Introduction to Engineering Design with Professional Development I (ENGR 2050)
Classroom Lab Activity

Activity 01-1	Course overview and introduction
Textbook Reference:	
Purpose / Goal:	Course overview, demonstration/discussion of leadership and design process, introduction to the Mini Project, pair grouping for Mini Project, complete online safety quiz
Materials / Resources Required:	4 square, helium sticks, syllabus, IED Mini-Project Competition document, playing cards for pair formation (optional), computer to display mini-project videos (optional)
Time Allocated:	1 hour 50 minutes

Introduce Instructors and Share Contact Information

Time Limit - 5 minutes

Instructors will review office location / hours and contact information with the students and start to draw on the expertise of each of the instructors with Engineering technical skills and Leadership/Team skills.

Review course objectives and syllabus

Time Limit - 20 minutes

The course will focus broadly on the mini project in the first 4 weeks and then the Team project the rest of the semester.

Since one of the objectives focuses on teamwork we thought we would do an activity that demonstrates some of the important factors…

Helium Stick Activity

Time Limit - 20 minutes

Instructions: Divide the class in half and have each group form 2 lines shoulder to shoulder. The lines should be facing each other and be about 1 ½' to 2 feet away. Have each person extend their index finger with the palm side down.

The Explanation

Our students often think that either working on a team doesn't require any "skills", or that they already have them. The helium stick activity demontrates that **cognitive understanding does not equal skill.** This exercise illustrates that teamwork is challenging -- even when the task itself may seem simple.

There are two sets of skills that are necessary to function as a high performance team: technical skills (task) and team skills (relational). This course will challenge both of these skill sets and both will be needed for you to be more productive.

What is the design process?

Time Limit - 15 minutes

Discuss the key important concepts of the design process.

Transition to Mini Project and Team Formation

Mini projects are to be executed by two person teams. Unfortunately it is possible to either start with an odd number of students or to end up with this due to adds / drops over the first few weeks. This may necessitate the creation of a few 3 person teams.

Introduction to the Mini Project

Time Limit – 15 minutes

Instructor will describe the Mini Project, and will (optionally) show the mini project videos from LMS. Alternatively, the students may be instructed to view the mini-project videos on their laptops. This will help the students begin to self-select the project they are interested in before forming teams.

Team Formation

Time Limit – 20 minutes

Guidelines

1. Form the teams during the first class.
2. If you start the class with an odd number of students, add the extra student to a team.
3. If any students join the class afterwards, add those students to an existing pair of students to make trios. Thus three new students cause the creation of three trios.
4. Do NOT form new students into new teams. By merging them into the existing ones they will gain the necessary continuity.
5. Once a two person team has been formed, do not dissolve it unless one of the two students drops the course. Add the remaining student to an existing pair to make a trio.

Team Formation Activity

At the option of the instructor, students may wish to separate themselves into 3 large groups based on the mini-project topic they find most interesting. The following “pair up” methods are suggested to form the actual mini-project pairs, from sub-groups or class-wide.

Choose one of the following quick “pairing up” methods

- Silent birthday line-up
- Count off by 2’s
- Line up by height / clothing colors
- Playing cards: set up 2 full sets of 2 suits plus jokers (this gets you 14 pairs)

Once they are in pairs, two fast startup activities will help the teams get started. First, each learns several simple facts about the other person:

- Name
- Major
- Graduation Year
- Home Town
- One favorite thing:
  - Color
  - Food
  - Place
  - Pet
  - etc.

Next, a "four square" style team building activity will help each learn more about each other. Pass out 4 square questions and have each student individually fill it out and then go through each question with their partner. This will help the forming stage and begin to put some thought into the design. Have students exchange contact information (e-mail, phone #) and decide when they are touching base next.

Project Selection

Teams should select which mini project they will take on. This can be accomplished by passing around a sign-up sheet. If possible, project materials may be made available at the first lecture so students should plan to bring money to that lecture.

Safety Guidelines and On-Line Quiz

Time Limit - 10 minutes

Students will complete the safety quiz online, in class if time permits otherwise outside of class time.

(Printed proof of completion must be provided to the instructor before the students are allowed to use the shop.)

Lecture Preparation

Be sure to bring your iClicker to all lectures with fresh batteries and a spare set – just in case! These will be used to take attendance and to participate in the interactive surveys.

Introduction to Engineering Design with Professional Development I (ENGR 2050)
Classroom Lab Activity

Activity 02-1	Creating a Gantt Chart
Textbook Reference:	Ulrich & Eppinger – pp 337-339
Purpose / Goal:	Understand the creation and usage of Gantt charts for project planning and tracking
Materials / Resources Required:	Paper, pencil, Laptop, Excel based Gantt Chart tool (from LMS)
Time Allocated:	30 minutes

Background

The Gantt Charting tool in Excel was discovered on-line at (http://www.vertex42.com/ExcelTemplates/excel-gantt-chart.html). Modifications and enhancements were then made to this tool in an effort to better tailor its use to student projects. This enhanced version of the tool has been posted to the Technical Writing Resources folder on LMS: https://lms.rpi.edu

Activity

Many people find it easier to "sketch" their project plan on paper before entering it into a formal tool. This activity is written in that manner. Instructors may elect to allow their students to go straight to the Excel tool.

1. On paper, define and write out all of the activities required to design and build your mini-project.
2. Evaluate each activity description to ensure that it is results oriented. Consider each activity to be the work required to achieve a goal. Well defined goals are often "SMART", as in:

Specific	**M**easurable	**A**ttainable	**R**ealistic	**T**ime constrained

3. For each activity, consider whether they depend on the completion of any of the other activities. An important element of project planning is to understand and plan for these dependencies.
4. For each activity, determine who will be the owner. Well managed projects have a single clearly identified owner for each task. Others may work on the task or be assigned to it but there should be a single owner.
5. Determine when each activity should start. Use your understanding of the task dependencies to alter the start dates accordingly.
6. Determine how long each activity will take and enter in the appropriate end date.
7. Once you have thought through the planning of your project you can enter the information into Excel to create a Gantt chart using the instructions below.

Creating Your Initial Gantt Chart

Copy/download and open the file. You can now enter your project's data.

- In cell A1 you can replace "Project Name" with the actual name of your project.

- Below that title, you can enter the individual tasks as defined for you project.
- For each task, enter the name or initials of the owner of that task. It's important to know who "owns" and is thus responsible for each task.
- From your paper draft project plan, enter the expected start and end dates for each task.
- If your project has already started then you will have some tasks already started and possibly some already completed. You can enter an estimated percentage in the Status column for those tasks. For the projects that might best use this simple tool, its recommended that you limit your inputs here to: 0% for tasks not started, 50% for tasks in process and 100% for completed tasks. The effort is often high while the accuracy is usually low for any other estimated status values. Keep it simple!

Based on the information you have entered so far, the spreadsheet will automatically "color in" the Gantt chart's bars and will automatically adjust the dates above the bars. It will also automatically color code tasks as either not started, in process or complete.

A sample Gantt chart might look like Figure 1. Note that in this sample, the project ends in early December although the chart continues for a longer period of time. The additional space was used to provide room to add comments to some of the tasks.

IED - Fall 2008 Semester	Status	Owner	Start	End	
LECTURE SERIES					
Lecture 1	100%	MA	8/26/2008	8/26/2008	
Lecture 2	100%	MA	8/29/2008	8/29/2008	used Lecture 2a slides
Lecture 3	100%	MA	9/2/2008	9/2/2008	used Lecture 2b slides
Lecture 4	100%	MA	9/5/2008	9/5/2008	skipped Lecture 3 slides
Lecture 5	100%	MA	9/9/2008	9/9/2008	
Lecture 6	100%	MA	9/12/2008	9/12/2008	
Lecture 7	100%	MA	9/16/2008	9/16/2008	
Lecture 8	100%	MA	9/19/2008	9/19/2008	Done out of sequence on 9/23/08
Lecture 9	100%	MA	9/23/2008	9/23/2008	Done out of sequence on 9/19/08
Lecture 10	100%	MA	9/26/2008	9/26/2008	
Lecture 11	100%	MA	9/30/2008	9/30/2008	
NO CLASS - EMPAC DAY	100%	SJ	10/3/2008	10/3/2008	
Lecture 12	100%	MA	10/7/2008	10/7/2008	
Lecture 13	100%	MA	10/10/2008	10/10/2008	
NO CLASS - MONDAY SCHEDULE	100%	SJ	10/14/2008	10/14/2008	
INDIVIDUAL PROJECTS					
Skill Survey	100%	indiv	8/26/2008	8/29/2008	Was actually conducted during week 4
Safety Quiz	100%	indiv	8/26/2008	9/2/2008	
Concept Memo	100%	indiv	8/26/2008	9/2/2008	
Tech Memo	100%	indiv	9/2/2008	9/12/2008	
Presentation / Demo	100%	indiv	9/16/2008	9/23/2008	second half delayed to following Tuesday
TEAM PROJECTS					
Team Formation	100%	GK / MA	9/27/2008	9/27/2008	
Milestone 1 - Proposal & Presentation	100%	teams	9/26/2008	10/10/2008	MJA delayed due date to 10/20/08
Team Project Design, Build & Test	10%	teams	10/10/2008	11/25/2008	
Milestone 2 - Demonstration	0%	teams	11/21/2008	11/25/2008	Can present on the prior Friday if leaving for beak
Milestone 3 - Final Report	0%	teams	11/15/2008	12/5/2008	

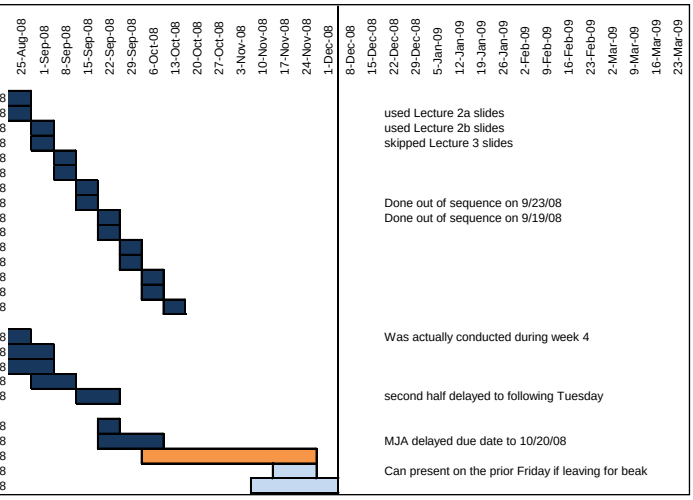

Figure 1 – Sample Gantt Chart

Maintaining Your Gantt Chart

Once the project's Gantt chart has been created using the tool there are several features that help manage the project.

- **Status updates.** By changing the percent complete in the status column, the Gantt chart will automatically update the color of the bars. This gives a fast color representation of the project's status.

- **Date changes.** Once the project can be fully "seen", problems with resource allocation can become more evident (too many things have to happen at the same time). When this happens, project dates may need to be adjusted. Simply change the Start or End date for a task and the tool will automatically update the chart.

- **New tasks.** Once a Gantt chart is created, additional tasks may be identified. Simply insert a row in the spreadsheet and fill in the data for that task.

- **Getting organized.** After all of the tasks have been listed it may be helpful to organize the chart. As the sample shows, you can insert rows in the chart that serve as headers for the tasks in that section. Our sample chart includes "LECTURE SERIES", "INDIVIDUAL PROJECTS", and "TEAM PROJECTS" as headers.

- **Finding your own assignments.** The tool has been set up to take advantage of Excel's filtering capabilities. The Task Name, Status, Owner, Start and End columns all have filtering turned on. You can filter the Owner column for just your name or initials to see only your tasks. As a project manager you can filter to see the task assignments for any one or even for multiple people on the team.

- **Finding late tasks.** You can filter the End date columns to find tasks that should have been completed by now. Simply filter the End date and user the special date filters to look for end dates that are "before" today. Then use the filter on the Status column to filter out any task already complete. The tasks you see are considered late!

- **Finding tasks that should have been started by now.** Repeating the date filtering on the Start date column looking for any dates "before" today will identify all the tasks that should have started by now. Adding a filter to the Status column to select only those with a Status of 0% will show you the tasks that have not yet begun.

- **Changing the date scale.** On the Setup tab of the workbook you can change the date scale from 7 days per column, as used for the example in Figure 1 to a value of 1 day per column. A scale of 7 days per column makes it easier to see a summary chart. A scale of 1 day per column makes it easier to actually manage the day to day activities for a single semester project.

