Project Two: Wastewater Filtration

Mechanical Design of Filters in a Wastewater Treatment Plant

Learning Objectives of Project Two

Project completion contributes to the development of the following learning outcomes:

LO.03	Demonstrate an understanding of the structure and properties of materials.
LO.06	Design a well-thought-out solution to a real-world problem, considering both technical and social implications of that solution.
LO.07	Demonstrate effective communication in a breadth of situations.
LO.09	Demonstrate effective teamwork on a design project.
LO.10	Plan and manage time effectively to achieve project goals.

List of deliverables

Deliverable	Submission Type	Deadline	Marks	Module
Milestone 0 + Milestone 1	Team	End of DS-1 (Wk-1)	P/F	M
Milestone 2	Individual + Team	End of DS-2 (Wk-2)	1.0	M
Milestone 3	Individual + Team	End of DS-3 (Wk-3)	1.5	M
Milestone 4	Team	End of DS-4 (Wk-4)	2.0	M
Milestone 5	Individual + Team	Feb 8th, 2025	P/F	M
Design Review and Work Period	Team		P/F	M
Presentation	Team	Feb 10 – 14, 2025 (In Lab A)	2.0	
Design Project Report	Team	Feb 15, 2025	1.5	M
Self- and Peer-Evaluation		Feb 15, 2025	0.5**	D
Administrative Responsibilities			Varies	D

**The self- and peer-evaluation is part of your 1P13 teamwork and project engagement grade.

Project Two Summary

In Project Two, you will be in an engineering design team that contributes to filtration system design and wastewater technologies. As part of a larger engineering group, your team will design a filtration component for a wastewater treatment plant by considering its mechanical properties and performance. Having general knowledge of wastewater treatment and filtration systems are critical for the success of your design; however, only the design of the filters themselves will be considered for the scope of this project. Your team will explore this design through the three levels of the Engineering Design Process.

First, you will explore the technology and learn about the design specifications of filtration systems. You will determine the design requirements (i.e., function, constraints, and objectives) of wastewater treatment filters in one of the four assigned scenarios (more details will be given for each scenario):

- Small Community Nuclear Contamination
- Microplastic Filtration for Large-Scale Plant
- Antibiotic Disposal for Hospital Wastewater Runoff
- Algae Growth and Accumulation in Treatment Ponds

Second, you will develop a conceptual design by selecting suitable materials for this filtration system based on the design requirements and top objectives considering the mechanical properties and performance.

Finally, you will develop a life cycle diagram and inventory of your design and its corresponding components. The information in this inventory will be used for the Eco Audit Tool in the ANSYS-Granta EduPack to assess the environmental impact throughout the duration of your solution's life cycle.

Your team will explore suitable material choices and conduct an Eco Audit for a wastewater filter, providing an opportunity to gain familiarity with engineering computational design tools for material selection and environmental impact analysis (ANSYS-Granta EduPack) for your proposed designs.

Summary of Project Objectives

Working in a team of **4-5 students**, you will:

1. *Identify* suitable objectives for the assigned design scenarios in terms of mechanical performance using an **objective tree (see Fall Term Design lectures).**
2. *Identify* suitable material(s) and/or alloys for manufacturing the filter using **ANSYS-Granta EduPack.**
3. *Identify* the environmental impact of your design choices using **ANSYS-Granta EduPack.**
4. *Justify* how your final design meets the needs of the application with suitable technical objectives.

Summary of Project Two Deliverables

Project Entry Research Memo: Each team member is required to complete a brief pre-project literature research memo (1 page long). This is expected to be completed before Milestone 2 in Week 2.

Administrative Responsibilities: Each team member is assessed individually based on specified criteria related to a team-based approach to learning.

Project Milestones: There will be 5 milestones required to be completed:

→ 1: Problem Statement
→ 2: Metrics
→ 3: Material Selection
→ 4: Porosity Calculations
→ 5: Eco Audit

Final Deliverables: Your team must complete a Design Summary and Presentation upon completion of Project Two, including the following components:

→ **Finalized problem statement:** define the suitable functions, constraints, and objectives of this project, and develop an objective tree for the specific scenario assigned to your team.
→ **Justification of high level and technical objectives** of the project for your team's specific scenario.
→ **Summary of material selection:** describe how your team selects your chosen material.
→ **Summary of environmental impact (design embodiment):** determine the carbon footprint of your final design.
→ **Summary** of peer-learning experience.

Introduction

Without water there would be no life. Water is needed for a variety of purposes both domestically and industrially. In our daily lives, we need water to keep our bodies healthy, to cook, and to clean. Industrially, water is needed for cooling, to generate electricity, and numerous manufacturing processes. As such, it is paramount that we have systems in place to ensure that we have access to clean water. There are numerous impurities present within water ranging from bacteria to chemicals to sediments – all these components need to be removed for us to have clean water that we can either ingest or return to the environment.

Figure 1. Examples of everyday domestic filters (left – coffee filter, right – water filter)

Water filtration systems are one of the avenues to accomplishing these goals. Simple filters can be used at home to filter water or coffee (Fig. 1). However, all the fluids and solids that go down the drain, whether in a household or a sewer, need to be treated before returning to the environment. These treatment facilities, wastewater treatment plants, are sometimes standalone facilities or are built into existing manufacturing processes. These facilities are designed, monitored, and maintained by process engineers to ensure that the impurities are separated from the influent (untreated water). Separating these components requires filters. Two of the most essential choices for the filter are: 1) the material and 2) the size & volume of the pores.

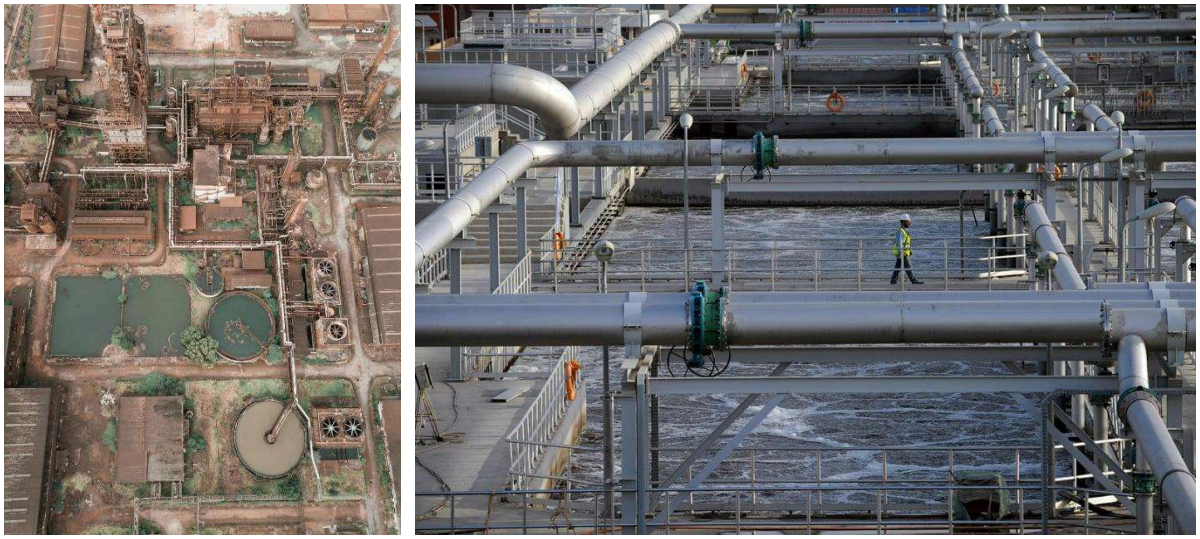


Figure 2. Examples of wastewater treatment facilities (left – top-down view of entire facility, right – grit removal)

In Project Two, your team will have the opportunity to design a wastewater filter based on the mechanical requirements specified by your engineering supervisor. Your focus will be to remove different sized impurities from the wastewater before it is released to the environment. You will determine optimal materials for your filter design based on an assigned engineering scenario (i.e. **conceptual design**). This selection will be done using the Ashby method using the material selection design tool, ANSYS-Granta EduPack. The most suitable material for each scenario should have high strength and stiffness, but it can also be compact, lightweight, economical, and/or sustainable (depending on your team's assigned scenario).

Your team will then determine the most effective porosity for the filter given the specific application (i.e., **design embodiment**). You will also be expected to determine the potential environmental impacts of the material with which you choose to make your filter. This will be accomplished using the EcoAudit functionality within ANSYS-Granta EduPack.

Design Specifications

The fluids in water and wastewater treatment facilities will apply a force to the filter. This force is necessary to ensure flow of the fluid through the filter and subsequently separate impurities. An example of a filter system is shown in Figure 3. It is common in wastewater facilities to have a filter arranged in a vertical setup where the fluid is pumped from outside the filter to the hollow center passing through individual hollow fibers to separate out impurities. To accomplish this, it is essential that the filter fibers do not fail under this applied force. Some of the dimensions of the fibers have been given (see Table 1, see Figure 4) while others remain unknown (material choice and cross-sectional dimensions, h). The filter also needs to be able to filter out the desired components as per your assigned Scenario.

Your team can choose to design the filter based on two different sets of criteria: strength and stiffness.

Table 1. Criteria choice for material selection for filter fibers

Strength Criteria	**Stiffness Criteria**
Constraint: Must not yield under a given load F or Yield strength must be higher than stress i.e., $\sigma < \sigma_y$ Stress: $\sigma_y > \frac{6FL}{bh^2}$	Constraint: Stiffness S of the filter needs to be less than a threshold S^*; i.e., $S < S^*$ Stiffness: $S^* > \frac{12Ebh^3}{L^3}$
Porosity Adjustment: $\sigma_y = \sigma_y(1-p)^n, n = 2$	Porosity Adjustment: $E = E(1-p)^n, n = 2$

Table 2. Definitions of Variables and Parameters

Definitions	
$\sigma_y \rightarrow Yield\ Strength$ $E \rightarrow Elastic\ Modulus$ $S \rightarrow Stiffness$ $F \rightarrow Force$	$L \rightarrow Length$ $b \rightarrow Cross\ sectional\ dimension\ 1$ $h \rightarrow Cross\ sectional\ dimension\ 2$ $p \rightarrow Porosity$ $n \rightarrow Set\ parameter\ for\ porosity\ calculation$

