen Material:	High carbon steel
Discuss and justify your selection in the space below (based on the MPIs and any other relevant considerations). All three of the material finalists had very similar if not the same properties. For this reason, the total rankings for each of the materials were very close. In the end, high carbon steel had the highest ranking because it has the highest strength compared to the other two materials. High carbon steel satisfies each of our criteria's the most, making it the top material to use for this design.	

Summary of Chosen Material's Properties

Material Name:	Average value:
Young's modulus E (GPa):	210
Yield Strength σ_y (MPa):	678.5
Tensile strength σ_{UTS} (MPa):	1055.5
Density ρ (kg/m^3):	7800
Embodiment Energy H_m (MJ/kg)	32.4
Specific carbon footprint CO_2 (kg/kg)	2.375