- **Adding more tasks than are provided in the sample Gantt Chart file.** The tool is provided with a number of tasks hoped to be adequate to manage a small multi-student project. You may add more lines by simply inserting as many as needed somewhere in the MIDDLE of the provided spreadsheet. This is important to retain the automatic features of the tool as provided. The creation of the bars and their color coding is accomplished by conditional formatting. By inserting rows into the middle, Excel will automatically apply that formatting to the new rows. If

you add rows AFTER the existing ones, you will have to use the format painter to extend the conditional formatting or manually edit all of the conditional formatting statements to ensure that they include your added rows.

- **Extending the date range of the Gantt Chart.** The provided tool was set up to permit a scale of 1 day per column and still extend over a complete 16 week semester. If you need more columns, simply insert more in the MIDDLE of the existing ones. This is for the same reasons as those explained in the previous section on adding rows. Adding columns in the middle of the existing ones will allow Excel to take care of the conditional formatting for you.

Using Your Gantt Chart to Manage The Project

Creating a Gantt chart is not a one-time activity! To be useful, it must be maintained. Thus at each class session or team meeting, the group should review their chart and make updates as appropriate.

Reviewing a Gantt chart

1. Does each entry have a deliverable or measurable outcome?
    a. How do you know when each task is complete?
2. Is every entry's duration no longer than one week
    a. Break into multiple sub tasks with unique deliverables / measurable outcome
3. Does every item have a single owner (others may help, but good project management dictates a single responsible person).
4. Is the chart current?
    a. Draw line representing "today".
    b. Is everything to the "left of today" already complete or in process?
        i. If not already complete then it's behind schedule.
            1. What is the plan to correct this?
        ii. If in process, is it as far along as expected?
5. Is everyone busy?
    a. If they are waiting for another task to complete (e.g. materials to be delivered or fabricated) is there something else they can be working on?
    b. If they have nothing to work on
        i. Can they assist a team mate?
        ii. Have they told their team of their availability?
        iii. Otherwise - something's probably wrong!
6. Is anyone overloaded?
    a. Ask team mates for assistance now, **before** something becomes late!

Now – **update your chart as needed**! Be sure to keep it in a location where your entire team can see it, such as on LMS or Google docs. Be sure to include this in your technical report.

Introduction to Engineering Design with Professional Development I (ENGR 2050)
Classroom Lab Activity

Activity 01-02-1	Course overview, introduction, Gantt Charts/Project Management
Textbook Reference:	See Activity 02-1 & Activity 02-2
Purpose / Goal:	Course overview, demonstration/discussion of leadership and design process, introduction to the Mini Project, team formation for Mini Project, complete online safety quiz
Materials / Resources Required:	Helium stick, IED Mini-Project Competition document, playing cards for pair formation (optional), computer to display mini-project videos (optional)
Time Allocated:	1 hour 50 minutes

Introduce Instructors and Share Contact Information

Time Limit - 5 minutes

Instructors will review office location / hours and contact information with the students and start to draw on the expertise of each of the instructors with Engineering technical skills and Leadership/Team skills.

Review course objectives and syllabus

Time Limit - 5 minutes

The course will focus broadly on the mini project in the first 4 weeks and then the Team project the rest of the semester. Students are to obtain the syllabus from LMS and read it.

Helium Stick Activity

Time Limit - 20 minutes

Instructions: Divide the class in half and have each group form 2 lines shoulder to shoulder. The lines should be facing each other and be about 1 ½' to 2 feet away. Have each person extend their index finger with the palm side down.

The Explanation

Our students often think that either working on a team doesn't require any "skills", or that they already have them. The helium stick activity demontrates that **cognitive understanding does not equal skill.** This exercise illustrates that teamwork is challenging -- even when the task itself may seem simple.

There are two sets of skills that are necessary to function as a high performance team: technical skills (task) and team skills (relational). This course will challenge both of these skill sets and both will be needed for you to be more productive.

What is the design process?

Time Limit - 5 minutes

Remind the students that the mini project follows the design process as summarized in the first lecture.

Transition to Mini Project and Team Formation

Mini projects are to be executed by two person teams. Unfortunately it is possible to either start with an odd number of students or to end up with this due to adds / drops over the first few weeks. This may necessitate the creation of a few 3 person teams.

Introduction to the Mini Project

Time Limit – 5 minutes

Instructor will describe the Mini Project, and will (optionally) show the mini project videos from LMS. Alternatively, the students may be instructed to view the mini-project videos on their laptops. This will help the students begin to self-select the project they are interested in before forming teams.

Team Formation

Time Limit – 10 minutes

Guidelines

1. Form the teams during the first class.
2. If you start the class with an odd number of students, add the extra student to a team.
3. If any students join the class afterwards, add those students to an existing pair of students to make trios. Thus three new students cause the creation of three trios.
4. Do NOT form new students into new teams. By merging them into the existing ones they will gain the necessary continuity.
5. Once a two person team has been formed, do not dissolve it unless one of the two students drops the course. Add the remaining student to an existing pair to make a trio.

Team Formation Activity

At the option of the instructor, students may wish to separate themselves into 3 large groups based on the mini-project topic they find most interesting. The following “pair up” methods are suggested to form the actual mini-project pairs, from sub-groups or class-wide.

Choose one of the following quick “pairing up” methods

- Silent birthday line-up
- Count off by 2’s
- Line up by height / clothing colors
- Playing cards: set up 2 full sets of 2 suits plus jokers (this gets you 14 pairs)

Once they are in pairs, two fast startup activities will help the teams get started. First, each learns several simple facts about the other person:

- Name

- Major
- Graduation Year
- Home Town
- One favorite thing, e.g. Color, Food, Place, Pet, etc.

Next, a "four square" style team building activity may be used to help each learn more about each other. Pass out 4 square questions and have each student individually fill it out and then go through each question with their partner. This will help the forming stage and begin to put some thought into the design. Have students exchange contact information (e-mail, phone #) and decide when they are touching base next.

Project Selection

Teams should select which mini project they will take on. This can be accomplished by passing around a sign-up sheet. Project materials will be made available in JEC2027 after 2PM on Thursday / Friday.

Safety Guidelines and On-Line Quiz

Time Limit - 0 minutes

Students must complete the safety quiz online outside of class time.

(Printed proof of completion must be provided to the instructor before the students are allowed to use the shop.)

Gantt Charts

Time Limit - 30 minutes

Use Activity 02-1 in its entirety. Let the students finish adding detailed tasks as homework.

Customer Requirements

Time Limit - 30 minutes

Use Activity 02-2 in its entirety in class.

Shop Tour

Time Limit - 0 minutes

Due to time constraints, the shop tour can be skipped. Simply alert students to the location of the shop and that the schedule will be available on LMS and the shop door.

Lecture Preparation

Be sure to bring your iClicker to all lectures with fresh batteries and a spare set – just in case! These will be used to take attendance and to participate in the interactive surveys.

Introduction to Engineering Design with Professional Development I (ENGR 2050)
Classroom Lab Activity

Activity 02-2	Conduct user needs/functional analysis
Textbook Reference:	Ulrich & Eppinger – pp. 56-68
Purpose / Goal:	To understand how customer requirements are collected and documented and how these are used for functional analysis
Materials / Resources Required:	Laptop
Time Allocated:	30 minutes

Description

During this class session you will:

1. Identify the types of potential users (customers) for your project. If possible, identify specific individuals who might use the project.
2. Identify the relevant customer needs.
3. Create a copy of the Customer Data Template found on the next page for each individual OR for each type of potential user
4. Use interview or other methods, fill in the customer statements using the question/prompt information as "thought provokers" to help the customer clarify their thinking.
5. Work with your partner after the interview / data collection is completed, to identify the customer needs that are related to each of the customer statements.

Defining the Customer

Who are the target customers for your project? What are some of their characteristics? What is their age range? Are they male or female? What is their typical education level? These are called the customer demographics.

Consider a product you have purchased, such as a cell phone or MP3 player. What might be the target customer demographics for that product? What are some demographics that may not be the target?

To properly develop your product you need to know the customer demographics!

Examples of possible customers:

- YOU!
- Your class partner
- Your family
- Your roommate(s)
- Other students in your department

Introduction to Engineering Design with Professional Development I (ENGR 2050)
Classroom Lab Activity

Create a list of potential customers for your mini-project. Using that list, create a customer data template as shown in Table 1 - Customer Data Template (from Ulrich & Eppinger, p. 62).

Table 1 - Customer Data Template (from Ulrich & Eppinger, p. 62)

Customer:		
Question / Prompt	**Customer Statement**	**Interpreted Need**
Typical Uses	*Statement 1*	*Related need*
Likes		
Dislikes		
Suggested Improvements		

Notes:

- create additional rows as needed
- delete the *italicized example*
- keep one statement / need per row
- can create a new table for each customer interviewed OR create a single table to consolidate results
- After each statement is clarified, identify the related need(s) from it.
- For each of the needs, be sure to identify possible metrics so that you can measure your success in meeting that need

There are examples and detailed explanations of collecting and interpreting customer needs in the textbook (pp61-68).

Activity 03-1	Mission Statement and Customer Requirements
Textbook Reference:	Ulrich & Eppinger, Chapters 4 & 5
Purpose / Goal:	To understand how a mission statement helps guide team activities. To understand how to fully explore and document customer requirements.
Materials / Resources Required:	Laptop, User Needs / Functional Analysis and Customer Data templates from the previous activity, Mini-Project documentation
Time Allocated:	1 hour

Description

Using the User Needs / Functional Analysis for your mini-project and the overall Mini-Project documentation as the context for this activity, you and your partner will seek:

- to define a unique mission for your team
- to extract the key customer requirements

The process you are following is detailed in chapter 4 of the textbook.

Table 1 - Mini Project General Mission Statement

Benefits	A project-based experience that motivates students to learn about the engineering design process
Goals:	Can be completed in about four weeks, inexpensive components, safe, challenging, appeals to a broad cross section of multidisciplinary interests and is fun.
Primary Markets:	RPI engineering students
Secondary Markets:	Prospective RPI engineering students
Assumptions:	• Satisfies competition requirements as specified by assignment • Students learn about interpreting customer requirements into design specifications, concept development, and prototyping • Can't be easily copied off the internet
Stakeholders:	IED Instructors

Mission Statement

Table 1 - Mini Project General Mission Statement provides the overall mission statement for the Mini-Project. It is based on Exhibit 4-3 in the textbook. Use the material and topics from the figure and customize it to reflect your team's particular mission statement. Clearly defined mission statements are brief and to the point. These help teams focus on their overall goals & objectives.

Customer Wants & Needs

The next step in identifying what the customer is looking for in a product is to develop an understanding of their "wants & needs". The following is a partial list of some possible wants and needs for the mini-project:

- I have limited time, so I'd like to have something that can be built with readily available materials.
- It must look cool with as many features as possible.
- I need to know exactly how much energy is required to meet basic requirements.
- Fit in my backpack without breakage.
- Be adaptable to varying competitive test conditions.
- Easy to assemble.
- Win the competition at all costs.
- Get an "A"
- Work reliably, especially on the day of the competition.
- Have fun!
- Be safe
- Inexpensive components
- Pertain to my disciplinary interests and capabilities.
- Hands-on

Review the Customer Data templates you created in the previous activity. Although those define, in customer terms the likes and dislikes of your customers, they are not directly actionable from an engineering viewpoint. From those templates and the above list of ideas, generate a specific table of wants and needs for your mini-project. These should be ranked in order of importance to your customer to help ensure that you address the items of highest priority. Table 2 - Interpreted Customer Needs provides an example of this.

Table 2 - Interpreted Customer Needs

No.	Customer Needs	Importance
1	Fit in my backpack without breakage.	3
2	Adaptable to varying competitive test conditions.	4
3	Satisfy basic requirements for the competition	5
4	Look cool with as many features as possible.	3
5	Work reliably, especially on the day of the competition	5

Customer Requirements

Using the material provided in the Mini-Project documentation, what additional raw customer data can you extract? Create another Customer Data template and fill that in using this "new" data.

Use the guidelines shown in Exhibit 4-7 (page 63) to interpret these raw statements of customer needs and wants. Update your interpreted customer needs table (Table 2) as needed with this new information.

Customers and Stakeholders

In the next activity you will identify and document the project stakeholders. You will then focus on completing the definition of your customer requirements and then translating them into technical specifications. As you do, consider the following questions:

- Are any customer requirements missing?
- Are any customer requirements redundant? Can any be eliminated?
- Which customer requirements require more investigation?
- Do any customer requirements prescribe how the concept should be implemented?
- Which customer requirements are the most important?
- Which customer requirements are the most difficult to implement?