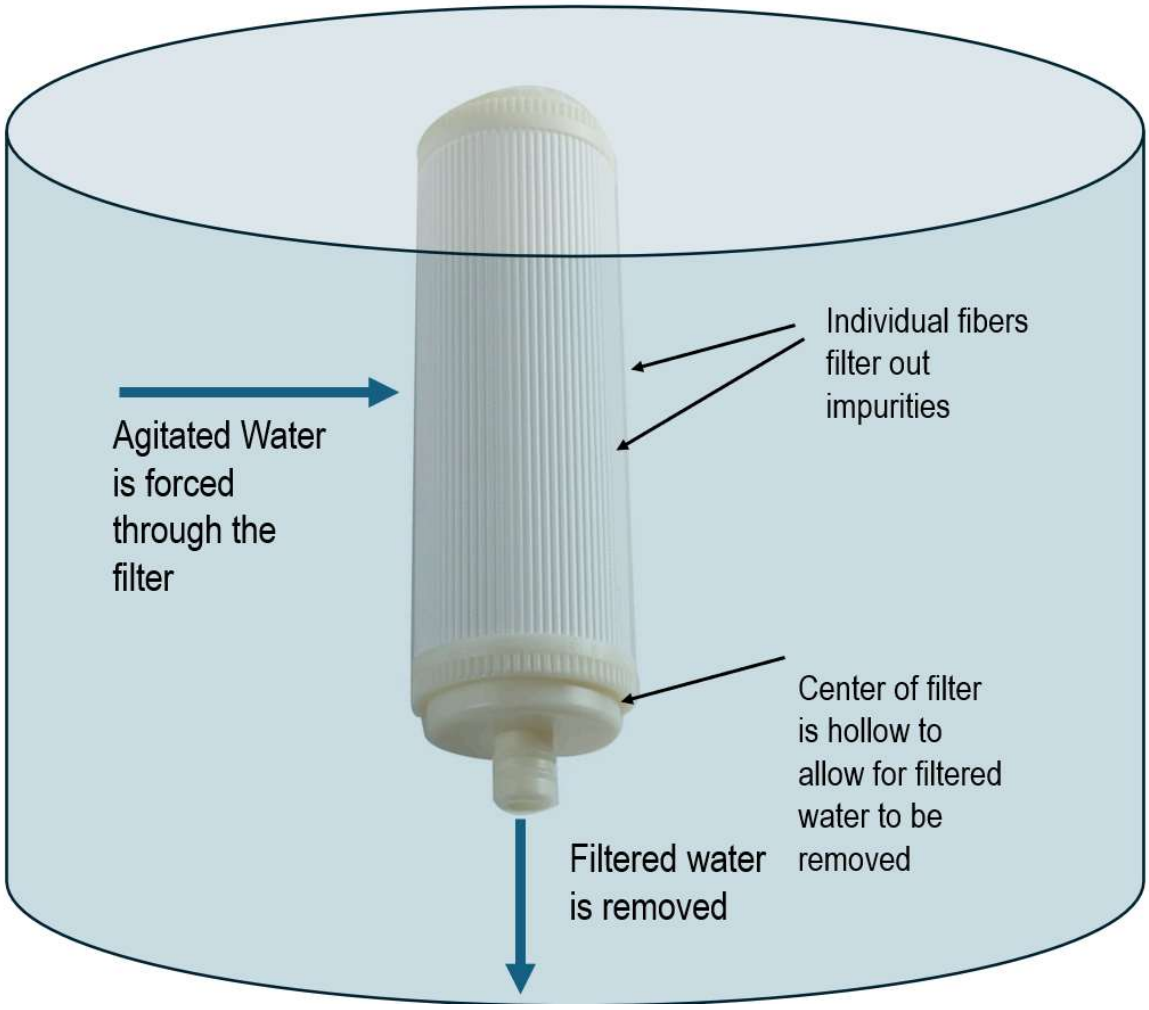


Figure 3. Schematic of an OUT-IN filter system. Water is pumped through the filter units (center) in a tank flowing from outside (OUT) the filter to inside (IN) the filter. The individual fibers (white) filter out impurities and the filtered water is removed through the hollow center of the unit.

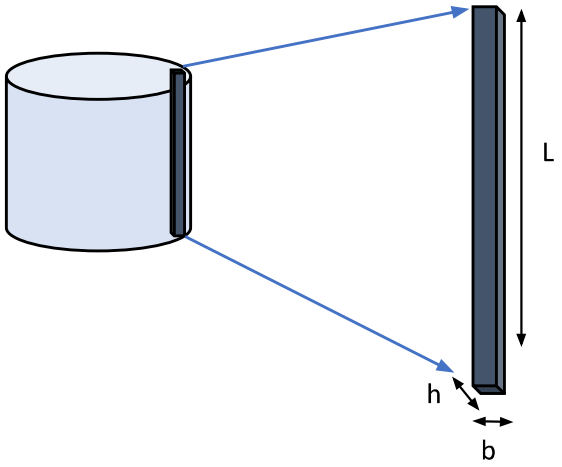


Figure 4. Schematic indicating the cross-section of the cylindrical hollow fiber.

Design Scenarios

Table 3. Suggested filter fiber dimensions for each scenario.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Diameter (mm)	6.35	6.50	7.0	7.25
Length (cm)	20	20	15	15
Shape	Cylinder	Cylinder	Cylinder	Cylinder

Scenario 1: Small Community Nuclear and Environmental Contamination

Contaminant Size Radius: microfiltration – 0.1-1 µm or nanofiltration 1-2 nm

For small towns and rural communities, the construction and maintenance of a centralized wastewater treatment system carries a significant cost of finances and resources. In MacMacster, a small community in southwestern Ontario adjacent to the Bruce Nuclear Power Plant, the town of 1000 has discussed severe concerns associated with the runoff provided by the power plant. After convening with the town council, you have been tasked to design a filtration system for a new, cost-efficient wastewater treatment plant that relieves the environmental and health hazards within the community. The design must consider the low budget that the town has to operate and maintain the plant, as well as reducing the nuclear and radioactive contaminants in the community's wastewater.

Scenario 2: Microplastic Filtration for Large-Scale Plant

Contaminant Size Radius: 10-20 µm

Microplastics and microbeads (found in many personal care products) represent a large concern for organisms in aquatic ecosystems to ingest. While primary treatment process may alleviate such levels of microplastics in effluent before it is released by the plant, dealing with large urban populations and their resulting volumes of wastewater significantly contributes to growing microplastic levels in the environment. Reviewing levels from the wastewater treatment plant in the city of Hamilton (with ~25000 citizens), the city found a level of 1 microplastic per liter of wastewater in the effluent released into the nearby river. Common polymers found in the samples include polyester polyamide, and acrylic. Your task is to modify the filtration system of the plant to help lower its corresponding microplastic levels. The filtration system must be able to optimize the capture and removal of the small-sized plastic particles and microbeads while mitigating their bypass through the current-existing screen filters.

Scenario 3: Antibiotic Disposal for Hospital Wastewater Runoff

Contaminant Size Radius: 5-10 µm

The growing worldwide use of antibiotics and their subsequent release into the environment have led to several ecological and human health concerns. Due to the excretion of used antibiotics and their direct disposal into wastewater systems, wastewater treatment plants have been prominent contributors in the development of antibiotic-resistant bacteria and genes. Analysis of samples from a rural hospital in Byron Bay, Australia has found

significantly high concentrations of ciprofloxacin, a commonly prescribed fluoroquinolone agent with low biodegradability, in their wastewater after treatment. Residents are concerned that the release of this water into the local river and its eventual use for irrigation or household purposes may cause infections from the selected resistant bacteria. Your task is to design a proposal for a filtration system for the plant that monitors the ciprofloxacin levels of effluent from the hospital's wastewater while being operated and maintained at a low budget. The design should provide a form of indication once ciprofloxacin levels reach a significant concentration as well as a method of its removal.

Scenario 4: Algae Growth and Accumulation in Treatment Ponds

Contaminant Size Radius: 1-100 µm

Nutrient rich environments in wastewater treatment plants help contribute to the growth and blooms of cyanobacteria (blue-green algae) in these facilities. While this algae has been previously used as biomass in biofuel applications, it can also reduce the overall efficacy of treatment processes by trapping organic material and clinging to surfaces of filtration units. A wastewater treatment plant in Tampakan, Philippines has reported a particularly abundant population of toxic blooms due to the city's equatorial climate and consistently high temperatures that help to foster algae growth in both the facultative and maturation ponds of the plant. The bacteria produce high levels of the heptatotoxin, microcytin, which have had negative health effects on local livestock that ingest the recycled water outputted by the plant. Your task in your design group is to design a filtration system for the wastewater treatment plant that monitors and prevents the proliferation of the toxic cyanobacteria levels.

Milestone Zero: Team Development

Assessment Type: Team
Time Allotted: Week 1 Design Studio (DS-1)
Submission Deadline: 11:59 PM the day of DS-1

Objectives and Requirements

For Milestone Zero, your team is required to formally document your team's personnel and the administrative roles and responsibilities each member will take on for the duration of the project. This formal documentation process is in the form of a **Team Charter**. Complete your charter on the *Team Charter* worksheet. Your worksheet must include the following:

1. **Team Personnel**: Record each team member's name (preferred name) and MacID in the Team Personnel table on the **Milestone 0 Cover Page worksheet** located in the **Milestone 0** section of the *P2 Worksheets (TEAM).docx* document.
2. **Team Portrait**: Take a selfie with your team, be creative! Upload your photo on the **Cover Page worksheet**.
3. **Project Leads**: *As a team*, come to an agreement on who will take the **Lead** for each administrative task (**M**anager, **A**dministrator, **C**oordinator, **S**ubject Matter Expert)
   → Record each team members name next to their assigned role in the *Project Leads* table on the **Team Charter worksheet**.
      - For a team of 5 students, there will be **two (2) Subject Matter Experts**
      - Otherwise, there can only be one team member for each role
   → Each team member must sign next to their name, indicating their acceptance of the expectations and responsibilities specific to their assigned role
      - Refer to the *Administrative Roles and Responsibilities* section
   → Team Manager ONLY: Complete the Preliminary Gantt Chart outlining the schedule and deliverables for the project.

Submission Details

1. **Project Administrator ONLY**:
   - Save your Milestone 0 (Team) *Cover Page*, *Team Charter* and the Preliminary Gantt Chart as a single PDF and submit it to the Avenue Dropbox titled **P2 Milestone 0 (Team)**
      - Use the following naming convention: **TeamID_P2_Milestone0.pdf**
      - This is a *team* submission that is the responsibility of the project *Administrator*
         - Submit all files as a **Group** on Avenue

Grading of Milestone Zero

Milestone Zero is graded on a **Pass/Fail** basis. Failure to submit all worksheets will result in a **10% deduction to your Project 2 grade**.

Milestone One: Problem Statement

Assessment Type: Team
Time Allotted: Week 1 Design Studio (DS-1)
Submission Deadline: 11:59 PM the day of DS-1

Objectives and Requirements

For Milestone One, your team will formulate a problem statement which defines the main function(s) of a **wastewater treatment facility**. The other outcome of this design studio is a set of clear objectives that can be considered for the design of a **wastewater treatment facility**.

Note: Your team will use this important information for the **wastewater treatment facility** design in the later weeks; there is no need to think of the final solution at this stage. A "solution-driven" approach to engineering often does not yield the best final design.

Note: You will be focusing only on a **wastewater treatment facility** in this milestone. For Milestone 2, you will focus more specifically on a wastewater ***filter***.