Introduction to Engineering Design with Professional Development I (ENGR 2050)
Classroom Lab Activity

Activity 03-2	Mini-Project Work time
Textbook Reference:	
Purpose / Goal:	Utilize classroom & shop resources to begin design and fabrication of the mini-project
Materials / Resources Required:	Project materials
Time Allocated:	

Activity

The shop will be available for students to work independently on their projects. The shop will be open based on the schedule posted on the shop door, shop desk, and LMS. Instructors may be available in the shop to assist their students.

Introduction to Engineering Design with Professional Development I (ENGR 2050)
Classroom Lab Activity

Activity 04-1	Public Speaking Essentials
Textbook Reference:	
Purpose / Goal:	To help students develop essential non-written communications skills as used for presentations.
Materials / Resources Required:	PowerPoint Slides, Audience Analysis Handout, Public Speaking 101 Handout, Preparing Effective Presentations Packet
Time Allocated:	1 hour for content and practice

Goals

1. Emphasize important elements of organizing and delivering effective presentations
2. Provide students with the opportunity for public speaking practice
3. Offer students the opportunity to conduct an Audience Analysis

Public Speaking

- Public Speaking Essentials – strategies to increase your communication and public speaking abilities.
- Content Dimension
- Relationship Dimension
- Public Speaking Basics
  The following components will be highlighted:

  - Opening/introduction
  - Main body
  - Conclusion
  - Audience Analysis
  - Organization
  - Delivery

Activity 04-2	Customer Requirements vs. Technical Specs
Textbook Reference:	Ulrich & Eppinger, Chapters 4 & 5
Purpose / Goal:	To understand how customer requirements are converted into technical specifications and how to use those to measure project success
Materials / Resources Required:	Laptop, User Needs / Functional Analysis & Customer Requirements from previous activities.
Time Allocated:	1 hours

Description

Using the User Needs / Functional Analysis for your mini-project as the context for this activity, you and your partner will seek to convert the important customer requirements into measurable technical specifications.

Safety Considerations

Although customers do not often express this, safety requirements are a part of every project. These concerns may range from trivial to substantial but still must be considered. Safety requirements include several sources:

- Governmental Regulations
  - OSHA
  - Food and Drug Administration (FDA)
- Industry Standards
  - National Electric Code
- Common Sense
  - No sharp edges
  - Potential choking hazards
    - No small parts for children's toys
  - Products not used as intended
    - Toasters & bathtubs do not mix!
  - Non-toxic
- Environmental
  - Air / Water Pollution
  - Noise Pollution
  - Impact to wetlands
  - Impact to people or animal traffic
- Organizational
  - School of Engineering Safety requirements

And more! For your mini-project, your table of requirements must include safety related items and how you plan to address them.

Customers and Stakeholders

We generally recognize customers as "stakeholders" – people with an important "stake" in the success of our projects. It is often helpful, and sometimes required, to consider who the other stakeholders are for a given project.

Examples of additional stakeholders are:

- OSHA
- The FDA
- The Nuclear Regulatory Commission (NRC)
- Other regulatory groups
- Insurance companies
- Patent Holders
- Advertisers

Some of these are safety related and some are groups with financial or legal interests in a project.

Develop a list of the additional stakeholders for your project.

Customer Requirements Become Technical Specifications

The textbook, on page 55, clarifies that customer needs are sometimes referred to as customer requirements in industrial practice. Customer needs generally are written in the "voice of the customer" while customer requirements have been further interpreted into engineering requirements.

As you develop your table of customer requirements, be sure to include these other stakeholders and their requirements as well. You may need to create additional tables of Customer Data using the template for these additional "customers". And based on their wants & needs you will most likely have to update the table of interpreted customer needs as developed in the previous activity.

From the table of customer needs you will now need to convert these to appropriate engineering technical specifications. Start with your prioritized table of customer needs and add three additional columns as shown below in the sample seen in Table 1.

Table 1 - Customer Requirements and Technical Specifications

Customer Requirement	Technical Specification		
	Metric	**Target Value / Range of Values**	**Actual Value / Range of Values**
User Comfort	*Maximum Noise Level*	*70db Max*	
User Comfort	*Maximum Device weight that can be hand carried.*	*30 lbs Max*	
Size – it should fit in my bathroom	*Height x width x depth of my bathroom*	*Up to 10'x12'x10'*	
Can be used by a child	*Average user's age*	*3-10 years old*	
Can be used by a child	*Expected strength capabilities of the average user*	*5 lbs or less to operate*	
Can be used by a child	Average user height	Operating controls no more than 3 feet above ground/floor	
Air dry my winter clothing to be "dry to the touch"	*Moisture content at 65 degrees F*	*2% - 10%*	
Support a person	*Weight (based on large adult) that can be placed on top of the device*	*250lbs min*	

Table 1 is a sample showing a number of customer requirements and how they have been converted to technical specifications. This was accomplished by first reviewing the customer needs data gathered in Activity 02-2. From those tables, the interpreted need becomes the basis for the customer requirements and the customer requirements drives the technical specifications.

Good specifications are clear and easy to understand. Rather than using a single key word or concept, it is recommended that the specifications contain more details. As in Table 1 - Customer Requirements and Technical Specifications, rather than use "height" as the specification, the example provided a clearer definition of height as it relates to this project.

Each customer requirement was analyzed to look for a measurement (metric) that could be applied. Examples of possible metrics and their units can be seen in Table 2 - Metrics and Corresponding Units. These would then be applied to each of the customer requirements. In the case of the requirement that the item "should fit in my bathroom" the specification should be clear that we are providing the size of my bathroom (other bathrooms may be a different size – but the requirement is to at least fit within MY bathroom). Making clear and accurate specifications is an important part of the engineering design process.

Table 2 - Metrics and Corresponding Units

Metrics	Units
Volume	Cubic feet
Weight	Lbs.
Launch Speed	Ft/second
Surface Finish	Visual
System complexity	Number of Parts

When converting your table of customer needs to a table of technical requirements as shown in Table 1:

- Create additional rows as needed
- Delete the *italicized example*
- Keep one customer requirement with corresponding technical specification per row
- Create additional rows with the same customer requirement if there are multiple technical specifications
- After each specification is identified, identify the related metrics for it as either a single value (usually an upper or lower limit) or as a range of values.
- Note the last column in the table. Once the project is built you can record your final test result here to help show which requirements you were able to achieve and which ones were not accomplished. A fair, honest and accurate evaluation is critical for good project management!

When you have completed your table of requirements and specifications evaluate them using these questions:

- Are any customer requirements missing?
- Are any customer requirements redundant? Can any be eliminated?
- Which customer requirements require more investigation?
- Do any customer requirements prescribe how the concept should be implemented?
- Which customer requirements are the most important?
- Which customer requirements are the most difficult to implement?

Often you will identify additional requirements as you review your table. Be sure to add these and convert them into the appropriate technical specifications as well.

Introduction to Engineering Design with Professional Development I (ENGR 2050)
Classroom Lab Activity

WORKSHEET - Customer Requirements and Corresponding Technical Specifications

This worksheet is provided to make it easier for you to create a table of customer requirements and technical specifications for your project. Simply edit the provided table with the information for your project. When complete, you can delete these instructions and copy the table into your report. Note that this is **not** needed for the Mini-Project's Final Technical Memo.

Table 1 - Customer Requirements and Corresponding Technical Specifications

Customer Requirement	**Technical Specification**		
	Metric	**Target Value / Range of Values**	**Actual Value / Range of Values**
User Comfort	Noise Level	70db Max	
User Comfort	Device weight	30 lbs Max	
Size – it should fit in my bathroom	Height x width x depth	Up to 10'x12'x10'	
Can be used by a child	Age	3-10 years old	
Can be used by a child	Strength	5 lbs or less to operate	
Can be used by a child	Height	Operating controls no more than 3 feet above ground/floor	
Air dry my winter clothing to be "dry to the touch"	Moisture content at 65 degrees F	2% - 10%	
Support a person	Weight (based on large adult)	250lbs min	

The above is a sample table showing a number of customer requirements and how they have been converted to technical requirements.

Notes:

- create additional rows as needed
- delete the *italicized example*
- keep one customer requirement with corresponding technical specification per row
- create additional rows with the same customer requirement if there are multiple technical specifications
- After each specification is identified, identify the related metrics for it as either a single value (usually an upper or lower limit) or as a range of values.
- Note the last column in the table. Once the project is built you can record your final test result here to help show which requirements you were able to achieve and which ones were not accomplished. A fair, honest and accurate evaluation is critical for good project management!

Activity 05-1	Understanding MBTI
Textbook Reference:	
Purpose / Goal:	To process the results of the Meyers-Briggs tool and to learn how to effectively work on teams through a better understanding of the individuals.
Materials / Resources Required:	
Time Allocated:	1:50

Understanding the MBTI

- Background on the MBTI Instrument
- Why we teach the MBTI
- What are the 4 dichotomies?

E / I Where we focus our attention/take in energy

S / N How we prefer to take in information

T / F How we prefer to make decisions

J / P How we deal with the outer world

- What are Preferences?

  - Extroversion, Introversion, Sensing, Intuition, Thinking, Feeling, Judging, Perceiving
  - Preference does not measure skill
  - Everyone has the capability to use all 8 preferences (and indeed we all do!)
  - Many of the words used in the MBTI do not reflect "common understandings." For instance, your everyday understanding of what it means to be *extraverted* is different from the intended use of the word as part of this tool.
  - Jung believed that preferences are inborn. What do you think? Are the behaviors of individuals influenced by environment and training? To what extent? Can you accurately predict behavior in others? How would you define personality? On what would you base a description of someone's personality?

Activity 06-1	Using Design Creativity Tools
Textbook Reference:	Ulrich & Eppinger – Chapter 6 / 7
Purpose / Goal:	Increase design creativity skills through the application of various tools
Materials / Resources Required:	Pencil, paper, laptop, Excel file "concept matrix sample", "freeplane" mind mapping software (free, OpenSource, from freeplane.sourceforge.net)
Time Allocated:	1:00

Using Design Creativity Tools – 1 hour

During this class session the ultimate objective is to expose the students to the following creativity tools

- Sketching (pages 126-127)
- Brainstorming
- Mind Mapping – Concept Classification Tree (page 112)
- Concept Combination Table (page 114)
- Simple Concept Screening
- Selection Matrix (page 130)

INSTRUCTORS – Please select from a combination of these tools for your class.

One suggested exercise is to use a typical item such as automobiles as the common item throughout this activity. The students can first create a mind map for different vehicle types such as an SUV, a sports car, a minivan, and a luxury car. The class can then compare the major branches (often very similar) and the weights given to a decision matrix (sometimes wildly different).

Sketching

Exercise 1 - The "manager and employee" exercise

- Students pair up. One is designated "manager" the other is the "employee"
- Employee is asked to draw a simple circle. Add two eyes and nose.
- Employee covers their eyes
- Manager now provides direction to add mouth, ears and hair to the existing sketch. Verbal instructions are typically permitted; others (such as literally hand-holding) may be permitted. You can provide a vague instruction and see what happens.
- Employee attempts to comply with request!

Desired Student Takeaways

- How challenging is it for the employee and why
- How challenging is it for the manager and why
- How can the communication be improved
- If the goal is to accurately describe something, note how much easier it is if you can "just see the picture"!

Engineers make sketches (informal) and drawings (formal) to readily convey large amounts of information. Different disciplines (Mechanical / Electrical / Nuclear / Chemical / etc.) use different tools to help visualize their designs.

Exercise – Sketch "Something"

Students are arbitrarily broken into 4 groups. On paper, blackboard or whiteboard as available in the classroom, students are given the instruction to sketch "something". The idea is to name a relatively common object but provide NO OTHER DIRECTION. The following are some possible items:

- Bridge
- Car
- Truck
- Plane
- Etc.

After a few minutes of group sketching, the groups are asked to explain their sketches. The discussion of their drawings might include:

- What did you draw?
- Why did you draw it that way?
- How does it work?
- What are its key features?
- What was challenging about deciding how to proceed?
- How did you make decisions?
- If you had more time, what would you change and why?

Desired Student Takeaways

The students will experience and learn a number of things including:

- That without a clear statement of customer requirements and concrete technical specifications, the designs will vary greatly!
- That it's challenging to get group consensus on a design, even for something that already exists!
- That a picture is a strong way to show a design' intent!
- Having limited time places pressure on the design process!