1. **Stage 1 (During DS-1)**: As *an individual, draft* an **initial problem statement** for the design of a wastewater treatment facility. The initial problem statement should focus on the main functions(s) of the facility, and not the filter. Complete the **Initial Problem Statement worksheet** located in the **Milestone 1** section of the *P2 Worksheets (INDIVIDUAL).docx* document.
2. **Stage 2 (During DS-1):** Discuss your assigned engineering scenario as a team. Create an **objective tree of a wastewater treatment facility for the assigned scenario. Each branch of your objective tree should have at least 3 layers. Complete and append your** objective tree on the **Objective Tree worksheet**, located in the **Milestone 1** section of the *P2 Worksheets (TEAM).docx* document.
3. **Stage 3 (During DS-1)**: As *a team*, prepare a **revised problem statement** for the design of a wastewater treatment facility. The problem statement should focus on the main functions(s) of the facility, and not the filter. Complete the **Problem Statement worksheet** located in the **Milestone 1** section of the *P2 Worksheets (TEAM).docx* document.

Note: Below is a quick guide that can be used to complete these tasks.

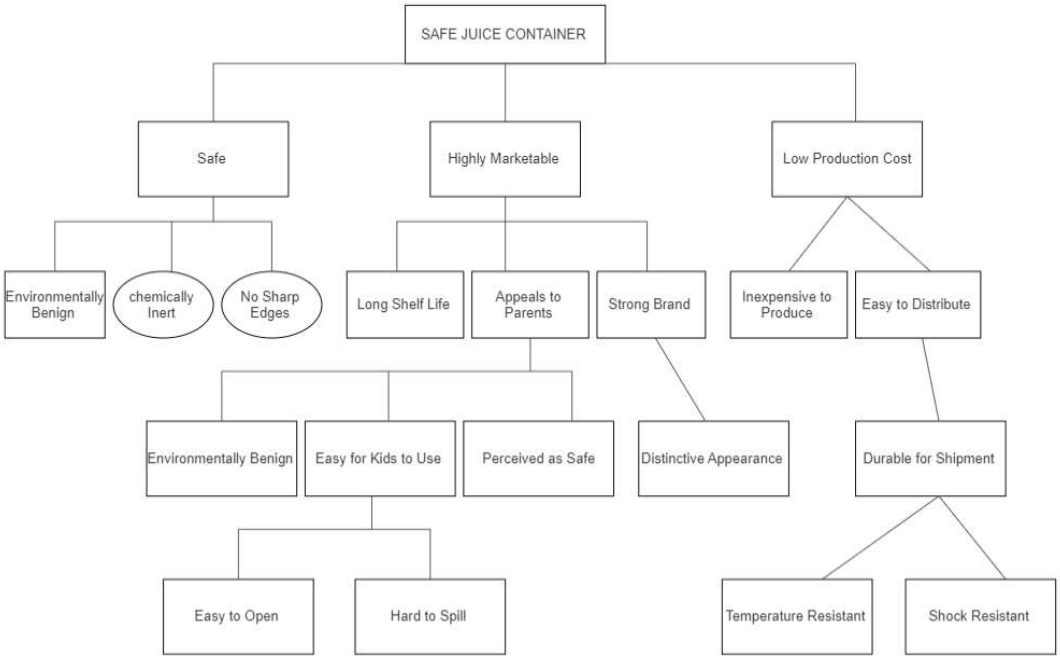
Function, constraints, and objectives:
Here is a reminder of some definitions:

- **Function**: "What does the component do?"
- **Constraints*****: "What non-negotiable conditions must be met?", "What are some negotiable but desirable conditions?"
- **Objective**: "What is to be maximized or minimized?", "What attributes are desirable?"

* It is sometimes useful to distinguish between "hard" and "soft" constraints. Dimension and Manufacturing Process might be absolute requirements (hard constraints); cost might be negotiable (a soft constraint).

Objective tree:
An **objective tree** is used to capture the criteria that the client/user would use to compare and contrast proposed designs. It is a visual representation of the relationships between objectives of a varying level of detail. An objective is a feature or behavior that the design should possess or exhibit. When in doubt, think adjectives!

Reading from top to bottom answers the question "**How** do we achieve the above goal?", e.g., how do we make a safe juice container. Reading from bottom to top explains "**Why** are we doing this?", e.g., why should a juice container be easy to open. Both questions should be answered with a new objective.



A **constraint** is defined as a limit or restriction on a design's behaviors or attributes. Often, stating a constraint can help you think about objectives to be placed on the tree. However, this does not imply that constraints can be copied word-for-word into an objective tree. Objectives and constraints must be clearly distinguished from each other on the tree. In the example above, the constraints (chemically inert and no sharp edges) are clearly distinguished by being **placed in an oval instead of a rectangle.** Note that in the above example, the middle and right branches have **4 layers** while the left one only has **2 layers**.

Submission Details

2. **Each Team Member**:
    - Save your Milestone 1 (Individual) worksheets, including the *Cover Page* and *Individual Problem Statement worksheets* as a single PDF, and submit it to the *Avenue Dropbox* titled **P2 Milestone 1 (Individual)**.
        - Use the following naming convention: **macID_P2_Milestone1.pdf**
3. **Project Administrator ONLY**:
    - Save your Milestone 1 (Team) worksheets, including the *Cover Page*, *Team Charter*, *Problem Statement*, and *Objective Tree* worksheets as a single PDF, and submit it to the *Avenue Dropbox* titled **P2 Milestone 1 (Team)**.
        - Use the following naming convention: **TeamID_P2_Milestone1.pdf**
        - This is a *team* submission that is the responsibility of the project *Administrator*
            - Submit all files as a **Group** on Avenue
        - Files missing from your submission will not be graded. **No exceptions**!

Grading of Milestone One

Milestone One is graded on a **Pass/Fail** basis. Failure to submit all worksheets will result in a **10% deduction to your Project 2 grade.**

PROJECT 2 MILESTONE 1 INDIVIDUAL RUBRIC

Criteria	Level 1	Level 2	Level 3	Level 4
Individual Problem Statement	Missing or in an unreadable format.	Readable statement, but concept of function is misunderstood.	Correctly identified the functions(s) of wastewater treatment plant technology, but statement is not concise and contains irrelevant information.	Well-written and concise statement that briefly and accurately identifies the the main function(s) of wastewater treatment plant technology.

List of Penalties	Deduction
Missing Names, MacIDs, Team Identifier	**–10% per occurrence**
Late Penalty	**–20% per day**
Submitted extra worksheets	**-10%**

PROJECT 2 MILESTONE 1 TEAM RUBRIC

Criteria	Level 1	Level 2	Level 3	Level 4
Objective Tree Comprehensiveness (2x)	Only one level of branches and inappropriate objectives present.	Not thorough (2 level of branches) - Inappropriate objectives present.	All obvious and common objectives are presented - at least 3 level of branches.	Wide range of relevant objectives are presented, Demonstrates above average insight into primary user.
Objective Tree Hierarchy (2x)	Fewer than 3 levels, including top-level goal.	Complete objective tree but students showed not understand of how/why hierarchy at all.	Goal at the top, mostly organized correctly (with minor error in how/why hierarchy).	Reading down answers how and reading up answers why for all of the provided objectives - Organized completely.
Problem Statement Content (Who/ what)	Client/ user is not defined, and the main function is not mentioned.	Fails to mention client/user, fails to clearly/ correctly mention function trying to be accomplished and objectives are not comprehensive.	Clearly mentions client/user, fails to clearly/ correctly mention function trying to be accomplished or objectives are not comprehensive.	Clearly mentions client/user, Clearly/ correctly mentions function trying to be accomplished and objectives are comprehensive.
Problem Statement Content (Where/ Why)	Does not mention where (environment it will be used in) nor why (reason for solving problem).	Does not mention one of where or why.	Attempts to mention where and why but is unclear/ not entirely correct.	Clearly and correctly mentions where (environment it will be used in) and why (reason for solving problem).
Problem Statement Accuracy	Unclear, does not make sense, or is a technical problem. Contains an implied solution.	Does not contain an implied solution. Contains lots of error bias.	Does not contain an implied solution. Contains only a few errors/ biases.	Does not contain an implied solution, Contain no errors or biases.

List of Penalties	Deduction
Missing Names, MacIDs, Team Identifier	**–10% per occurrence**
Late Penalty	**–20% per day**
Submitted extra worksheets	**-10%**

Milestone Two: Metrics and Regulations

Assessment Type: Individual (Stage 0) + Team (Stages 1, 2, and 3)
Time Allotted: *During* Week 2 Design Studio (DS-2)
Submission Deadline: 11:59 PM the day of DS-2

Objectives and Requirements

Your team will be assigned one scenario at the beginning of Design Studio 2. You will be working on this scenario only for all the activities of Design Studio 2.

0. **Stage 0 (Before DS-2)**: *Each team member* is required to write a *one-page* **literature research memo**. This will be used to start your team activities during DS-2. In the research assignment you will be summarizing the current state of filtration technology. You must have 2-4 references from various online sources (following IEEE notation). Complete your research memo on the **Pre-Project Research Memo worksheet** located in the **Milestone 2** section of the *P2 Worksheets (INDIVIDUAL).docx* document.
1. **Stage 1 (During DS-2)**: As a *team*, **generate a set of metrics for your filter**. These metrics are meant to evaluate the top 3 objectives you identified in Milestone 1. List the metrics for each objective on the **Metrics worksheet** located in the **Milestone 2** section of the *P2 Worksheets (TEAM).docx* document. Below are some guidelines meant to help you complete this task.

> **Metrics**:
> Objectives, or design goals, are the desired attributes of the design (i.e., what the design will "be" and what qualities it will have). Objectives allow exploration of the design space to select amongst alternatives that are at least acceptable or satisfactory.
>
> How do you know how to evaluate the objectives in different design alternatives?
> - Metrics help measure the degree to which objectives are achieved
> - Metrics can be specific, **quantifiable**, and include units of measurement when applicable
> - Metrics can also be **qualitative** in cases where there is no direct measurement available

> **Example of Establishing Metrics for a Given Objective**:
>
> Objective: Device should be Easy to Use
>
> Metric: Rating of how long an average user takes to learn the device
> - Let's select a range from 0 (worst) to 100 (best)
>
> Units: Number of minutes it takes for an average user to learn to use the device
> - 0-2 Minute(s): 100 points
> - 2-4 Minutes: 75 points
> - 4-10 Minutes: 50 points
> - 10-15 Minutes: 25 points
> - 20+ Minutes: 0 points

2. **Stage 2 (During DS-2)**: As a *team*, identify means to achieve the following functions: Remove contaminants, regulate flow, and [add two more functions]. For the "remove contaminants" function means should be realistic but this is not required for the other functions.