Brainstorming

Suggested Process

- Pick an engineering topic
- Students take out a piece of paper.
- Timed – 5 minutes - Students individually write out everything they can think of related to the topic
- Appoint one student as "scribe". Ideally have them go to the front of room and use the board / flipchart / overhead projector as available.
- Timed – 5 minutes – Let scribe randomly choose students to read out an item from their sheet and let class add to that item. Scribe attempts to capture as many of these as possible
- At end, scribe takes each item in turn to see if anyone already had that written down. If so, put an "X" next to it. Anything left over was generated due to the group's ability to bounce ideas off each other.

Discussion

- How many ideas were people able to come up with alone?
- What was hard/easy about that?
- How did the ability to see/hear other's ideas help generate new ones?
- Did you create new ideas based on a combination of others

In true brainstorming, EVERYTHING is written / posted to a place everyone can see and anyone can add items. It's often done with post-it notes or index cards/push pins. Brainstorming can be exhausting so it is normally time limited to 30 minutes or so max after which the information gathered is processed. Ideas can then be sorted, ranked, explained, etc. and then all the info should be captured / documented. Brainstorming is effective in small groups such as the size of a typical IED/PD1 team.

Mind Mapping – Concept Classification Tree

Although the text describes these as "Concept Classification Trees" the overall technique is broadly applicable and is also known as "Mind Mapping". This is somewhat like sketching with words or words and pictures. As applied in the textbook, it is used to graph out the various concepts to help show their relationship. It can also be used to help outline entire reports or individual sections, to break out the elements of an experiment or to help gather ideas related to project planning.

Process Flow

- Start with a central idea
- Create an initial sketch
- Add words or even pictures to capture ideas related to the central theme.
- Pick a branch and identify items related to that branch.
- Repeat for each branch
- Simply repeat for the entire map until you have enough detail!

This is a sample "empty" mind map created with OpenSource program "freemind" (available for free at: freemind.sourceforge.net).

Figure 1 - Sample "empty" mind map

Here is the same map but redrawn slightly to place all the branches on one side of the central topic.

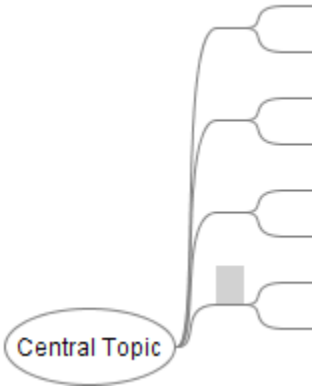

Figure 2 - Re-arranged empty mind map

The overall framework for the IED projects can be expressed as a mind map as seen below. You can have the students work from the syllabus document and create their own copy of this as a class activity.

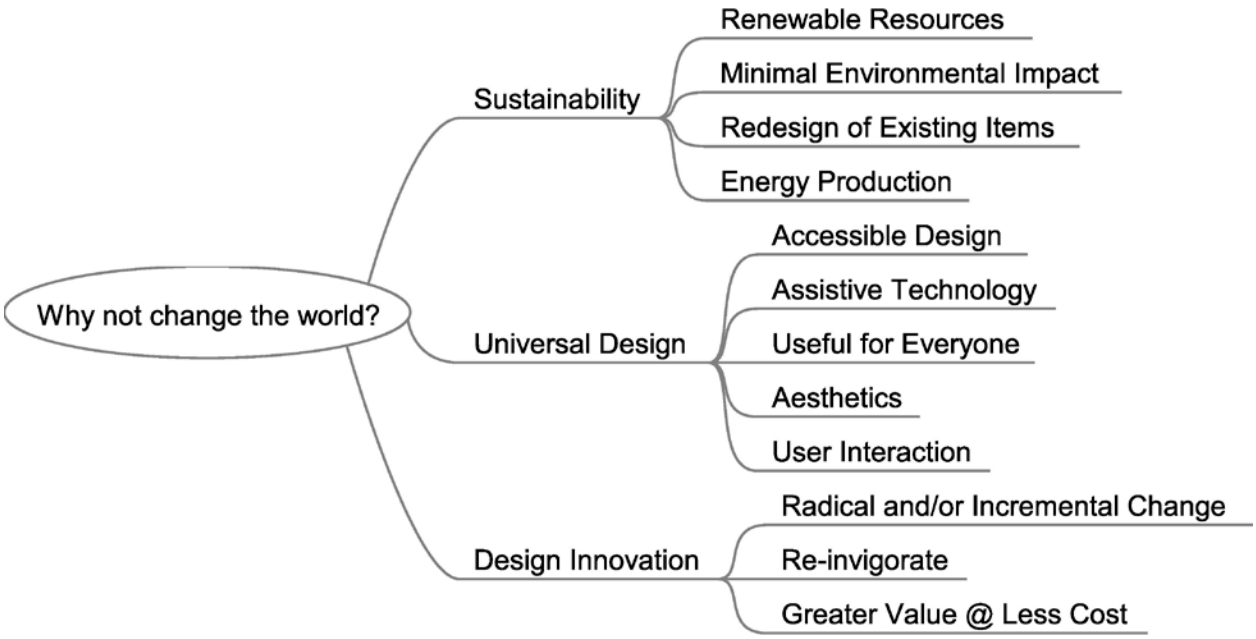

Figure 3 - IED Project Framework

The figure below shows a completed mind map outlining a specific engineering topic. This particular software tool allows additional decorations to the mind map to help convey information. It also supports color coding and grouping of elements in "clouds" as seen in the "feature processing branch".

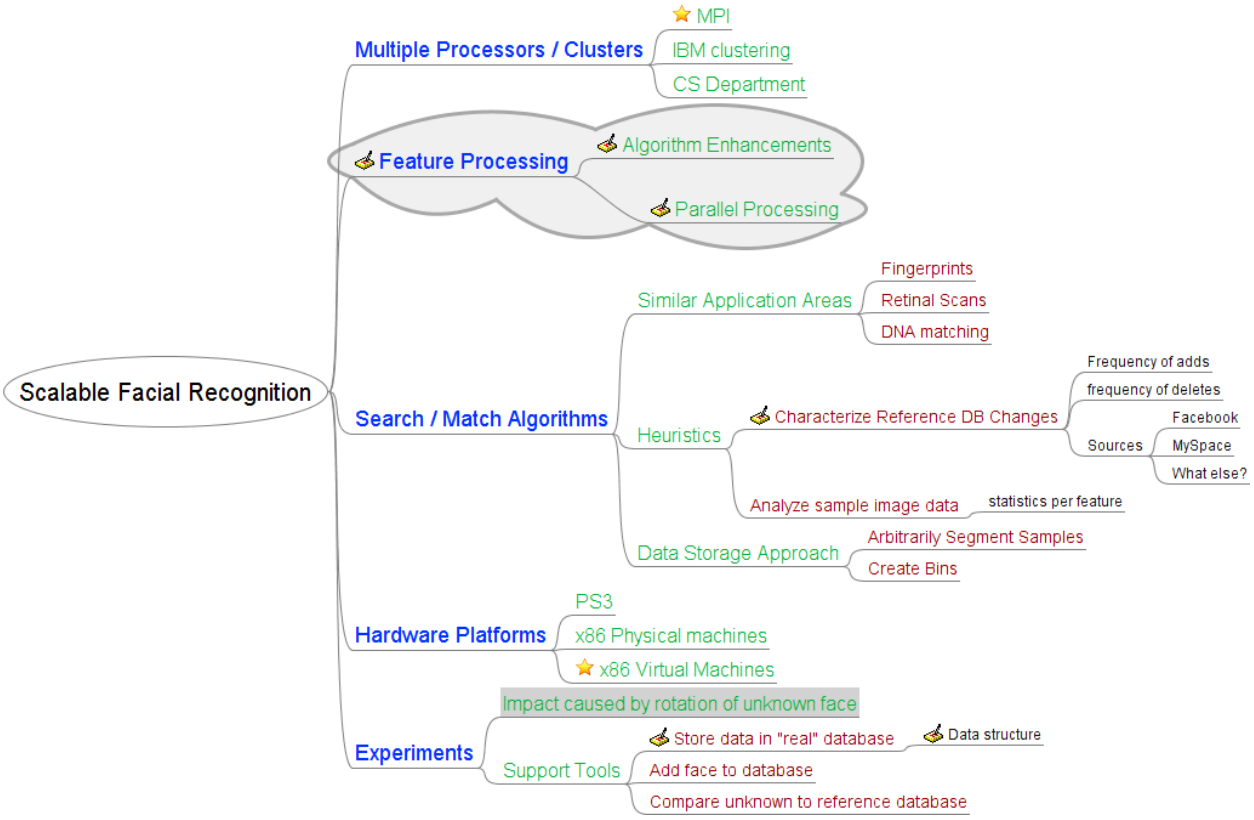

Figure 4 - Mind Map for an engineering problem

Concept Combination Table

Detailed instructions for creating and using a concept combination table can be found in the textbook on pages 114-118. A worksheet is provided as a separate document for the students to help them quickly fill out their own selection matrix for their project.

Once the chart is completed it is possible to evaluate the different combinations of sub-solutions against one another, seeking to identify one or more possible overall approaches. A copy of the chart from that document is repeated here for convenience.

Table 1 – Concept Combination Table

Sub-problems			
Sub-problem 1	***Sub-problem 2***	***Sub-problem 3***	***Sub-problem 4***
Solution Fragment 1-1	Solution Fragment 2-1	Solution Fragment 3-1	Solution Fragment 4-1
Solution Fragment 1-2	Solution Fragment 2-2	Solution Fragment 3-2	Solution Fragment 4-2
Solution Fragment 1-3	Solution Fragment 2-3	Solution Fragment 3-3	Solution Fragment 4-3

Work with a partner. Using the worksheet and the process in your textbook, identify the sub-problems for your project. Then, identify the possible solution fragments for each of the sub-problems.

Simple Concept Screening

This is a fast and simple approach to sorting out a number of possible answers. As engineers we often apply complex analysis tools and models to mathematically represent various technical challenges. At times, however, only a fast go-no go decision is needed to select topics for further detailed analysis. The risk, of course, is that the "right answer" is accidentally ruled out! This is why we document our decision methods, the criteria for evaluating those decisions and the process and results of the decision making in technical reports. This allows others to consider and possibly re-evaluate our efforts – potentially coming up with a different approach.

- Select topic for entire class using a branch from the "Change the World" mind map
- Break students into 4 small groups
- Students list their concepts for projects that fit into that topic.
- Use the table format below
- List the pros and cons for each
- Determine a final ranking and capture that on the table

- Consider having students email you their tables to help create a database of examples

Table 2 - Concept Screening Table Template

Concept	Pros	Cons	Ranking

Discussion topics:

- How difficult or easy is it to rank the items and why?
- How well do the "pros" and "cons" capture the spirit and complexities of each concept?
- How well does this tool help you explore your concepts?

Selection Matrix

Detailed instructions for this activity can be found in the textbook on pages 130-138. A worksheet is provided as a separate document for the students to help them quickly fill out their own selection matrix for their project. The completed selection matrix can then be inserted into your report as below.

Table 3 – Selection Matrix

	Concepts				
	A	**B**	**C**	**D**	**E**
Selection Criteria	**Sample Data**				
Criteria 1	0				
Criteria 2	-1				
Criteria 3	1				
Criteria 4	1				
Criteria 5	1				
Criteria 6	-1				
Criteria 7	1				
Criteria 8	1				
Criteria 9	0				
Criteria 10	-1				
Sum of +1's	5	0	0	0	0
Sum of 0's	0	0	0	0	0
Sum of -1's	-3	0	0	0	0
Net Score	2	0	0	0	0
Rank					
Continue?					

Using the concepts generated in the previous activity the students can now employ the decision matrix to make a better determination of the “ranking” of each concept.

Discussion Topics:

- How does the matrix method compare to the simple table of pros & cons?
- How can you apply this to make better decisions?
- What are the risks of using this technique?
- How can those risks be reduced?

WORKSHEET - Concept Combination Table

Use this worksheet to create your own Concept Combination Table. When it is complete, you can delete the instructions and use the resulting table in your report. You may add or delete columns and rows as needed.

Table 1 – Concept Combination Table

Sub-problems			
Sub-problem 1	***Sub-problem 2***	***Sub-problem 3***	***Sub-problem 4***
Solution Fragment 1-1	Solution Fragment 2-1	Solution Fragment 3-1	Solution Fragment 4-1
Solution Fragment 1-2	Solution Fragment 2-2	Solution Fragment 3-2	Solution Fragment 4-2
Solution Fragment 1-3	Solution Fragment 2-3	Solution Fragment 3-3	Solution Fragment 4-3

Instructions

1. Examine each of the sub-problems in turn.
2. For each sub-problem, what are some of the possible solutions to providing for the function.
3. With a key word or two, describe that solution fragment.
4. Each cell may only address a part of the complete solution. Do not worry about trying to address the other sub-problems, only seek to address that one particular sub-function.
5. How many solution fragments can you find for each sub-problem? Try to find as many as possible. You may apply other creativity tools, such as classification trees / mind mapping, brainstorming etc., toward identifying these possibilities.