Functions	Means			
Remove Contaminants				
Regulate Flow				

3. **Stage 3 (During DS-2)**: As a *team*, discuss the regulations and policies engineers must adhere to depending on the location of your assigned scenario. Take notes on matters such as regulations for material acquisition, contaminants/waste standards, electricity standards, optimal energy output range depending on the electrical systems that need to be powered as discussed in your scenario. Please note your discussions in *P2 Worksheets (TEAM).docx* document. Ensure that your notes are thorough and complete since you will reflect on your findings on the final report for project 2. Below are some links to initiate your research, and you are welcome to conduct further investigation at your discretion.
    a. ***Scenario 1:***
        i. Filter Regulations - Health Canada
    b. **Scenario 2:**
        i. Filter Regulations - Health Canada
    c. **Scenario 3:**
        i. Wastewater Management Guidelines - Australia
    d. **Scenario 4:**
        i. Water Quality Guidelines - Philippines

Submission Details

1. **Each Team Member**:
   - Save your Milestone 2 (Individual) worksheets, including the *Cover Page* and *Research Memo* as a single PDF, and submit it to the *Avenue Dropbox* titled **P2 Milestone 2 (Individual)**.
     → Use the following naming convention: **macID_P2_Milestone2.pdf**

1. **Project Administrator ONLY**:
   - Save your Milestone 2 (Team) worksheets, including the *Cover Page*, and worksheets for **Stages 1-to-3** as a single PDF, and submit it to the *Avenue Dropbox* titled **P2 Milestone 2 (Team)**.
     → Use the following naming convention: **TeamID_P2_Milestone2.pdf**
     → This is a *team* submission that is the responsibility of the project *Administrator*
       - Submit all files as a *Group* on Avenue
     → Files missing from your submission will not be graded. **No exceptions**!

Grading of Milestone Two

Milestone Two is worth **1/8 marks of your total Project 2 grade (12.5%).** Each team member will receive their own grade for Stage 0 of the Milestone (0.5/8 marks). All team members will receive the same grade for Stage 1,2,3 of the Milestone (0.5/8 marks). Failure to submit all worksheets will result in a **10% deduction to your Project 2 grade.** Rubrics are provided on the following pages.

PROJECT 2 MILESTONE 2 INDIVIDUAL RUBRIC

Criteria	Level 1	Level 2	Level 3	Level 4
Pre-Design Studio Individual Research Memo	Missing or in an unreadable format.	Complete content but text is poorly written, shows lack of research or is factually wrong.	Complete content, summary of technology is easy to understand.	Meeting all expectations (see column "3"), plus includes references in proper IEEE format.
Academic Integrity	Copied directly from source. Did not paraphrase.	Did not copy directly from source. Properly paraphrased.		
Followed Template	Did not use the worksheet.	Used the worksheet.		

List of Penalties	Deduction
Missing Names, MacIDs, Team Identifier	**–10% per occurrence**
Late Penalty	**–20% per day**
Submitted extra worksheets	**-10%**

Project 2 Milestone 2 Team Rubric

Criteria	Level 1	Level 2	Level 3	Level 4
Metrics	No valid metrics/ units.	Valid metrics/ units for 1 objective only.	Valid metrics/ units for 2 objectives only.	Valid metrics/ units for 3 objectives.
Morphological Analysis - Functions	Less than two valid functions are listed OR more than one function is solution oriented.	Lists two valid functions and at least one function is too specific.	Lists at least two valid and solution-neutral functions.	
Morphological Analysis - Means	At least two unrealistic means for Remove Contaminants function or missing at least two means for any functions.	One unrealistic mean for Remove Contaminants function or a missing mean for any function.	Sufficiently lists means for all functions **AND** all means for the Remove Contaminants function are realistic.	Level 3 is met **AND** means cover a wide range of different possible solutions.
Regulations	Inadequate or missing discussion on key regulations.	Basic discussion covering at least 1 regulation (material acquisition, contaminants/waste standards, electricity standards, optimal energy output) with limited detail.	Good discussion covering at least two relevant regulations (material acquisition, contaminants/waste standards, electricity standards, optimal energy output) with clear notes.	Thorough discussion covering at least three relevant regulations (material acquisition, contaminants/waste standards, electricity standards, optimal energy output).
Discussion of Sustainable Choices and Compliance with Regulations	Discussion is very poor, non-existent, or not related to good sustainable practice and/or scenario-relevant regulations.	Discussion is unclear and only addresses some long-term sustainability considerations and scenario-relevant regulations.	Discussion addresses long-term sustainability considerations and scenario-relevant regulations.	Discussion addresses long-term scenario-relevant sustainability considerations and regulations. Insightful and/or thoughtful considerations going beyond what is discussed in class.

List of Penalties	Deduction
Missing Names, MacIDs, Team Identifier	**–10% per occurrence**
Late Penalty	**–20% per day**
Submitted extra worksheets	**-10%**

Milestone Three: Conceptual Design – Material Selection

Assessment Type: Individual (Stage 2) + Team (Stage 1)
Time Allotted: *During* Week 3 (DS-3)
Submission Deadline: 11:59 PM the day of DS-3

Objectives and Requirements

For Milestone Three, you are required to perform a material selection for your filter fibers, based on your *assigned* scenario. Rank which materials (i.e. "material candidates") have properties most suitable for a particular application by using a material performance index (MPI).

→ *Recall*: an MPI is a numerical index that evaluates how well a material performs based on a single **function**, **constraint**, and **objective** for a given engineering application
- We will discuss the derivation of an MPI in both lectures and lab activities

→ A total of 8 possible material performance indices (MPIs) will be provided by your IAIs
- This includes different combinations of **constraints** (stiffness- and strength-limited) and **objectives** (lightweight, economical, low energy in manufacturing, and low carbon footprint in manufacturing)

During lab B in Wk-2, the IAIs and TAs walked you through an example of material selection process in designing a lightweight turbine blade for a stiffness-limited design. The Wk-2 lab is meant to prepare you for Milestone 3 by helping you become familiar with:

→ The concept of function, constraints, and objectives,
→ Translating qualitive design statement into physical equations of material selection,
→ Deriving a material performance index (MPI), and
→ Selecting a material using the ANSYS-Granta EduPack material selector (Figure 5)

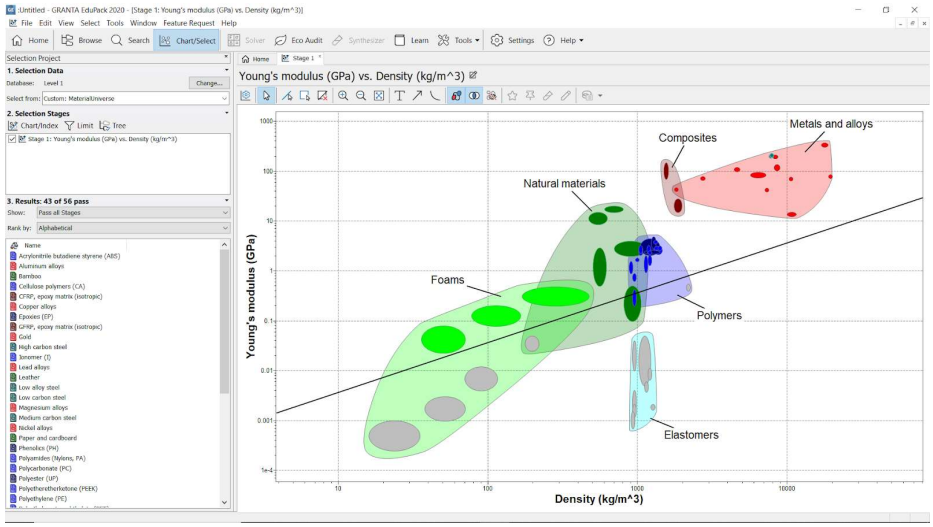


Figure 5. A screenshot of the Granta EduPack interface

IMPORTANT: **For those using the virtual machines, make sure to save your work by printing page to pdf in the EduPack software and emailing it to yourselves. Please refer to the Granta Troubleshooting and Q&A document on Avenue if you need any help.**

1. **Stage 1 (During Wk-3)**: As a *team*, discuss and determine one primary objective and one secondary objective for your *assigned* scenario. *For each objective* (2 in total), **your team is required to list the Material Performance Index (MPI)** for 2 assigned constraints: *stiffness-limited design* and *strength-limited design*. List the MPI for each objective and each assigned constraint (4 MPI's in total) on the **Material Selection: Problem Definition worksheet** located in the **Milestone 3** section of the *P2 Worksheets (TEAM).docx* document.
   → Write a short justification for each objective to explain why you feel they are the most suitable ones for your assigned scenario

   NOTE: A list of MPI formulas will be provided to you. You will first need to derive the "minimize mass" MPI for both Yield Strength and Young's Modulus.

2. **Stage 2 (During Wk-3)**: Each *team member* is required to **perform a materials selection for *one* MPI identified in Stage 1**, using the ANSYS-Granta EduPack material selector.
   → **Save a PDF of the material property chart** for your assigned MPI. Insert a screenshot of the material property chart on the **Material Selection: MPI and Material Ranking worksheet** located in the **Milestone 3** section of the *P2 Worksheets (INDIVIDUAL).docx* document.
   → Please note the following when using the ANSYS Granta EduPack material selector:
      - The material database should be **Materials Science and Engineering**
      - Consider how the material might alter when exposed to water or varying acidity levels. Additionally, evaluate its processability to ensure you can make it porous. Finally, consider how recyclable the material is.

   Rank the top 5 materials for your assigned MPI based on their index value. List the top 5 materials on the **Material Selection: MPI and Material Ranking worksheet**.
   ****For teams of *3***, your team is only required to complete one material selection selection but a total of four MPIs where the fourth one you will do as a group.

   ****For teams of *5***, two members will create a material property chart for the same MPI but should work individually and submit their individual works separately.

Submission Details

1. **Each Team Member**:
   - Save your Milestone 3 (Individual) worksheets, including the *Cover Page* and *Material Selection: MPI and Material Ranking* worksheets as a single PDF, and submit it to the *Avenue Dropbox* titled **P2 Milestone 3 (Individual)**.
     → Use the following naming convention: **macID_P2_Milestone3.pdf**
     → The Project Administrator must submit a copy as well
2. **Project Administrator ONLY**:
   - Save your Milestone 3 (Team) worksheets, including the *Cover Page*, and *Problem Definition* worksheets as a single PDF, and submit it to the *Avenue Dropbox* titled **P2 Milestone 3 (Team)**.
     → Use the following naming convention: **TeamID_P2_Milestone3.pdf**
     → This is a *team* submission that is the responsibility of the project *Administrator*
       - Submit all files as a **Group** on Avenue
     → Files missing from your submission will not be graded. **No exceptions**!

Grading of Milestone Three

Milestone Three is worth **1.5/8 marks of your total Project-1 grade (19%).** Each team member will receive their own grade for Stage 2 of the Milestone (0.5/8 marks). All team members will receive the same grade for Stage 1 of the Milestone (1/8 marks). Rubrics are provided on the following pages.

PROJECT 2 MILESTONE 3 INDIVIDUAL RUBRIC

Criteria	Level 1	Level 2	Level 3	Level 4
Summary of Material selection, MPI (1,2,3, or 4)	Missing document, or unreadable with a lot of grammatical errors.	Properties match the MPI in the table. But error in drawing the slope of MPI in the plot. Figure is unclear (e.g., too pixelated to read).	Properties match the MPI in the table. Properly show the slope of the MPI. Figure is clear, but material labels are missing.	Properties match the MPI in the table. Properly show the slope of the MPI. Figure is clear and material labels are clear.