Once the chart is completed it is possible to evaluate the different combinations of solution fragments against one another, seeking to identify one or more possible overall approaches.

	Concepts				
	A	**B**	**C**	**D**	**E**
Selection Criteria	**Sample Data**				
Criteria 1	0				
Criteria 2	-1				
Criteria 3	1				
Criteria 4	1				
Criteria 5	1				
Criteria 6	-1				
Criteria 7	1				
Criteria 8	1				
Criteria 9	0				
Criteria 10	-1				
Sum of +1's	5	0	0	0	0
Sum of 0's	0	0	0	0	0
Sum of -1's	-3	0	0	0	0
Net Score	2	0	0	0	0
Rank					
Continue?					

Introduction to Engineering Design with Professional Development I (ENGR 2050)
Classroom Lab Activity

Activity 06-2	Technical Writing
Textbook Reference:	
Purpose / Goal:	To introduce technical writing elements as will be required for the various project deliverables.
Materials / Resources Required:	Textbook, Pencil/pen, paper, laptop, APA Style Guide - http://www.ccp.rpi.edu/apa.html, Final Report template available on LMS.
Time Allocated:	50 minutes

Goals

This course includes professional development elements including both written and oral communications. Good communications skills are a key component of a successful engineering practice. No matter how great a design is the value is diminished if the designer cannot clearly and accurately explain the design! This same is true for students in this course.

Although there are several elements that differentiate technical papers from creative writing, technical writing is formal in style and more structured.

The Types of Technical Document

There are two basic types of document used in this class:

Technical Memo	A less formal document that usually covers only a single area or detail of a project or may act as a brief summary of work.
Technical Report	A structured formal document that completely describes a project, typically from start to finish.

Typical Document Contents / Structure

For a Technical Memo, the following sections would typically be included beyond the author's name(s), the date and the subject:

- Introduction
- Main Topic
- Conclusion / Recommendation

The main topic can and should be broken into multiple sections as needed to help maintain the readability of the material. These subsections help organize the main topic. As the overall "structure" of the memo is relatively straightforward, no template is currently provided.

Because technical reports are more formal documents they generally have the following sections:

- Cover Page
- Executive Summary

- Introduction
- Requirements
- Design Process
- Final Design
- Results and Discussion
- Conclusions
- References
- Appendices

A complete template for the final report is available on LMS. The template includes directions on what to include with each section. While minor adjustments to the template may be appropriate for some projects, it is generally complete and sections should not be dropped without a discussion with the instructors. Ask your instructors if it is unclear where information should be placed in the report.

Finding and Correcting Common Mistakes –

The following is a writing sample that includes mistakes of grammar, punctuation, and spelling. Working with your partner, can you find and correct all of the problems in the sample texts below? What else should be added to make the material easier to understand?

> The design we have created, brings an alternat solutions, to harnessing wind power at an affordable rate.
>
> The customer for this wind belt was originally targeted to be the average homeowner looking for greener energy solutions. However, after creation and actual testing was done, the optimal power output we were looking for was not achieved. Therefore, we have changed our target customer to people who live in the mid-west or another windy location where power cannot be produced by traditional means, such as in a windy third world country.
>
> It is designed to perform at a suitable level for the customer by oscillating at a defined wind speed threshold. The challenge was to determine, “dose this meet there requirements”?
>
> The final design consists of a rectangular frame measuring 3” long by 18” wide by 4.5” high built out of ¼” thick polycarbonate plastic. 2” diameter PVC tubes are attached to the frame by threaded ¼” bolts and hex nuts, which allow for movement in the tubes and, consequently, the adjustment of tension in the ribbon. The ribbon, which is ½“ wide Mylar coated Taffeta tape, is secured to the PVC by the bolts and stretches across the length of the frame to the opposite PVC tub.
>
> ½” diameter by 1/8” thick neodymium (NdFeB) magnets with a strength of 1.48 Tesla each are placed on either side of the ribbon about an inch from the PVC tubes.
>
> The frame may be made first, using a band saw to cut the pieces of the basic frame and the brackets. The brackets may be secured to the frame material with rivets and a riveting tool, or

small nuts and bolts. Any holes that are to be riveted must be pre-drilled. After this is complete, drill one hole on each side of the frame which will be used to insert the bolts for the tensioning device. Once these holes have been drilled, four holes need to be drilled on each side of the top and bottom pieces of the frame in order to attach the coils. The coils may be attached solely their with eight zip ties, two for each of the four coils. The Mylar coated taffeta tape may be attached to the tensioning device by cutting a small slit in the tape, and inserting the bolt through the tape when the construction is complete. Two magnets must carefully be attached to either side of the tape, as they are often delicate and brittle. The pulling force of the magnets and friction against the tape will hold them in place. The magnets should be attached to the tape and separated only by the thickness of the tape.

Evaluation –

The instructor will select teams to share their findings with the class. How can the material be improved?

Properly Citing Material –

Information that is properly referenced allows the reader to use that reference to gain additional information and understanding of the material. This also provides credit to the author of that material for their work. When references are not included or are not properly made, the reader may have difficulty checking the facts or confirming the information as presented. At worst, lack of proper citations could result in plagiarism which is a violation of our Academic Policies.

A simple guideline for illustrations, pictures and diagrams – if you did not draw it from scratch or actually take the photograph yourself, it must be cited!

Exercise –

Write a small paragraph summarizing the section “Hints for Generating Solution Concepts” on Page 109-110 of your IED textbook. Properly cite the source (or sources if they are within the section) below the paragraph.

Adjusting To Formal Writing Style

It can be a challenge for students to make the transition from creative writing to technical writing. Ask yourselves some of these questions as you review the material:

- Was any information missing?
- What information wasn’t there?
- Did you have to make any assumptions? What where they?
- How can this writing be improved?
- In addition to different wording, what else would make this easier to follow?
- What does this device / project look like?
- How well are the “5 W’s and 1 H” addressed? (Who / What / When / Where / Why / How)

Working with your partner, rewrite the following sample text from their casual / informal style to a more appropriate formal style suitable for use in a technical memo.

> I wanted to build a new method to detect bats entering and leaving caves so I researched it. Then I figured out how to detect the bats. Then, I looked for ways to connect sensors to a computer. I discovered that my laptop was out of disk space. What I discovered was that this would be really really hard! So then I looked at other ways to do it.
>
> When I bought all the stuff I needed to build the detector I was missing some parts. Some sockets and some connectors. I had most of the chips already and I borrowed some from a friend so it was almost free. I stayed up all night and worked really hard on the box for this. I put the circuit board inside the case. The case was 3 inches deep. It ran on batteries. I connected a red wire to the plus terminal on the battery and to pin 5 of the circuit board. I also connected ground. There were three more pins to connect to the other chips on the circuit board. The chips needed five volts to work rite.
>
> A small motor turned the wheel on the door to make it open and close by turning just a little bit. It worked really good. It worked once and opened the door. In theory, it could open a bigger door too. Their was a handle on it to make it easier. With a bigger handle you could use two hands.
>
> Because bats live in caves the project had to work outside. In the winder the bats sleep. They sleep most of the winter. So the hole project has to work in the cold, even the coldest parts of New York. Volunteers and people would check on the project to see how many bats came in and how many came out.
>
> When the project was done it worked perfectly. It counted ten bats.

Evaluation –

The instructor will select teams to share their findings with the class.

Resources

Center for Communications Practices at Rensselaer, APA Style Guide - http://www.ccp.rpi.edu/apa.html

Introduction to Engineering Design with Professional Development I (ENGR 2050)
Classroom Lab Activity

Activity 07-1	Mini Project Presentations
Textbook Reference:	N/A
Purpose / Goal:	For students to present an overview and conduct a demonstration of their mini-projects.
Materials / Resources Required:	Student projects. Presentations are to be emailed to the instructor BEFORE the start of class. The instructor's laptop will be used to show all presentations. Students are NOT to swap their PC in/out for presentations due to the time factor. Mini Project Presentation Rubric.
Time Allocated:	1:50

The Process

Each section has a maximum of 14 teams. The Monday / Tuesday classes and the Thursday / Friday classes are available for presentations. Instructors may split the presentations between these two time slots as they see fit, including the option of having all teams present during either of the two times.

The presentations are an opportunity to practice Professional Development skills. The presentations are to be formal, given from the "front" of the room. Teams should create and use PowerPoint slides as the basis for their presentation. Each team will have from 3-5 minutes for their presentation and 2-3 minutes for Q&A with the exact times to be set by the instructor.

Teams can assume that the audience has general information about the project and the basic requirements. The presentation does not need to go into detail on these – they will be very similar from project to project. The presentation should include any requirements the team developed which would be unique from team to team. The presentation should focus on the team's design approach to meeting all requirements and the analysis / testing done to verify the results, which will also vary from team to team.

Evaluation

The Mini Project Presentation rubric will be used for evaluation.

Homework

In preparation for Activity 9-1, Team Formation, all students are to read the Team Project descriptions and begin considering which project(s) they prefer and why.

Introduction to Engineering Design with Professional Development I (ENGR 2050)
Classroom Lab Activity

Activity 08-1	Mini Project Presentations
Textbook Reference:	N/A
Purpose / Goal:	For students to present an overview and conduct a demonstration of their mini-projects.
Materials / Resources Required:	Student projects. Presentations are to be emailed to the instructor BEFORE the start of class. The instructor's laptop will be used to show all presentations. Students are NOT to swap their PC in/out for presentations due to the time factor. Mini Project Presentation Rubric.
Time Allocated:	1:50

The Process

Each section has a maximum of 14 teams. The Monday / Tuesday classes and the Thursday / Friday classes are available for presentations. Instructors may split the presentations between these two time slots as they see fit, including the option of having all teams present during either of the two times.

The presentations are an opportunity to practice Professional Development skills. The presentations are to be formal, given from the "front" of the room. Teams should create and use PowerPoint slides as the basis for their presentation. Each team will have from 3-5 minutes for their presentation and 2-3 minutes for Q&A with the exact times to be set by the instructor.

Teams can assume that the audience has general information about the project and the basic requirements. The presentation does not need to go into detail on these – they will be very similar from project to project. The presentation should include any requirements the team developed which would be unique from team to team. The presentation should focus on the team's design approach to meeting all requirements and the analysis / testing done to verify the results, which will also vary from team to team.

Evaluation

The Mini Project Presentation rubric will be used for evaluation.

Homework

In preparation for Activity 9-1, Team Formation, all students are to read the Team Project descriptions and begin considering which project(s) they prefer and why.

Introduction to Engineering Design with Professional Development I (ENGR 2050)
Classroom Lab Activity

Activity 09-1	Team Formation and Exploration of Problem Areas for Team Project
Textbook Reference:	Ulrich & Eppinger, Chapters 6 & 7
Purpose / Goal:	Identify & discuss potential team problem areas. To provide a public speaking opportunity.
Materials / Resources Required:	Laptop, paper, pencil
Time Allocated:	1:50

Team Formation

Time Limit – 50 Minutes

At the start of class, your instructors will place you into your teams. From this point on, you should normally sit together as a team during class and lectures.

Professional Development

- Team Assignments/1st team consultation
  - appropriate infrastructure put in place for team success
- Address MBTI preferences within team
- Review Team Development Models
- Tools for Team Success
  - ground rules
  - team contract
  - means of communication
  - MBTI preferences of team members
  - contact info
  - goals
  - roles and responsibilities
  - strengths and weaknesses

Discuss & Select Team Project Focus Area

Time Limit – 1 hour

- Each team is to have a discussion of potential problem areas that their team project can address
- Each team member should contribute to the discussion and to the on-going decision making process
- As this process MUST finish at the end of the NEXT CLASS, teams are encouraged to meet outside class time!
- Teams MUST document their process, criteria, weightings, decision making methodology, etc. as part of their design process. This is to be included in the Milestone 1 – Concept Proposal and ultimately in the final report.
- Invite each team to speak for 3 minutes on their process & final choice. This provides a public speaking opportunity as well as a chance to explain their work.

The Process

Review The Project Topic Areas / Themes / Ideas

- Look For Possibilities
- Identify New But Related Ideas

Apply Creativity Tools To Explore The List

- Team Member's Background
- Team Member's Experiences
- Team Member's Interests

Identify Team's Criteria For Narrowing Down The List

- How Will Your Team Choose?
- Make a List of Your Criteria Individually, Then Blend Together!
- Are All Considerations Equal in Weighting?

Select Decision Making Tool Set

- Which Decision Making Tools Do The Team Members Prefer / Why?
- Decision Matrices Are Suggested As An Easy Way to Capture Large Amounts of Information
- All Criteria Must Have Documented Explanations - Why Are They Important And How Are They Measured?

Implement Your Decision Making Tools

- Add in Your Chosen Criteria
- Gain Team Concensus on The Relative Merits of Each Criteria
- Tally Your Findings

The above is a suggested, not mandatory process. The key is that the team must find a way to collaboratively work together to produce a “total greater than the sum of the parts”.

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Activity 10-1	Team Project 2
Textbook Reference:	Ulrich & Eppinger, Chapter 7
Purpose / Goal:	Finalize potential team problem areas, select focus area, review the lessons learned from the mini-project experience, write team Statement of Work, develop & organize end user wants/needs
Materials / Resources Required:	Laptop, paper, pencil, "Example - Statement of Work" Word template, "Example - Customer Requirements vs. Technical Specifications" Word template
Time Allocated:	1:50

Discuss & Select Team Project Focus Area

- Each team is to continue discussion of potential problem areas that their team project can address
- Each team member should contribute to the discussion and eventually to the decision making process
- Team selects a decision making tool, preferably including a decision matrix
    - An explanation for each criteria used in the matrix (or other tool) must be documented
- Team completes decision making tool to select their focus area
- Optional – invite each team to speak for 3 minutes on their final choice

Review Lessons Learned

Each team member has learned from their experiences during the mini-project. Document your collected "lessons learned" from the mini-project in a two column table. In the second capture any plans or action items related to each lesson, as in "need more of…" or "try to avoid …". These will help in your team formation and alert everyone for some of the non-technical "things to watch out for"! Include this table in your team's final report along with your analysis of how well the team leveraged this information.

Write Team Statement of Work

The design process continues by clearly and concisely defining the problem statement. The Problem Definition phase includes(Dym & Little, 2009):

1. Clarify Objectives
2. Establish metrics for objectives
3. Identify constraints
4. Revise Client's Problem Statement

We have created a template for capturing this information in a Statement of Work document. This is a one page statement of the project's planned work. It helps define what items are in scope for the

project / project team and what items are not to be included. These out of scope items often form the basis for follow-on projects.

The process:

- Working as project teams
- Download and review the template for the Statement of Work
- Note the example given
- Consider how the areas on the template apply to your team project
- Remove the sample text and fill in the template items with the appropriate information for your project.
- Some of the items will require significant discussion and may result in only a very preliminary Statement of Work. The Statement of Work on larger / longer projects may get revised a number of times. In those cases, each revision is typically separately negotiated with the sponsor / client / customer.

The team Statement of Work is to be included in the Milestone 1 Concept Proposal deliverable and serves as an overview of your final choice of project approach.

Develop & Organize End User Wants/Needs

For your team project, you will next need to identify and document the user's wants and needs. These are the customer's requirements. To be successful, your project should be attempting to meet or fill those user requirements.

You will be using the skills developed in earlier classes for:

- defining who are your target customers
- analysis of customer requirements vs. technical specifications
- using creativity tools, e.g. mind maps and decision matrices to capture, organize and prioritize these requirements

This analysis of customer requirements and the corresponding technical requirements is to be included in your team's Milestone 1 – Concept Proposal deliverable.

Works Cited

Dym, C. L., & Little, P. (2009). *Engineering Design.* Hoboken: John Wiley & Sons, Inc.

Activity 10-1 EXAMPLE Statement of Work

Statement of Work (v.2/6/08) - Shoe Assist Device

Team
John Smith, Mary Jones, Harry Black, Sam White, Priscilla Brown, Tom Grey

Semester Objectives
1. Design and build a working device for the project sponsor similar to the one originally made for him that no longer functions
2. Perform engineering analyses and tests to guide design of a second phase superior device
3. Design and construct and deliver the second phase device that significantly shortens the time for the project sponsor to put on his shoes
4. Generalize the basic design to work for others who face similar challenges
5. Research and evaluate advanced solutions involving automation, sensor implementation to the shoe assist problem

Approach
Rapidly produce a simple device out of easily manipulated material that the project sponsor can actually use. Observe the device in use and use the lessons learned to develop a second generation device for the project sponsor and a generic concept that can address a broad spectrum of people with related disabilities.

Deliverables and Dates
1. Fabricate and deliver first device to the project sponsor (1/26)
2. Results of engineering analyses and tests (2/15)
3. Second generation device design approved (3/1)
4. Second generation device fabricated and delivered to the project sponsor (3/31)
5. Document Test results from the project sponsor's use of second generation device (3/15)
6. Report on evaluation of applicability of advanced technology (4/15)
7. Prototype of more general use shoe assist device.

SOW Instructions
The above is an example of a Statement of Work. Using the review notes as a guide, update this with the proper information for your team project.

When you have finished, please delete all the review notes and this section of instructions!

Comment [MJA1]: Be sure to date your document! If it changes, be sure to change the date as well.

Comment [MJA2]: Project Name/Description

Comment [MJA3]: Briefly – what are the goals for this project?

Comment [MJA4]: In general, without details / specifics, how will you accomplish those goals?

Comment [MJA5]: Identify and list some of the concrete deliverables for your project. Can you demo one or more subsystems? Can you produce & describe complete CAD drawings? Can you share the test plan for the subsystems and the integrated unit?

Activity 11-1	Team Consultation
Textbook Reference:	
Purpose / Goal:	To begin to work together as a team to determine how the team will interact with each other throughout the IED project.
Materials / Resources Required:	
Time Allocated:	1 hour

Team Consultation Packet

- Sharing Team Member Contact Information
- Individual Preferences Worksheet
- Team Type Table
- MBTI Discussion Points
- Team S.W.O.T. Analysis
- Team Ground Rules
- Team Structure
- Team Work Statement
- Team Identity
- Roles and Assignments
- Team Contract

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Activity 11-2	Requirements Definition
Textbook Reference:	Ulrich & Eppinger, Chapter 5
Purpose / Goal:	To define and document the requirements for the team project.
Materials / Resources Required:	Laptop, Problem area definitions, focus area definition, statement of work, and user wants / needs from previous activity. Mini-project work on customer specifications & requirements. Example – Requirements Definition file available from LMS.
Time Allocated:	1 hours

Description

Using the User Needs / Functional Analysis for your team project and the other inputs as the context for this activity, your team will seek to convert the important customer requirements into functional requirements and measurable technical specifications.

Follow the same process as used for the mini-project but use the team project as the context. Use the table in the provided example file as your starting point.

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Table of Customer Requirements and Corresponding Technical Specifications

Customer Requirement	Technical Specification	Target Value / Range of Values	Actual Value / Range of Values
User Comfort	*Noise Level*	*70db Max*	
User Comfort	*Device weight*	*30 lbs Max*	
Size – it should fit in my bathroom	*Height x width x depth*	*Up to 10'x12'x10'*	
Can be used by a child	*Age*	*3-10 years old*	
Can be used by a child	*Strength*	*5 lbs or less to operate*	
Can be used by a child	Height	Operating controls no more than 3 feet above ground/floor	
Air dry my winter clothing to be "dry to the touch"	*Moisture content at 65 degrees F*	*2% - 10%*	
Support a person	*Weight (based on large adult)*	*250lbs min*	

The above is a sample table showing a number of customer requirements and how they have been converted to technical requirements.

Notes:

- create additional rows as needed
- delete the *italicized example*
- keep one customer requirement with corresponding technical specification per row
- create additional rows with the same customer requirement if there are multiple technical specifications
- After each specification is identified, identify the related metrics for it as either a single value (usually an upper or lower limit) or as a range of values.
- Note the last column in the table. Once the project is built you can record your final test result here to help show which requirements you were able to achieve and which ones were not accomplished. A fair, honest and accurate evaluation is critical for good project management!

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Activity 11-2 Requirements Definition – Worksheet

Use this worksheet to create your own table to be included into your report.

Table X - Customer Requirements and Corresponding Technical Specifications

Customer Requirement	Technical Specification	Target Value / Range of Values	Actual Value / Range of Values
User Comfort	*Noise Level*	*70db Max*	
User Comfort	*Device weight*	*30 lbs Max*	
Size – it should fit in my bathroom	*Height x width x depth*	*Up to 10'x12'x10'*	
Can be used by a child	*Age*	*3-10 years old*	
Can be used by a child	*Strength*	*5 lbs or less to operate*	
Can be used by a child	Height	Operating controls no more than 3 feet above ground/floor	
Air dry my winter clothing to be "dry to the touch"	*Moisture content at 65 degrees F*	*2% - 10%*	
Support a person	*Weight (based on large adult)*	*250lbs min*	

The above is a sample table showing a number of customer requirements and how they have been converted to technical requirements.

Notes:

- create additional rows as needed
- delete the *italicized example*
- keep one customer requirement with corresponding technical specification per row
- create additional rows with the same customer requirement if there are multiple technical specifications
- After each specification is identified, identify the related metrics for it as either a single value (usually an upper or lower limit) or as a range of values.
- Note the last column in the table. Once the project is built you can record your final test result here to help show which requirements you were able to achieve and which ones were not accomplished. A fair, honest and accurate evaluation is critical for good project management!

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Activity 12-1	Team Project Concept Generation and Selection
Textbook Reference:	Ulrich & Eppinger – Chapter 6 / 7
Purpose / Goal:	Generate a sufficiently large number of design approach concepts to permit each team to select and document at least one for implementation.
Materials / Resources Required:	Pencil, paper, laptop, Excel file "decision matrix sample", "freemind" mind mapping software (free, OpenSource, from freemind.sourceforge.net), "IED Team Project Description", Table of Customer Requirements and Technical Specifications from the previous class activity.
Time Allocated:	1:50

Overall Objective

There are two ultimate objectives for this class session. The first is to validate the table of Customer Requirements and Technical Specifications developed in the previous class. These must be clearly understood and documented before identifying and selecting project concepts.

In generating these project concepts, the students are expected to use the relevant creativity tools practiced in an earlier activity including:

- Sketching
- Brainstorming
- Mind Mapping
- Morphological Chart
- Concept Screening
- Decision Matrix

Review of Customer Requirements and Technical Specifications

During the first part of the class, each team will present their table to the class for review. One member from each team should be appointed as the spokesperson. The class and instructor can then provide feedback on the table. The intent is to ensure that the requirements are clearly and accurately documented and that meaningful and realistic metrics have been identified.

The Concept Generation and Selection Process

Using a combination of the creativity tool(s) of your choice, generate and document at least three different concepts for approaching the design of your team project.

The concept proposal documentation should include (at least):

- a sketch and corresponding description / explanation of each design alternative
- an explanation of the design process(es) used to arrive at each

- an explanation of which alternative you are proposing to follow

Your Milestone One – System Concept deliverable is based on the result of this activity.

Activity 13-1	No class scheduled
Textbook Reference:	
Purpose / Goal:	
Materials / Resources Required:	
Time Allocated:	2 hour

No Class Scheduled

Due to the academic calendar this is either a holiday or a regular day. To keep the schedule on track, no class is scheduled for this day.

Activity 14-1	Team Project Concept Reviews
Textbook Reference:	
Purpose / Goal:	Share preliminary concepts from each team
Materials / Resources Required:	Pencil, feedback/review forms
Time Allocated:	2 hours

Team Project Concept Reviews

- Each team is to present Team Project concept
- Powerpoint presentations are recommended! Alternatives include poster displays or short handouts (one copy per person required)
- Recommendation is that each team email their presentation to instructor by the start of class. Instructor's PC remains connected to projector and is used for all presentations. Next best alternative is for each team to bring their presentation on a USB memory stick for the instructor's PC to project. Last alternative is to allow each team in turn to bring their PC to the projector. Note that this often leads to lost time due to PC <-> Projector connection issues!