List of Penalties	Deduction
Missing Names, MacIDs, Team Identifier	**–10% per occurrence**
Late Penalty	**–20% per day**
Submitted extra worksheets	**-10%**
Incorrect File Format	**-10%**

PROJECT 2 MILESTONE 3 TEAM RUBRIC

Criteria	Level 1	Level 2	Level 3	Level 4
Technical Objectives (justification of chosen MPIs)	Missing document, unreadable, or technical objective makes no sense and MPI and objectives do not match.	Only one technical objective makes sense. MPI and objective match.	Both selected technical objectives make engineering sense. Justification is reasonable, with only a small degree of error.	The selected technical objectives make engineering sense. On top of that, justification is well thought out and clearly stated.
MPI and Limits	MPI done incorrectly.	MPI done correctly without specific limits.	MPI done correctly with specific limits.	MPI done correctly with specific limits and scenario specific limits.

List of Penalties	Deduction
Missing Names, MacIDs, Team Identifier	**–10% per occurrence**
Late Penalty	**–20% per day**
Submitted extra worksheets	**-10%**
Incorrect File Format	**-10%**

Milestone Four: Material Selection and Porosity Calculations

Assessment Type: Team (Stages 1-3)
Time Allotted: *During* Week 4 Design Studio (DS-4)
Submission Deadline: 11:59 PM the day of DS-4

Objectives and Requirements

For Milestone Four, you are required to choose a material (i.e. "material candidates") for your filter design. In Milestone 3, you will have produced a short list of top five performing materials based this MPI. You will be asked to consolidate these materials as a *team* and discuss additional criteria to evaluate their performance under your engineering scenario. Additionally, you will be asked to apply porosity calculations and determine if they have affected your material's suitability should they fall under a specific performance threshold based on its adjusted elastic modulus / yield strength.

1. **Stage 1 (During DS-4)**: As a *team*, you are required to consolidate your rankings, narrow down the material candidate list, and discuss additional engineering considerations (beyond mechanical performance) that are relevant to your *assigned* scenario.
    a. **Consolidate your individual material rankings from Milestone 3.** List the rankings for each team member on the tables provided in **Material Selection: Material Alternatives and Final Selection worksheet** located in the **Milestone 4** section of the *P2 Worksheets (TEAM).docx* document.
    b. **Narrow down the material candidate list to 3 finalists** by choosing the 3 materials which showed up the most across all MPI rankings. Save the material datasheet for each finalist as a PDF and distribute amongst all team members. Record the 3 finalists on the **Material Selection: Material Alternatives and Final Selection worksheet** located in the **Milestone 4** section of the *P2 Worksheets (TEAM).docx* document.
    c. **Evaluate your three material finalists** against your objectives, constraints and/or any other criteria relevant to your assigned scenario. Perform your evaluation using the *Decision Matrix* provided to you and **select one material** to be used for the rest of your design process. Complete the **Material Selection: Material Alternatives and Final Selection worksheet** located in the **Milestone 4** section of the *P2 Worksheets (TEAM).docx* document.
        i. Discuss and justify your choice of material based on the results from your decision matrix and any other relevant criteria. Feel free to refer to the material finalists' datasheets for any relevant information that will enable your discussion.
        ii. Your MPI ranking takes into consideration both material and mechanical properties relevant to the objectives of your assigned scenario.

2. **Stage 2 (During DS-4)**: As a team, you are required to apply porosity conditions to your selected material.
    a. From Granta, **determine the relevant material properties** of your selected material from Stage 1 under Mechanical Properties.
        i. If your material provides a range of values for Young's Modulus or Yield Strength, take the average of the highest and lowest limit provided.
    b. Calculate the porosity of the material.
        i. Recall: Values that will be helpful for this calculation include the diameter and thickness of the filter fibers (which are provided in the Project Module in the Design Scenarios section

in Pg. 9-10) as well as the particle radius of the contaminant based off your assigned scenario.

c. Once the porosity has been calculated, **determine the effective Elastic Modulus or Yield Strength** and compare this to the original value based on the material properties from Granta.

Consider the following equations for this Stage:

i. $E_{Effective} = E(1 - P)^n$

ii. $\sigma_{y,effective} = \sigma_y(1 - P)^n$

iii. $P = \frac{(\#\ of\ Pores \cdot Volume\ of\ a\ Singular\ Pore)}{Volume\ of\ Filter\ Fiber}$

3. **Stage 3 (During DS-4)**: As a team, you are required to evaluate whether the inclusion of porous conditions for your material has affected its suitability to be used as a filter for your scenario.

a. Compare the EFFECTIVE elastic modulus / yield strength of your material determined from Stage 2 to the material's performance on the Ashby chart.

i. You may assume that the density of the material stays the same, and for materials with ranging density values, you may take the average or middle density value.

ii. Note: Your EFFECTIVE elastic modulus / yield strength should be lower than the value of the original material since you are making it porous

iii. Evaluate whether the material with porous conditions falls below suitable performing conditions in relation to the index line within the Ashby chart

iv. You must provide graphical justification in your explanation to achieve full marks.

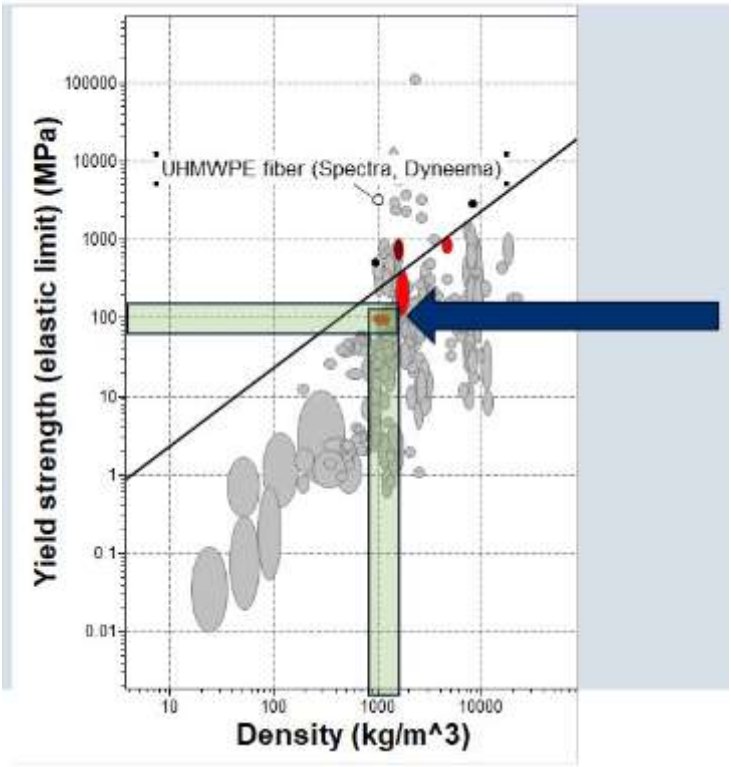


Figure 5. Analysis of the decrease for yield strength for UHMWPE fiber because of porous calculations. The positioning of the value below the index line indicates that it falls below the performance required for material consideration.

Submission Details

1. **Project Administrator ONLY**:

   - Save your Milestone 3 (Team) worksheets, including the *Material Alternatives and Final Selection* and *Porosity Calculations and Performance Justification* worksheets as a single PDF, and submit it to the *Avenue Dropbox* titled **P2 Milestone 4 (Team)**.
     → Use the following naming convention: **TeamID_P2_Milestone4.pdf**
     → This is a *team* submission that is the responsibility of the project *Administrator*
       - Submit all files as a **Group** on Avenue
     → Files missing from your submission will not be graded. **No exceptions**!

Grading of Milestone Four

Milestone Four is worth **2/8 marks of your total Project-2 grade (25%).** All team members will receive the same grade for Stages 1,2 3 of the Milestone (2/8 marks). Rubrics are provided on the following pages.

PROJECT 2 MILESTONE 4 TEAM RUBRIC

Criteria	Level 1	Level 2	Level 3	Level 4
Summary of Material Ranking (3.5x)	Missing document, or unreadable figures.	Table is complete and readable, but the top ranked materials do not make engineering sense (e.g., say foam or very soft polymer as high stiffness materials or say very expensive material like gold for an economical design).	For each MPI, the top ranked materials are mostly correct, with only a small degree of error.	For each MPI, the top ranked materials are 100% correct without any errors.
Decision Matrix (1.5x)	Missing or unreadable document.	Less than three materials evaluated, or less than three additional criteria considered or improper use of decision matrix	Appropriate use of decision matrix with all three materials evaluated and all three additional criteria considered	Excellent use of decision matrix with all three materials evaluated and more than three additional criteria considered
Final Justification (1.5x)	Missing document, or unreadable with a lot of grammatical errors. Did not summarize the findings effectively.	Effectively summarized the findings but did not explain how the MPI and decision matrix were used to justify the material selection. Little to no mention of additional considerations.	Effectively summarized the findings and showed understanding of the purpose of the MPI and the decision matrix. Some mention of additional considerations.	Effectively summarized the findings and showed understanding of the purpose of the MPI and the decision matrix in material selection. Relevant and well-thought-out discussion of additional considerations.
Summary of Chosen Material's Properties	Missing or unreadable.	Incomplete, and material name and properties are inconsistent.	Complete, and material name and properties are largely consistent (with only small errors).	Complete, and material name and properties are consistent.
Calculations	Both porosity or adjusted Young's Modulus/Yield strength are calculated incorrectly. Calculations are incomplete or no work or derivation is shown.	Either porosity or adjusted Young's Modulus/Yield strength are calculated incorrectly. Some work is shown, but steps are difficult to follow. Approach is not justified and unclear.	Porosity and adjusted Young's Modulus/Yield Strength are calculated correctly but steps are somewhat difficult to follow. Approach is not justified or unclear.	Porosity and adjusted Young's Modulus/Yield Strength are correctly calculated. Work flows logically and steps are easy to follow. Appropriate values are referenced from the project module and approach is justified.
Porous Material Performance Verification	Effect of porous conditions on material is poorly explained or incomplete.	Effect of porous conditions on material is explained. No graphical justification is provided.	Effect of porous conditions on material is effectively explained along with a graphical justification.	

List of Penalties	Deduction
Missing Names, MacIDs, Team Identifier	**–10% per occurrence**
Late Penalty	**–20% per day**
Submitted extra worksheets	**-10%**

Incorrect File Format	**-10%**

Milestone Five: Design Embodiment – Eco Audit

Assessment Type: Team
Time Allotted: *During* Week 5 Lab A and Design Studio (DS-5)
Submission Deadline: 11:59PM on Saturday, February 8th, 2025

Objectives and Requirements

For Milestone 5, you are required to:

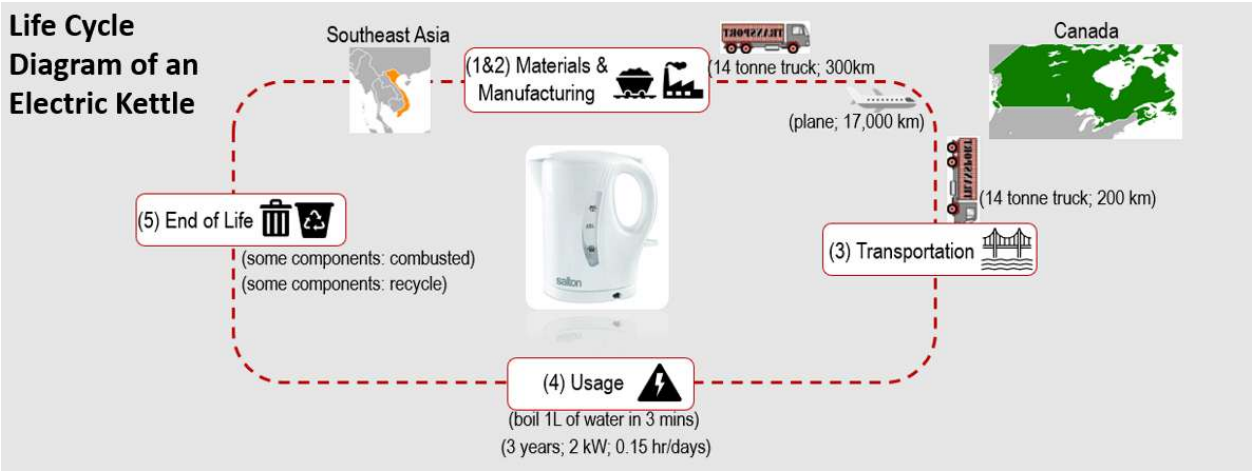
1) Create a life cycle diagram for your design

2) Provide a Life Cycle Inventory

3) Complete an Eco Audit in Granta.

1. **Stage 1 (During Lab A):** *Individually*, **create a life cycle diagram for your design.** See Figure 6 for an example. This diagram should address all 5 steps of a product life cycle: Raw material extraction, Manufacturing & Processing, Transportation, Usage and Waste Disposal. **Your submitted file should be a pdf.**
    - → Each group member should select one of the **top 3** materials from your previous milestones, ensuring there is a LCA available for each material
    - → Be sure to use academic papers when conducting research (refer back to DCW2) and use in-text citations
    - → For this DS, we will be using a **Gate-Grave** LCA where the material originates from a company instead of from extraction
    - → Your TAs and IAIs will be providing feedback along the way

Figure 6. Example level of detail for a Life Cycle Diagram for an Electric Kettle



1. **Stage 2 (During DS-5):** As a *team*, **provide a complete life cycle inventory for your design.** See Table 3 for an example. The LCI should consider all details referenced in your life cycle diagram. Your components should be listed as masses (hint: use density to convert volumes to corresponding masses). Be sure to

include your references in IEEE. Complete the **Life Cycle Inventory** located in the **Milestone 5** section of the *P2 Worksheets (TEAM).docx* document.

2.

Table 3. Example level of detail for a Life Cycle Inventory for an Electric Kettle

Material	Mass (kg)	Process	End of Life
Polypropylene (PP)	0.3631	Polymer Molding	Combustion
Polyoxymethylene	0.0171	Polymer Molding	Combustion
Stainless Steel	0.0749	Roll Forming	Recycle

3. **Stage 3 (During DS-5):** As a team, complete an Eco Audit for your top 3 materials in Granta. Complete the **Eco Audits** located in the **Milestone 5** section of the *P2 Worksheets (TEAM).docx* document.
   → Be sure to include all modes of transportation required to get from Gate to Grave.

4. **Stage 4 (During DS-5):** Discuss the implications of these results influence your material selection in the overall filter design. Complete the **Discussion of Eco Audit Implications** located in the **Milestone 5** section of the *P2 Worksheets (TEAM).docx* document.

Milestone Submission Details

1. **Each Team Member**:
   - Save your Milestone 5 (Individual) worksheets, including the *Cover Page* and *Material Selection: MPI and Material Ranking* worksheets as a single PDF, and submit it to the *Avenue Dropbox* titled **P2 Milestone 5 (Individual)**.
     → Use the following naming convention: **macID_P2_Milestone5.pdf**
     → The Project Administrator must submit a copy as well
2. **Project Administrator ONLY**:
   - Save your Milestone 5 (Team) worksheets, including the *Cover Page* and *Design Embodiment* worksheet as a single PDF, and submit it to the *Avenue Dropbox* titled **P2 Milestone 5 (Team)**.
     → Use the following naming convention: **TeamID_P2_Milestone5.pdf**
     → This is a *team* submission that is the responsibility of the project *Administrator*
       - Submit all files as a *Group* on Avenue
     → Files missing from your submission will not be graded. **No exceptions**!

Grading of Milestone Five

Milestone Five is graded on a **Pass/Fail** basis. Failure to submit all worksheets will result in a **10% deduction to your Project 2 grade**. Rubrics are provided on the following pages.

PROJECT 2 MILESTONE 5 INDIVIDUAL RUBRIC

Criteria	Level 1	Level 2	Level 3	Level 4
Life Cycle Diagram		Missing, unreadable or incomplete document.	Completed life cycle diagram in a clear and organized format.	

PROJECT 2 MILESTONE 5 TEAM RUBRIC

Criteria	Level 1	Level 2	Level 3	Level 4
Life Cycle Inventory		Missing, unreadable or incomplete (lack of citations).	Inventory is complete with three top materials but lacks citations. Work for mass calculation is either not shown or is incorrectly determined.	Inventory is complete with three top materials along with cited information on processes and end-of-life. Work for mass calculation is shown and correct.
Eco Audit		Missing or incomplete.	Screenshot of Eco Audit summary graph and energy cost and CO2 footprint table provided.	
Implications	Missing or unreadable discussion on explanation.	Some details provided on Eco Audit implications for material selection but fails to incorporate numerical data from Granta or effectively summarize findings.	Detailed discussion on Eco Audit implications for material selection along with reference to Granta data. Effective summary of findings and consideration of energy costs / carbon footprint from Eco Audit.	Detailed discussion on Eco Audit implications for material selection along with references to Granta data. Connection is made to the impact on previous design stages beyond referencing the Eco-Audit. Effective summary of findings and consideration of energy costs / carbon footprint from Eco Audit.

List of Penalties	Deduction
Missing Names, MacIDs, Team Identifier	**–10% per occurrence**
Late Penalty	**–20% per day**
Submitted extra worksheets	**-10%**
Incorrect File Format	**-10%**

Design Review and Work Period

Assessment Type: Team
Time Allotted: DS5/Own Time

Stage 1 (During DS-5) - Design Review: Your team will present their porosity calculations to their TA. TAs and teams will go through calculations together to ensure every team is on the right track. Teams will then spend a few minutes with their mentors discussing the status of their project to ensure all teams can complete a successful final report and presentation.

Stage 2 (During DS-5) – Work Period: Teams are to use this time to ensure Milestones 1-5 are complete (if you have not attended lab A for Milestone 5, use this time to get familiar with the lab material). Once all Milestones are complete, teams should use this time to work on their final report and prepare their final presentation.

Final Presentation

Assessment Type: Team
Time Allotted: DS-5 + Own Time
When: Lab-A (Week of Monday, February 10, 2025 to Friday, February 14, 2025)

Objectives and Requirements

As a *team,* you are required to present your design during Lab-A to the rest of your section, TAs, and IAIs. **You will have 7 minutes to present with 1-2 minutes for questions.** The goal of these presentations is to explain how you arrived at your design choices and justify them using a combination of elements from all previous milestones including (but not limited to):

- Your Scenario
- Problem Statement, Metrics
- Sustainability Considerations
- Regulations
- Material Selection
- Porosity Choices
- Eco Audit Results

The presentation will have two parts:

1. ***Presentation***
   The presentation must meet the following requirements.
   → It must be no longer than 7 minutes.
   → All team members must be present and speak for an equal amount of time.
   → The presentation must be accompanied by a PowerPoint presentation that has the following information about your final design:
      - The project must be identified by a name for the team and design. Include team members names, their MacID's, and the team name. This information must be clearly displayed at the first slide.
      - Include task/problem your design addresses (problem statement).
      - An outline of the design's benefits and how it fits your given scenario.
      - A description of materials, costs, and construction along with their justification.
      - Description of your thought process to choose your final material
         1. It is expected that this explanation refers to the mechanical requirements, the porosity requirements and the Eco Audit results

Important Note: Reading off cue cards, scripts, devices with a script are highly discouraged during your presentation (a penalty will be applied if any of these are used during your presentation). You will have a workshop on presentations called "MS PowerPoint Fundamentals & Practice Presentations" in Design Communication Workshop #3. You will be able to use this workshop to start preparing for the project presentation but it is not expected to be the only time you work on your presentation.

2. ***Question and Answer Period***
   - → After a team has completed their presentation, the evaluators (TA's, IAI's), and other groups will have an opportunity to ask any questions they wish.
   - → All team members must be present.
   - → Ask a question for at least one group.
   - → To receive full marks for this section your team will have to ask another team at least one question

Submission Details

1. **Project Administrator ONLY**:
   - Upload a ***.PPTX** copy of your PowerPoint presentation document to the *Avenue Dropbox* titled **P2 Final Presentation - DS Day**
     - → Use the following naming convention: **TeamID_P2_FinalPresentation.pptx**
     - → **If the presentation is not uploaded by 11:59 PM of the night before your presentation day there will be a penalty applied.**
     - → This is a *team* submission that is the responsibility of the *Project Administrator*
     - → Files missing from your submission will not be graded. **No exceptions**!

Grading of Final Presentation

The Final Presentation is worth **2 marks of your total Project-2 grade (25%).** The grade will be based on how compelling your presentation is, the creativity and innovativeness of your design, and its value to the client.

Administrative Responsibilities Reminder

Each team member is expected to contribute to the various administrative responsibilities inherent in any project. To accomplish this, each design project will require team members to assume one of four *Project Lead* administrative roles. The purpose of the Project Leads is to ensure administrative responsibilities are equitably distributed amongst *all* team members. Each Project Lead will have a unique set of expectations and responsibilities. If there are any issues about the behaviour and contributions from group members, please contact prof1p13@mcmaster.ca or inform your IAIs of your concerns **before the appropriate deadline** for submissions and deadlines.