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Classroom Lab Activity

Activity 15-1	Managing Feedback
Textbook Reference:	
Purpose / Goal:	To help students develop the skills needed to create and utilize constructive feedback and to incorporate that into their work.
Materials / Resources Required:	
Time Allocated:	1 hour

Managing Feedback

- Giving and Receiving Feedback
- Strategies for delivering and receiving effective feedback
- Feedback and teams
- Johari Window Model
- Group activity
- Types of Feedback
  - Positive feedback
  - Constructive
  - Negative
  - Destructive

Activity 15-2	Managing Conflict
Textbook Reference:	
Purpose / Goal:	To help students develop the skills necessary to identify and manage conflict within their teams.
Materials / Resources Required:	
Time Allocated:	1 hour

Managing Conflict

- Managing Conflict Effectively
- Conflict Overview
- Sources/Levels of conflict
- Conflict Management Strategies
- Thomas and Kilman's 5 Modes of Conflict Overview
  - Avoidance
  - Accommodating
  - Compromising
  - Competition
  - Collaborating
  - Team activity

Activity 16-1	Team Project – First Informal Design Review
Textbook Reference:	
Purpose / Goal:	Team projects are initially reviewed for several criteria to drive students toward successful implementations.
Materials / Resources Required:	Laptop, paper, pencil, team's "Statement of Work" document, team's Concept Proposal document, Milestone 2 Rubric
Time Allocated:	1:50

Team Project – First Informal Design Review

Purpose

To help the teams get off to a proper start on their team projects by verifying that they have considered several important items as described below.

Consultations by Instructors

Instructors are to talk to and work with all of the teams to understand their initial project direction and to offer suggestions, corrections and other guidance as needed. As instructors we are essentially serving as Project Managers to coach the student teams toward success.

The following are some suggested things for an instructor to look at when reviewing the team's efforts. This is NOT considered nor planned to be a complete list!

1. Product safety
    a. Is the product inherently safe?
    b. Are there potential safety hazards during manufacture?
    c. Are there potential safety hazards during installation / assembly?
    d. Are there potential safety hazards during operation?
    e. Are there environmental considerations?
    f. Is the product potentially harmful to animals?
2. Product lifecycle considerations
    a. What will be the useful life of the product?
    b. What is to be done with the product when it is no longer useful?
        i. Repair?
        ii. Replace?
        iii. Dispose?
    c. Is there a "break-in" period?
3. Manufacturing considerations
    a. Can the product be manufactured for a "reasonable" cost?
    b. Does Rensselaer have or have access to the required manufacturing processes?
4. Cost estimates & budgets
    a. The team should begin creating an estimated project budget
    b. Add as many line items as are currently known or which can be readily estimated
    c. Update the budget weekly as more required items become known and as actual costs are accumulated
5. Realistic project scheduling / planning

   a. Are school breaks / vacations accidentally shown as "work time"?
   b. Are the estimated durations reasonable based on instructor experience?
   c. Is there time / effort planned for individual subsystem testing?
   d. Is there time / effort planned for integrating the subsystems into a final working unit?
6. Viability of the team's concept
   a. Are there any identifiable problems inherent in the team's approach?
   b. Is the complexity appropriate to this program?
   c. Is the concept meaningful?
   d. Does it meet our safety guidelines or how can it be adjusted to do so?

Subsystems

By the end of this class, the team should have a documented list of their subsystems and each member should have their assigned subsystem. It is recommended that multiple students NOT be assigned to a single subsystem but instead that the subsystem be broken down further. Then each student can have a clearly defined subsystem with individual responsibility and tangible output.

There are two typical subsystem diagrams – the "flat" and the "hierarchical". An example of the flat diagram would be seen in Figure 1 - Flat Subsystem Diagram.

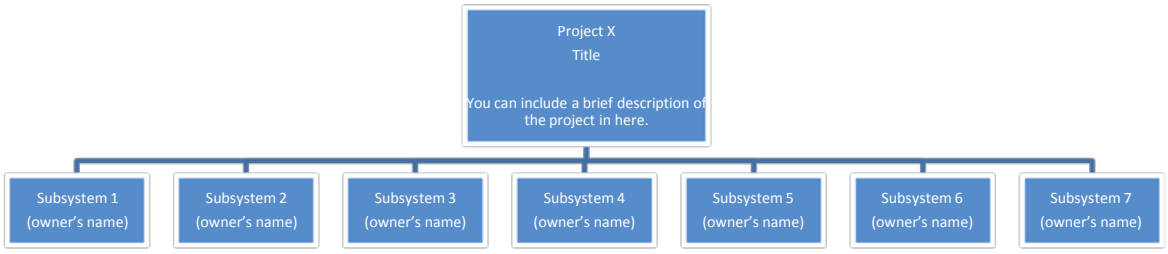

Figure 1 - Flat Subsystem Diagram

An example of a hierarchical subsystem diagram can be seen in Figure 2 - Hierarchical Subsystem Diagram.

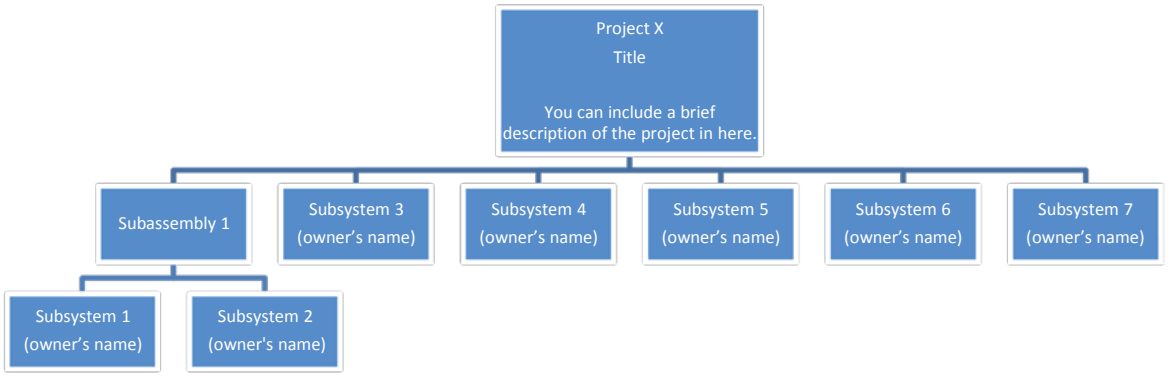

Figure 2 - Hierarchical Subsystem Diagram

As the students are defining the subsystems it is critical that they consider what the interfaces are to and from that subsystem, how it interacts with the rest of the system and how they will test that subsystem. They may need to fabricate a fixture or test setup. This is especially important when they need to demonstrate their subsystem's operation at the final demonstration (Milestone 2). Students should be aware of and review the rubric for that milestone.

Looking Forward

In the remaining classes the teams are to continue their design activities and to document those for their final report / presentation. The most successful teams will capture this documentation each time they meet rather than attempt to generate it all at the end.

The goal is to ask enough questions to develop everyone's confidence that they can succeed with their project!

Activity 17-1	Team Project Design Reviews / Consultations
Textbook Reference:	
Purpose / Goal:	Team projects are reviewed for several criteria to help direct students toward successful implementation of their designs.
Materials / Resources Required:	Laptop, paper, pencil, "Statement of Work" Word template, design documentation, analysis / calculations for the system and subsystems.
Time Allocated:	1:50

Team Project Design Reviews

Resources

During these class sessions the teams will have access to the shop and classroom for the purpose of working on their projects. During these class times the students have access to:

- Their IED Instructor
- IED Shop TA's
- Design Lab Technician as available
- Archer Center Staff as available
- IED shop equipment resources, e.g. benches, machinery, electrical tool kits, mechanical tool kits, electronic work benches, etc.

Expectations

Although this is unstructured time, it is important that the students understand that there are still ground rules and expectations. These include:

- Attendance at each class session
- Focus on their team's project

Students should not be playing computer or other games, surfing the web except for conducting project research, or performing work / assignments for other classes. These are inappropriate and detrimental to their team's top performance.

Consultations by Instructors

Instructors are to talk to and work with all of the teams to understand their project status and offer suggestions, corrections and other guidance as needed. As instructors we are essentially serving as Project Managers to coach the student teams toward success.

Things to look at when reviewing the team's efforts:

1. A meaningful Statement of Work
    a. Is the problem statement clear?

   b. Is the problem statement manageable?
   c. Can it actually be accomplished in a single semester by sophomores?
   d. Have they broken it down into useful deliverables?
   e. Have a different student (each class) present their Statement of Work and a status update with respect to it.
2. Meaningful breakdown into subsystems
   a. Can / does a single person own each subsystem
      i. This is recommended as this builds individual accountability and allows each person to design/build/test their subsystem somewhat independently of their team mates
      ii. Do they know how they will test / validate / verify / demonstrate their subsystem
         1. Before the project's end date?
         2. As part of their final demo?
   b. Does each person have a clear assignment
      i. People tend to make little progress in the absence of clear assignments!
3. Meaningful Gantt chart
   a. Ask a different student each class to tell the team's progress by reading their Gantt Chart
   b. Does each entry have a deliverable or measurable outcome?
      i. How do you know when each task is complete?
   c. Is every entry's duration no longer than one week
      i. Break into multiple sub tasks with unique deliverables / measurable outcome
   d. Does every item have a single owner (others may help, but good project management dictates a single responsible person).
   e. Is the chart current?
      i. Draw line representing "today".
      ii. Is everything to the "left of today" already complete or in process?
         1. If not already complete then it's behind schedule.
            a. What is the plan to correct this?
         2. If in process, is it as far along as expected?
   f. Is everyone busy?
      i. Ask each student to name one thing they just completed
      ii. If they are waiting for another task to complete (e.g. materials to be delivered or fabricated) is there something else they can be working on?
      iii. If they have nothing to work on
         1. Can they assist a team mate?
         2. Have they told their team of their availability?
         3. Otherwise - something's probably wrong!
   g. Is anyone overloaded?
      i. Ask team mates for assistance now, **before** something becomes late!
   h. Is anyone "stuck"
      i. Is it a resource constraint?
      ii. Is it a knowledge constraint?
         1. They are not expected to know everything within their own major nor any other! Encourage them to seek assistance by pointing them in the right direction.
4. Are there sketches (that become CAD drawings) for major elements

   a. Early on, pencil sketches are encouraged
   b. As the project progresses and design details are solidified, CAD or other electronic drawings should be produced by the team (do not wait until the end!)
5. Do they have a cost budget?
   a. Where do the current expenses stand vs. the budget?
   b. What are the planned expenses and are they in the budget?
6. What are the "unanswered questions"
   a. Is there a documented list of things the team does not yet, but needs to, know?
   b. Ask each student to identify one thing they have a question about and their plan for getting it resolved (email, phone call, meeting with faculty/staff, etc.).
   c. Students with NO questions may need to dig deeper into their design!

The goal is to ask enough questions to develop your confidence and their confidence that they can succeed!

Activity 18-1	Team Project Design Reviews / Consultations
Textbook Reference:	
Purpose / Goal:	Team projects are reviewed for several criteria to help direct students toward successful implementation of their designs.
Materials / Resources Required:	Laptop, paper, pencil, team's "Statement of Work", design documentation, analysis / calculations for the system and subsystems.
Time Allocated:	1:50

Team Project Design Reviews

The materials from the previous week should be used again to conduct the on-going design reviews.

Review Models / Analysis / Calculations

At this point in the project's development, the students should have a firm grasp of the system's overall operation and the general operation of each subsystem.

Instructors should have informal discussions with each team / member to review the development of the models and the associated analytical work. Help the students develop sketches that might help them analyze their work.

This will help the students remember to apply the design process rather than only use intuition or guesswork.

Activity 19-1	Team Project Design Reviews / Consultations
Textbook Reference:	
Purpose / Goal:	Team projects are reviewed for several criteria to help direct students toward successful implementation of their designs.
Materials / Resources Required:	Laptop, paper, pencil, team's "Statement of Work", design documentation, analysis / calculations for the system and subsystems.
Time Allocated:	1:50

Team Project Design Reviews

The materials from the previous week should be used again to conduct the on-going design reviews.

INSTRUCTORS - It is important at this time to verify that the project as currently being designed continues to meet all School of Engineering safety requirements and is within the size constraints as outlined in the syllabus materials.

Review Models / Analysis / Calculations

At this point in the project's development, the students should have a firm grasp of the system's overall operation and the general operation of each subsystem.

Instructors should have informal discussions with each team / member to review the development of the models and the associated analytical work. Help the students develop sketches that might help them analyze their work.

This will help the students remember to apply the design process rather than only use intuition or guesswork.

Activity 20-1	Apply Design for Manufacturing (DFM) Methods
Textbook Reference:	Ulrich & Eppinger – chapter 11
Purpose / Goal:	To learn how to apply Design for Manufacturing analysis to a project. To understand and apply costing structures to the team project and produce an estimated project cost.
Materials / Resources Required:	Laptop, paper, pen/pencil, textbook, "Example – Manufacturing Costs.xlsx" and "Shop Resources" – both available from LMS
Time Allocated:	1 hour 50 minutes

Description

The Design for Manufacturing approach creates helps keep designers aware of the costs and cost trade-offs of their designs. Using the appropriate tools as outlined in the textbook, students will perform the first step of DFM to develop a detailed manufacturing cost estimate for their team project. As the team project is a one of a kind prototype, the remaining steps will not be performed.