Project Two Final Presentation – Team Rubric

Criteria	1 Below Expectation	2 Marginal	3 Meets Expectation	4 Exceeds Expectation
Introduction	There is no introduction slide or no members introduce themselves.	There is an introduction slide, but the title is missing or unclear. Only some members introduce themselves.	There is an introduction slide with a title. Most members introduce themselves clearly.	There is an introduction slide with a proper presentation title. Each member introduces themselves.
Problem Definition	Multiple of the following are not provided or are incorrect: Scenario is established to the audience. Problem statement is clear and correctly constructed. Relevant regulations or sustainability concerns are mentioned.	Scenario is established to the audience. Problem statement is clear and correctly constructed. Relevant regulations or sustainability concerns are not clearly identified.	Scenario is established to the audience. Problem statement is clear and correctly constructed. Relevant regulations or sustainability concerns are mentioned.	In addition to meeting the Level 3 criteria, there were choices made that go beyond what was provided in lecture, lab, DS.
Choice of Material	The material chosen is inappropriate for the design. At least one of the following was not considered in the material choice: Mechanical requirements, scenario specific elements, environmental impacts.	At least one of the following was not considered in the material choice: Mechanical requirements, scenario specific elements, environmental impacts.	Mechanical requirements, scenario specific elements, environmental impacts were all considered in the choice.	Mechanical requirements, scenario specific elements, environmental impacts were all considered in the choice. A strong attempt was made to demonstrate an understanding of how each of these components contributed to the final choice.
Presentation Slides	Slides contain major errors and lack a logical progression. Diagrams	Slides contain minor errors and almost lack a logical	Slides logically present the main components of the project and recommendations.	Slides logically present the main components of the project and

	or graphics are absent or confuse the audience. Unacceptable number of spelling and/or grammar mistakes on slides.	progression. Material is mostly readable and the graphics reiterate some of the main ideas. Noticeable spelling & grammar mistakes on slides.	Material is readable and the graphics highlight and support the main ideas. Minimal spelling &/or grammar mistakes on slides.	recommendations. Material is readable and the graphics highlight and support the main ideas. No spelling &/or grammar mistakes. Correct use of jargon throughout slides.
Communication	Speakers are often inaudible or hesitant, often speaking in incomplete sentences.	Speakers are somewhat audible and fluent on their topic.	Speakers are mostly audible and fluent on their topic.	Speakers are audible and fluent on their topic.
Presentation Efficacy	Presentation does not flow between group members. The order of information lacks structure and is rather difficult to follow. There are no or little transitions between when moving between slides and presenters.	Presentation flows somewhat well between group members. The order of information lacks structure and is rather difficult to follow. There are no or little transitions between when moving between slides and presenters.	Presentation flows mostly well between group members. Information is presented in a logical order, but transitions are interrupted when moving between slides and presenters.	Presentation flows well between group members and is cohesive and engaging. Transitions between sections are smooth and presented in a logical order that is easy to follow.
Question/Answer Period		Speakers have difficulty responding clearly and accurately to audience questions.	Speakers respond to most questions accurately and appropriately.	Speakers respond accurately and appropriately to audience questions and comments. Team asks at least 1 appropriate question to another group.

List of Penalties	Deduction
Team member(s) not speaking equally in presentation.	**–5% for the entire team.**
Presentation not uploaded before 11:59PM EST of night before presentation.	**-5% for the entire team.**
Presentation goes over allotted time	**-10% per minute**
Speaker(s) uses notes**	**-10% for the individual(s)**

**Penalty will not be applied if student has appropriate SAS accommodations

Final Deliverable – Design Project Report

Assessment Type: Team
Time Allotted: Own Time
Submission Deadline: Saturday, February 15, 2025

Final Submission: Design Project Report

Create a **design project report** that compiles all work completed over the course of the project and summarizes your achievements. This project report should summarize your previous milestone work. Please note that you must share your *Collaborative Working Document* with the Course Instructors at prof1p13@mcmaster.ca to ensure that document revisions are accounted for.

Your report should include a **title page**, **signed academic integrity statement**, and the following sections:

1. **Finalized Problem statement**: In one paragraph, briefly describe the nature of your engineering scenario and the problem definition of your **Filter** design, including concepts such as function, engineering constraints, and high-level objectives.
2. **Justification of Technical Objectives and Material Performance Indices**: In one paragraph, briefly summarize the objective tree, objective matrix, and how your team determined the relevant material performance indices (MPIs) for your engineering scenario.
3. **Porosity Calculations**: In one paragraph, present your porosity calculations and explain why your team selected the specific pore size.
4. **Justification of Eco Audit**: In one paragraph, provide a concise summary of your Eco Audit findings and explain how your team identified the optimal solution.
5. **Conceptual Design – Justification of Selected Material**: In one paragraph, briefly summarize the material selection process. Justify how the chosen material satisfies the project objectives.
6. **Discussion of Regulations:** Please provide a brief overview of how your design complies with the regulations, policies, and socio-cultural concerns of your specific geographic location in two paragraphs. This includes allowable energy settings and allotted area, if any. If any modifications are necessary to enhance the practicality of your design, suggest potential changes and innovative technologies that can help overcome these obstacles.
7. **Discussion of Sustainable Choices:** Discuss possible long-term environmental effects of your filter design. During your design process (material selection) what are some end-of-life considerations that you could have considered regarding the materials, location and build of the filter?
8. **Concluding Remarks – Reality Check**: Briefly state what you have learned, a bring home message, and a discussion of additional engineering considerations that are worth exploring in the future.
9. **Summary of Contributions**: include a table that summarizes the contributions made by member of the group.
10. **Reference List**: A properly formatted reference list of all sources cited in the above sections. Reference list is different from Source Materials Database.
    → *Reference list* refers to the sources used for the main body of the report. *Source Materials Database* is a comprehensive list of *all* source materials and resources that have been used throughout the project.
11. **Appendices**
    - **Appendix A: Project Schedule**

- Preliminary Gantt Chart (**Manager**)
- Final Gantt Charts (**Administrator**)
- Logbook of Additional Meetings and Discussions (**Coordinator**)

- **Appendix B: Scheduled Weekly Meetings**
  - Meeting minutes
  - Meeting agenda
- **Appendix C: Comprehensive list of sources**
  - Source Materials Database (**Subject Matter Expert**)
- **Appendix D: Additional Documentation**
  - Life Cycle Inventory
- **Appendix E: Design Studio Worksheets**
  - Worksheets for all Design Studio Milestones, specifically those submitted as a team (**Administrator**)
  - You are *strongly* encouraged to save all documents (i.e., report and each milestone worksheet) as a PDF and use a free PDF combiner to combine them into 1 PDF.

You are required to complete your **design project report** using the template Word document that has been provided to you on Avenue-to-Learn

- Content > 4-Design Projects > Student Resources > **1P13_Project_Report_Template.docx**

Follow the template formatting explicitly!

IMPORTANT NOTE: For Project-2, you are not required to write an Executive Summary. In the provided template, you should include your Finalized Problem Statement in place of the Executive Summary.

Submission Details

1. **Project Administrator ONLY**:
   - Upload a ***.PDF** copy of your **design project report** to the *Avenue Dropbox* titled **P2 Design Report**
     → Use the following naming convention: **TeamID_P2_DesignReport.pdf**
     → This is a *team* submission that is the responsibility of the project *Administrator*
       - Submit all files as a ***Group*** on Avenue
     → Note that **Turnitin.com** will be used to check for plagiarism
     → Files missing from your submission will not be graded. **No exceptions**!

Grading of Design Project Report

The Design Summary is worth **2/8 marks of your total Project-1 grade (25%).** All team members will receive the same grade for the Final Deliverable. A rubric is provided on the following pages.

Project 2 Final Deliverable Team Rubric

Criteria	Level 1	Level 2	Level 3	Level 4
Finalized problem statement (2x)	Poorly written and missing at least one of the following concepts: functions, constraints, and objectives.	Stated clearly and briefly the nature of the problem. But did not have good understanding of functions, constraints, and objectives for the given scenario.	Stated clearly and briefly the nature of the problem. Showed good understanding of functions, constraints, and objectives for the given scenario.	Stated clearly and briefly the nature of the problem. Showed good understanding of functions, constraints, and objectives for the given scenario. Thoughtfulness in presentation of additional considerations.
Technical Objectives and Material Performance Indices (2x)	Poorly written and showed no understanding of what a technical objective is or how to use MPI as a design concept.	The chosen technical objectives and MPIs make sense, but the team did not provide a thorough justification.	The chosen technical objectives and MPIs make sense. The team did provide justification for the chosen technical objectives, but there are small errors or illogical arguments.	Provided logical arguments and showed a good understanding of why a chosen technical objective is related to the assigned scenario. Correct relationship between the objective and MPIs.
Conceptual Design – Justification of Selected Material (2x)	Poorly written and did not show any evidence of the work.	Showed evidence of their material selection process, but not in the most effective manner. Justification is solely based on MPIs.	Demonstrated good understanding of the technical process of material selection and showed evidence such as plots from Granta Edupack. Justification focused on MPIs, but provided some thought on additional material limits.	Demonstrated good understanding of the technical process of material selection and showed evidence such as plots from Granta Edupack. Justification is well-reasoned and includes a thoughtful discussion of additional material limits.
Porosity Consideration	Fails to provide basic explanation of porosity's impact on mechanical properties and make little to no connection to specific scenario.	Provide basic explanation of porosity's impact on mechanical properties and make unclear connections to specific scenario.	A general explanation of porosity's impact on mechanical properties, and some relevant connections to specific scenario.	A detailed explanation of porosity's impact on mechanical properties, and make strong, relevant connections to specific scenario.
Justification of Eco Audit	Missing or unreadable discussion on explanation.	Some details provided on Eco Audit implications for material selection but fails to incorporate numerical data from Granta or effectively summarize findings.	Detailed discussion on Eco Audit implications for material selection along with reference to Granta data. Effective summary of findings and consideration of energy costs /	Detailed discussion on Eco Audit implications for material selection along with references to Granta data. Connection is made to the impact on previous design stages beyond referencing the Eco Audit. Effective summary of findings and consideration

			carbon footprint from Eco Audit.	of energy costs / carbon footprint from Eco Audit.
Discussion of Sustainable Choices and Compliance with Regulations	Discussion is very poor, non-existent, or not related to good sustainable practice and/or scenario-relevant regulations.	Discussion is unclear and only addresses some long-term sustainability considerations and scenario-relevant regulations.	Discussion addresses long-term sustainability considerations and scenario-relevant regulations.	Discussion addresses long-term sustainability considerations and scenario-relevant regulations. Insightful and/or thoughtful going beyond what is discussed in class.
Concluding Remarks – Reality Check	Poorly written. Arguments do not follow a logical and methodical order.	Showed understanding of the project requirements but did but effectively communicate in a logical and methodical order. Missing a bring home message.	In general, demonstrated an understanding of design requirements of the filter. Missing discussion of additional considerations or a bring home message.	In general, demonstrated an understanding of design requirements of the filter. Thoughtful discussion of additional considerations. Has a strong bring home message.
Appendix C – References (if necessary) (Up to 5% Potential Penalty of Final Deliverable)	Used unprofessional sources and ignored the IEEE format. **(5 % penalty)**	Used professional sources, but full of formatting errors (i.e. not in accordance with IEEE format). **(3 % penalty)**	Used professional sources. Mostly followed the IEEE format, with some small errors. **(2 % penalty)**	Used professional sources, in full accordance with the IEEE format. **(0% penalty)**

List of Penalties	Deduction
Missing Names, MacIDs, Team Identifier	**–10% per occurrence**
Incorrect File Format	**-10%**
Late Penalty	**–20% per day**

Self-and Peer-Evaluation

Assessment Type: Individual
Time Allotted: Own Time
Submission Deadline: Saturday, February 15, 2025

Objectives and Requirements

Each team member is expected to contribute equitably and effectively to the team's overall performance, throughout the duration of the project. This contribution is evaluated through both a *self-evaluation* and a *peer-evaluation*. Each team member will evaluate themselves and their peers on the following dimensions:

- → Contributing to team's work
- → Interacting with teammates
- → Keeping the team on track
- → Expecting quality
- → Having relevant KSAs (Knowledge, Skills, and Abilities)

Submission Details

Complete your self- and peer-evaluation using the URL that will be emailed out.

Grading of Self- and Peer-Evaluation

Your self- and peer-evaluation is graded as part of your **teamwork and engagement grade**, which accounts for 10% of your overall 1P13 grade (10 marks). **Each design project self/peer evaluation score is worth 5% of your teamwork and engagement grade (0.5/10 marks**).

Team members are expected to take the self- and peer-evaluation process seriously. This is an important learning opportunity in terms of being able to evaluate one's own work as well as give and receive feedback on the work of others. ***It is not intended as an exercise in padding each other's marks***! Team members may be expected to justify their peer evaluation scores in a meeting with your instructor, individually or as a team. Failure to justify your peer evaluation may result in an adjustment to your peer-evaluation score.

Administrative Roles and Responsibilities

Each design project will require team members to assume one of four ***Project Lead*** administrative roles. The purpose of the Project Leads is to ensure administrative responsibilities are equitably distributed amongst *all* team members. Each Project Lead will have a unique set of expectations and responsibilities, and all team members are expected to contribute towards the project as a whole.

Three Strike System

The three-strike system is a method used to enforce that all members contribute equally to the group project and on the chance that a team member is refusing to cooperate or complete their task, then the strike system will be enforced. The first strike serves as a warning from the TA assigned to your group. The second strike serves as a second warning from your lead design studio IAI. The third strike involves the lead professor for the project, in which a penalty will be applied to the individual's grade as deemed appropriate by the professor. Please note that in severe circumstances, the penalty can lead to a grade of zero for the individual's overall grade in the project. In the event that there are underlying circumstances that may prevent a team member from completing their work, please communicate said circumstances with your team and with your design studio IAI to prevent you from acquiring a strike.

Project Leads

Project-1 requires that each team member assumes one of four ***Project Leads*** over the duration of the project (**M**anager, **A**dministrator, **C**oordinator, **S**ubject Matter Expert).

Manager: A breakdown of the Project Manager's Expectations and Responsibilities is as follows:

→ *Expectations*:

- Facilitate discourse among team members and with 1P13 instructional team
- Promote an equitable work environment
- Assume a leadership role in identifying and managing team conflict

→ *Responsibilities*:

- Act as a ***Lead Facilitator*** with the 1P13 instructional team during weekly Design Studio
- Complete and submit a ***Preliminary Gantt Chart***, at the beginning of the project

Administrator: A breakdown of the Project Administrator's Expectations and Responsibilities is as follows:

→ *Expectations*:

- Monitors progress of deliverables to ensure team remains on track to meet deadlines
- Ensures team members are aware of all project deadlines and expectations

→ *Responsibilities*:

- Assume responsibility for ***submitting all team deliverables***
- Complete and submit an updated ***Final Gantt Chart***, at the end of the project

Coordinator: A breakdown of the Project Coordinator's Expectations and Responsibilities is as follows:

→ *Expectations*:

- Coordinate team meetings outside of weekly Design Studio's
- Keep a record of all meetings and discussions outside of weekly Design Studios, both in-person and online meetings

→ *Responsibilities*:

- Act as a **Lead Contributor** in completing all *TEAM* worksheets during Design Studio

- Note: this does not mean the Coordinator is the only person expected to fill out each Milestone worksheet. Rather, *they are expected to be a lead contributor* (other team members are encouraged to contribute as well).
- Complete and submit a ***Logbook of Additional Meetings and Discussions***

Subject Matter Expert: A breakdown of the **Subject Matter Expert's** Expectations and Responsibilities is as follows:

→ *Expectations*:

- Assume responsibility for building a database that clearly documents the source of all information gathered and research conducted
- Assume responsibility for ensuring source materials are broad and reliable
- Assume responsibility for ensuring completion of the Project Report is collaborative

→ *Responsibilities*:

- Share a ***Collaborative Working Document*** of your *Design Summary* (i.e., Microsoft Office SharePoint document) at the beginning of the Project
- Complete and submit a ***Source Materials Database*** at the end of the Project

For a team of 5 students, there are ***2*** Subject Matter Experts

- The Source Materials Database can be completed jointly

Submission and Grading Details

Each Project Lead has a number of administrative responsibilities that must be completed over the course of the project. A summary of the administrative responsibilities is outlined in Table 4 below.

Table 4: Project Lead Responsibilities

Lead	Administrative Responsibility	Deadline	Marks
Manager	Facilitate Design Studio discussions	Ongoing	P/F
Manager	Preliminary Gantt Chart	Day of Wk-1 DS	0.5
Administrator	Submission of Team Deliverables	Ongoing	P/F
Administrator	Final Gantt Chart	Submit with Design Report	0.5
Coordinator	Act as *Lead Contributor* in completion of TEAM Milestone worksheets	Ongoing	P/F
Coordinator	Logbook of Additional Meetings & Discussions	Submit with Design Report	0.5
Subject Matter Expert	Collaborative Working Document	Prior to Wk-4 DS	P/F
Subject Matter Expert	Source Materials Database	Submit with Design Report	0.5

Administrative responsibilities are evaluated as part of the **teamwork and engagement grade**, which accounts for **10% of your overall 1P13 grade** (10 marks).

- ***Ongoing*** responsibilities (e.g., chair, note-taker) are evaluated by the TA each week
  - They are evaluated based on completion and are graded as **Pass/Fail**.
  - Failure to meet your responsibilities may result in a **0.5-mark deduction** to your **teamwork and engagement grade** for *each occurrence*. Examples include:
    - Failure to prepare a TA meeting agenda as Design Studio Chair (Manager)
    - Failure to submit one or more team deliverable (Administrator)
    - Failure to record minutes of TA meeting as Note-Taker (Coordinator)
    - Failure to submit collaborative working document (Subject Matter Expert)
- Administrative responsibilities with ***deadlines*** (e.g., Gantt chart, logbook, etc.) are evaluated based on the **P-1 Project Lead Rubric**, which is has been **posted to Avenue**.
  - Each responsibility is worth 5% of your overall **teamwork and engagement grade (0.5/10 marks)*****.
  - However, failure to complete and/or submit the associated administrative deliverables will result in upwards of a **1-mark deduction** to your overall **teamwork and engagement grade (1/10 marks)**.

Design Studio Lead Facilitator (Manager) and Worksheet Lead Contributor (Coordinator)

During each Design Studio, teams will be required to complete a set of worksheets in accordance with their assigned Milestone, as well as meet informally with members of the 1P13 instructional team. The Manager and Coordinator are expected to play a key role in these tasks (although they should ***not*** be the only ones).

Lead Facilitator: The **Manager** is expected to lead discussions with members of the 1P13 instructional team during team meetings in Design Studio. This includes facilitating discourse among team members or coordinating question and answer sessions with the instructional team.

→ *Submission and Grading Details*:

- There are no submissions required for this responsibility
  - The **Manager** is evaluated on the extent to which they engage with members of the 1P13 instructional team during discussions
- The Manager's role as Lead Facilitator is graded as **Pass/Fail**

Lead Contributor: The **Coordinator** is expected to coordinate completion of all TEAM worksheets during weekly Milestones in Design Studio. The Coordinator is not expected to be the ***only*** contributor. But it is it necessary that they are ***one*** of the contributors.

→ *Submission and Grading Details*:

- There are no submissions required for this responsibility
  - The **Coordinator** is evaluated on the extent to which they are actively involved in completion of each Milestone *TEAM* worksheet
- The Coordinator's role as Note-Taker is graded as **Pass/Fail**

Preliminary Gantt Chart (Manager)

The Preliminary Gantt Chart is a graphical representation of your team's proposed project schedule, outlining team meetings, planned progression of tasks, and all project deadlines.

→ *Submission and Grading Details*:

- Include *Preliminary Gantt Chart* in *Project Schedule* section of *Design Summary*
- The *Preliminary Gantt Chart* is graded as **Pass/Fail**

Final Gantt Chart (Administrator)

The *Final Gantt Chart* is a graphical representation of your team's *actual* project schedule and should be overlaid on the *proposed* project schedule.

→ *Submission and Grading Details*:

- Include *Final Gantt Chart* in the *Project Schedule* section of the *Design Summary*
- The *Final Gantt Chart* is graded as **Pass/Fail**

Submission of Team Deliverables (Administrator)

The Administrator is responsible for submission of all *team deliverables*, ensuring team deliverables are submitted to the correct location by the required deadline. This includes weekly Milestone worksheets and Final Deliverables. Other team members' individual submissions are ***not*** the Administrator's responsibility. However, the *Administrator* is still responsible for their own individual submissions.

→ *Submission and Grading Details*:

- Milestone Worksheets:
  - Submit to appropriate *Avenue Dropbox* as outlined in *Milestone Instructions*
  - Include worksheets in the *Design Studio Worksheets* section of your *Design Summary*
- Final Deliverables:
  - Follow submission instructions outlined in the Final Submission section
- The Administrator's role in submitting team deliverables is graded as **Pass/Fail**

Logbook of Additional Meetings and Discussions (Coordinator)

The *Logbook of Additional Meetings and Discussions* is a collective of documents, images, and screenshots that reflect team progress outside of scheduled Design Studios. There is no standard format. In-person meetings can be documented either in a notebook or digitally. For online meetings and discussions on communication platforms (e.g., Slack, Messenger, Group Chat), a screen shot of conversations is sufficient. The only explicit requirements are that: 1) all meetings and discussions are consolidated, 2) meetings and discussions are chronologically presented, and 3) the date of each meeting/discussion is clearly indicated.

→ *Submission and Grading Details*:

- Include your *Logbook of Additional Meetings and Discussions* in the *Project Schedule* section of your *Design Summary*
- The *Logbook* is graded as a **Pass/Fail**

Collaborative Working Document (Subject Matter Expert)

The Collaborative Working Document is an editable version of the *Design Summary*, written in an online document that tracks user history and edits (e.g., Microsoft Office SharePoint document).

→ *Submission and Grading Details*:

- Share your *Collaborative Working Document* with the Course Instructors at prof1p13@mcmaster.ca
  - All team members should use easily identifiable names and not aliases
- The *Collaborative Working Document* is graded as a **Pass/Fail**

Source Materials Database (Subject Matter Expert)

The *Source Materials Database* is a comprehensive list of *all* source materials and resources that have been used throughout the project. This includes references cited in each team member's pre-design studio Individual Research Memo, references cited in your Final Deliverable Design Summary, and any additional sources that directly or

indirectly contributed to the overall learning experience but may not have been specifically cited in a written document (e.g., personal communications, websites, etc.). It is **not** the responsibility of the Subject Matter Expert (SME) to source all of these resources. Rather, the SME is responsible for consolidating sources collected by all team members in a single location. Please note that the *Source Materials Database* is different from the *Reference List* mentioned earlier.

→ *Submission and Grading Details*:

- Include your *Source Materials Database* in the *List of Sources* section of your *Design Summary*
  - The *Source Materials Database* should adhere to IEEE referencing standards
- The *Source Materials Database* is graded as a **Pass/Fail**