The manufacturing cost estimate developed during this activity is to be completed independently by the team and included in their Milestone 3 deliverable, the final report.

Estimating Manufacturing Costs

Background Information

Manufacturing costs can be broken into:

- Component costs
- Assembly / fabrication / manufacturing costs
- Overhead

Costs can also be identified as fixed versus variable. Fixed costs are the onetime costs associated with the project. Variable costs are those that depend on the number of units being made. For example, although it may cost $1000 to make the first unit it might only cost an additional $400 each time you make another copy of the product.

As you identify the costs for your project, classify them as either fixed or variable.

Resources

The Spreadsheet Tool

To assist the teams in compiling their cost estimates, an Excel spreadsheet "Example – Manufacturing Costs.xlsx" has been provided. Note that the spreadsheet takes advantage of "grouping" to help divide the costs into categories while providing subtotals for each of those categories. Experiment with the grouping and ungrouping feature. Note that when the group is collapsed, you can still see its subtotal.

Cost Approximations

The textbook has appendices to chapter 11 that provide a range of typical costs.

Students have access to the various shops and facilities here at Rensselaer for fabrication / assembly. A resource document explaining their various costs is provided in LMS.

Labor is an area frequently misunderstood by student engineers. Materials that have to be purchased have a clearly identifiable cost – it's on the receipt! Student labor is humorously referred to as "free" in the context of academic classes since, of course, no paychecks are issued. But to develop an understanding of costs, the team should identify a theoretical cost structure for labor items.

The Process

1. Appoint one team member to open the example spreadsheet and record data.
2. Use any of your design creativity tools to identify as many of the various cost items as possible.
3. Start with the material costs. These are usually easier to identify.
4. Be as specific as possible without attempting to list "every nut & bolt, every wire, every gear" in the project.
5. If you are not able to identify individual items then identify the assembly / sub-assembly.
6. Do not worry about listing the multiple components if you are purchasing an assembly. For example, if you plan to include a microcontroller and the chip is part of a development kit, simply list the development kit. If you will use a gear motor, you do not need to separately list the motor and the gearbox.
7. Enter all the gathered information into the spreadsheet.
8. Review each line item and identify the quantity required and the cost per item.
9. Leverage the textbook's list of estimated costs.
10. Leverage the costing information associated with the Rensselaer shops.
11. Utilize the textbook for additional guidance and suggestions on breaking the items down.
12. Expand the spreadsheet as required.

Although the team project is not one that is expected to be mass produced, you should include explanations of potential cost savings in your write-up for Milestone 3. This should include cost savings due to quantity discounts, potential re-design opportunities, alternate design approaches, etc.

It is important to recognize that cost estimates are a dynamic document. As the design process continues, additional information and insight gathered will suggest changes to the cost estimate. Be sure that your team captures this original cost estimate and saves it as your "baseline". Make a working copy of it and update the working copy as your information grows. Include both your original baseline cost estimate and your final cost estimate in your Milestone 3 report.

Category	Type	Fixed/Variable	Description	Qty	Cost Each	Total Cost
Components	Standard	Fixed		1	1	1
Components	Standard	Fixed		1	2	2
Components	Standard	Variable		2	3	6
Components	Custom	Fixed		3	4	12
Components	Custom	Fixed		4	5	20
Components	Custom	Variable				0
Components	Custom	Variable				0
Components Total						41
Assembly	Labor	Fixed		2	3	6
Assembly	Labor	Fixed		1	5	5
Assembly	Equipment	Variable		1	7	7
Assembly	Equipment	Fixed		2	6	12
Assembly	Tooling	Fixed		3	5	15
Assembly	Tooling	Variable		4	4	16
Assembly Total						61
Overhead	Support	Fixed		1	10	10
Overhead	Indirect Allocation	Variable		1	15	15
Overhead Total						25
Grand Total						127

Activity 21-1	Informal Subsystem Demonstrations and Team Project Design Reviews / Consultations
Textbook Reference:	
Purpose / Goal:	Team projects are reviewed for several criteria to help direct students toward successful implementation of their designs.
Materials / Resources Required:	The Team Project itself, Laptop, paper, pencil, "Statement of Work" Word document, design documentation, project materials
Time Allocated:	1:50

Subsystem Demonstrations

At this point in the design process, students should be implementing their designs for the various subsystems. During this class time students should be able to (informally) demonstrate one or more of the key function(s) of their subsystem.

This provides each student with an opportunity to get feedback from both team members and the instructor on their subsystem and highlight any potential system integration issues. This "progress check" allows the students to have adequate time to iterate (check & correct) their design to increase the chance of success at the Milestone 2 demonstration.

Students should also now be thinking about how they will demonstrate their subsystem at Milestone 2. They should be considering which key function will be shown and how that will be accomplished. Students should also be determining how they will measure / confirm that the function is performing / operating properly.

Team Project Design Reviews

The materials from the previous week should be used again to conduct the on-going design reviews.

Activity 22-1	Informal Subsystem Demonstrations and Team Project Design Reviews / Consultations
Textbook Reference:	
Purpose / Goal:	Team projects are reviewed for several criteria to help direct students toward successful implementation of their designs.
Materials / Resources Required:	The Team Project itself, Laptop, paper, pencil, "Statement of Work" Word template, design documentation
Time Allocated:	1:50

Subsystem Demonstrations

At this point in the design process, students should be implementing their designs for the various subsystems. During this class time students should be able to (informally) demonstrate one or more of the key function(s) of their subsystem.

This provides each student with an opportunity to get feedback from both team members and the instructor on their subsystem and highlight any potential system integration issues. This "progress check" allows the students to have adequate time to iterate (check & correct) their design to increase the chance of success at the Milestone 2 demonstration.

Students should also now be thinking about how they will demonstrate their subsystem at Milestone 2. They should be considering which key function will be shown and how that will be accomplished. Students should also be determining how they will measure / confirm that the function is performing / operating properly.

Team Project Design Reviews

The materials from the previous week should be used again to conduct the on-going design reviews.

Introduction to Engineering Design with Professional Development I (ENGR 2050)
Classroom Lab Activity

Activity 23-1	Team Project Design Reviews / Consultations
Textbook Reference:	
Purpose / Goal:	Team projects are reviewed for several criteria to help direct students toward successful implementation of their designs.
Materials / Resources Required:	Laptop, paper, pencil, "Statement of Work" Word template, design documentation, Milestone 2 rubric
Time Allocated:	1:50

Team Project Design Reviews

For this activity, the teams will conduct informal audits between teams. For this Team A audits Team B in one classroom area while Team C audits Team D in another. Subsequently, B audits C while D audits A. This reinforces the value of peer evaluations and builds upon the previous material on Giving and Receiving Feedback.

Team presents to the Audit Committee (10 minutes)

The audit is started with the team making an oral presentation to the auditors (with the rest of the group present):

- Our need and our customers
- Our primary stakeholder requirements and specifications
- How will each subsystem be demonstrated (MUST use Milestone 2 as a reference)
- Our biggest challenges

Individual to Individual (7 minutes)

Then auditors and team members should pair themselves one-to-one (with the occasional odd two-to one or one-to-two) and ask/discuss three questions:

- How is your team organized to complete the prototype?
- What is your role in that organization?
- What is your personal greatest challenge?

Auditor's Report (10 minutes)

The auditors then discuss their findings and prepare an oral report on their consensus findings to the team. The Auditor Reports are made with the whole class listening.

- What are the team's biggest challenges?
- Is the team sufficiently organized to meet them?
- Are there any significant discontinuities in the team or the team's design process?

The above is then repeated for the second team pairing, e.g. B audits C while D audits A.

The remainder of class time is then available for continuing project work.

Activity 24-1	Team Project Design Reviews / Consultations
Textbook Reference:	
Purpose / Goal:	Team projects are reviewed for several criteria to help direct students toward successful implementation of their designs.
Materials / Resources Required:	Laptop, paper, pencil, "Statement of Work" Word template, design documentation, Milestone 2 rubric
Time Allocated:	1:50

Team Project Design Reviews

The materials from the previous week should be used again to conduct the on-going design reviews.

INSTRUCTORS - It is important at this time to verify that the project as currently being designed continues to meet all School of Engineering safety requirements and is within the size constraints as outlined in the syllabus materials.

Preparation for Milestone 2

Students should download the Milestone 2 rubric and fill in the table at the top listing the subsystems and information related to how each will be demonstrated and verified.

Instructors must review this table to ensure that the students will have a meaningful demonstration at Milestone 2.

Introduction to Engineering Design with Professional Development I (ENGR 2050)
Classroom Lab Activity

Activity 25-1	Team Project Design Reviews / Consultations
Textbook Reference:	
Purpose / Goal:	Team projects are reviewed for several criteria to help direct students toward successful implementation of their designs.
Materials / Resources Required:	Laptop, paper, pencil, "Statement of Work" Word template, design documentation, Milestone 2 rubric
Time Allocated:	1:50

Team Project Design Reviews

The materials from the previous week should be used again to conduct the on-going design reviews.

INSTRUCTORS - It is important at this time to verify that the project as currently being designed continues to meet all School of Engineering safety requirements and is within the size constraints as outlined in the syllabus materials.

Preparation for Milestone 2

Continue as needed from the previous activity.

Students should download the Milestone 2 rubric and fill in the table at the top listing the subsystems and information related to how each will be demonstrated and verified.

Instructors must review this table to ensure that the students will have a meaningful demonstration at Milestone 2.

Activity 26-1	No class scheduled - HOLDAY
Textbook Reference:	
Purpose / Goal:	
Materials / Resources Required:	
Time Allocated:	2 hour

No Class Scheduled

Due to the academic calendar this is a holiday No class is scheduled for this day.

Activity 27-1	Team Project Demonstrations
Textbook Reference:	
Purpose / Goal:	To demonstrate that the overall project works and meets its functional requirements and that each subsystem works to its intended purpose.
Materials / Resources Required:	Project materials, Team Project Milestone 2 rubric, Team Project Description document.
Time Allocated:	2 hours

Team Project Demonstrations

- Milestone 2
- Project team demonstrations

Demonstrations are to be graded using the Team Project Milestone 2 rubric. Time allocations per demo are included in the Team Project Description document. Instructors may use either or both allocated class sessions to conduct the demos at their discretion.

While teams may use a display graphic / system diagram / feature list, this is NOT a presentation. Teams should focus on demonstrating that the project in its entirety and each of the subsystems works as expected. This is NOT the time to explain how the project works, fabrication details or why any design decisions were made.

Activity 28-1	Team Project Demonstrations
Textbook Reference:	
Purpose / Goal:	To demonstrate that the overall project works and meets its functional requirements and that each subsystem works to it's intended purpose.
Materials / Resources Required:	Project materials, Team Project Milestone 2 rubric, Team Project Description document.
Time Allocated:	2 hours

Team Project Demonstrations

- Milestone 2
- Project team demonstrations

Demonstrations are to be graded using the Team Project Milestone 2 rubric. Time allocations per demo are included in the Team Project Description document. Instructors may use either or both allocated class sessions to conduct the demos at their discretion.

While teams may use a display graphic / system diagram / feature list, this is NOT a presentation. Teams should focus on demonstrating that the project in its entirety and each of the subsystems works as expected. This is NOT the time to explain how the project works, fabrication details or why any design decisions were made.

Activity 29-1	Team Project Presentations
Textbook Reference:	
Purpose / Goal:	To practice Professional Development skills related to public speaking, to communicate the design
Materials / Resources Required:	PowerPoint presentation sent to instructor PRIOR to class
Time Allocated:	1:50

Team Project Presentations

- Milestone 3
- Project team presentations

Presentations are to be evaluated as per the rubric. Time constraints for each presentation are given in the Team Project Description document. Instructors may use either or both of the allocated class times at their discretion.

Activity 30-1	Team Project Presentations
Textbook Reference:	
Purpose / Goal:	To practice Professional Development skills related to public speaking, to communicate the design
Materials / Resources Required:	PowerPoint presentation sent to instructor PRIOR to class
Time Allocated:	1:50

Team Project Presentations

- Milestone 3
- Project team presentations

Presentations are to be evaluated as per the rubric. Time constraints for each presentation are given in the Team Project Description document. Instructors may use either or both of the allocated class times at their discretion.