

**TIDEE**

Transferable Integrated Design Engineering Education



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## **UNIT 4: Multi-week Engineering Design Project**

### **Session 1: Planning and Identifying Criteria**

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### **Session 1: Planning and Identifying Criteria**

#### **Announcements and Objectives for the Day (10 minutes)**

- Become familiar with design contest rules
- Understand major design issues that need to be addressed
- Create an initial problem definition based upon criteria
- Establish commitment from team members
- Develop a timeline to effectively utilize team skills to produce an exemplary racing vehicle

#### **Introduction to Design Problem (3 minutes)**

Each team will be supplied with two copies of the latest edition of the design contest rules. Additional information can be achieved by visiting the website.

#### **Determine Design Criteria (20 minutes)**

#### **Identification of Past Design Issues (13 minutes)**

#### **Prioritize Design Criteria (18 minutes)**

#### **Establish Preliminary Timeline (20 minutes)**

The instructor will facilitate this activity by gathering information periodically and helping the class develop a consensus of how the timeline fits together.

#### **Research Paper Products (3 minutes)**

Assignment: Research to find out what kinds of paper products are available to build a human powered paper vehicle. Record information, like how it is constructed, its thickness and sizes available and bring that information and a sample to share with the class during the next class period.

#### **Reflectors Report.**

## Session Overview

This initial session focuses on creating a workable schedule, identifying milestones, establishing commitments from team members. The investigation is begun by identifying the issues surrounding the problem and establishing timelines to accomplish the goal of creating an exemplary design for the contest. The class will:

1. Review the design contest rules
2. Develop a list of the major design issues to be addressed
3. Investigate design issues relative to this contest
4. Prioritize initial design criteria
5. Create a timeline with milestones to direct their design process.

Near the end of the session a five week timeline chart is introduced. The instructor will determine the basic schedule and indicate on the timeline chart the day when each classroom session is to be undertaken. Your team will engage in an activity that helps each member identify appropriate elements within the categories listed below and then determine the due or action date (including weekends).

- Obtain Materials
- Design Tasks
- Construction Tasks
- Presentation Tasks

The setting and tracking of milestones is used for the creation of the prototype as well as for planning the post-race presentation. Periodically through the project, the timeline chart will be reviewed to determine if the development of the prototype is on schedule and/or additional items need to be considered.

The session concludes with an assignment to research the availability of paper products in the local area and a reflectors report providing feedback on how well the teams have engaged in the design process.

## Activity: Determine Design Criteria

**Objective:** To develop an initial set of design criteria from which conceptual designs can be developed

### Tasks

1. Review the contest rules for a human powered paper vehicle.
2. From the rules determine criteria that should be considered when designing a successful **human powered paper vehicle**. Note that these criteria may change during the process as more information is gathered.
3. Begin to think about creating a scale that identifies the importance of the item under consideration.
4. Reporters report team's design criteria.
5. When this task is completed, the instructor will provide you with information concerning problems encountered in previous designs.
6. See next activity.

### Deliverables

- Reporter prepares a summary of team's results.
- Recorder records and summarizes results presented by other teams.

### Criteria for Success

- Team members listen and support other teams' efforts.
- Teams begin to understand scope of design process.

### Resources

- Design contest rules.
- Fifteen minutes of team activity.
- Human Powered Vehicle website: <http://www.technology.ewu.edu/hppv/main.htm>

## Identification of Past Design Issues

Examine past designs is a valuable method you can use to determine relative strengths and areas needing improvement. The best approach is to look at a successful design and make it better. This section looks at tricycles and problems encountered when using paper products as the construction material.

Riders can create tremendous forces and torques through the location of their weight and the pressure on pedals when delivering the power to drive the vehicle. After determining which skeletal material to use in the construction, areas that need special care in designing include the following:

1. **Connections:** If paper is used to make the connection, then it must be layered as thick as the skeletal material. If tape is used, then it must be designed so that it will bond appropriately to the skeleton and that it can take the torque and twisting motion supplied by the rider.
2. **Fork:** The fork is a very weak area and causes many possible modes of failure, including bending, torque or torsion. The two legs of the fork must transition from a single column where all members are each strong enough to carry the load. A good approach is to begin by designing all three elements with the same size of material.
3. **Turning Sleeves:** This part can often fail immediately in torque because it does not have a long enough sleeve. When the race is run the part takes a beating through wear as the vehicle goes through the rigors of the course, with particular problems dealing with turning and the ramp.
4. **Wheel Connections:** Many wheels just fall off due to wear. They must be freely turning. The two back wheels will fail in torsion if they are connected through a solid axle. Humans can exert a tremendous torque through pedals so the driving wheel must be connected solidly to the crank.
5. **Crank:** The crank is the most difficult part to design in paper. It is better to use a metal crank and pedals and work on making a proper wheel connection.
6. **Wheels:** Most wheels work quite well. This is usually not a critical component.
7. **Balance:** The location of the rider is critical. Sometimes weaker parts can be minimized by the where the rider sits. Make sure that the center of gravity is within the human powered vehicle.

## **Resource Availability for Paper Products in the Tacoma Area**

- ❖ Addison Construction Co. for 18" diameter paper tubes called sonotubes.
- ❖ Carpet stores for tubes.
- ❖ Dumpsters for cardboard.
- ❖ The Packaging Store in Lakewood for cardboard.
- ❖ The Carauster Co (in the Tacoma tide flats) for cardboard.
- ❖ A Pepsi Bottling Plant for cardboard.

## Activity: Prioritize Design Criteria

**Objective:** To formulate a ranked set of criteria and elements from which conceptual designs can be developed

### Tasks

1. Discuss the limitations and values of paper products as a construction material.
2. Review the following list to determine whether other items should be included as criteria that need to be considered when designing a successful human powered paper vehicle.
  - a) Aesthetics
  - b) Strength
  - c) Construction time, cost
  - d) Balance
  - e) Ease of construction
  - f) Human resources
  - g) Materials and facility availability
  - h) Criteria based on rules of the contest
  - i) Stability
3. Discuss how each of the criteria from the more inclusive list will impact the development of a design.
4. Discuss the relative importance of each of the criteria and prioritize the list by assigning a weighting factor to each criterion.
5. Prepare a list of criteria with weighting factors.

### Deliverables

- Reporter prepares a summary of team's results.
- Recorder records and summarizes results presented by other teams.

### Criteria for Success

- Team understands how design parameters and criteria affect the process.
- The group establishes a list of criteria that will be useful to develop a design.
- Teams are ready to begin the conceptual design phase which will be driven by appropriate criteria.

### Resources

- Information from presentation of engineering issues from previous human powered paper vehicle designs.
- Twenty minutes of team activity.

## Activity: Establish Preliminary Timeline

**Objective:** To develop a preliminary timeline to establish what and when elements need to be completed in order to create a successful design process

### Tasks

1. Review the topics and days listed on the Timeline Chart for each of the seven sessions in this unit.
2. Discuss what items should be found within each of the four categories. Obtain materials is partially filled out.
  - Obtain materials
  - Design
  - Construction
  - Presentation
3. Determine a deadline for each of the items within the four categories.
4. Review the final results to determine if the sequence between elements is appropriate.
5. Review the final results to determine if it is balanced between time and human resources available.
6. Prepare to report results to the class.

### Deliverables

- Reporter periodically presents a summary of team's results.
- Recorder records and summarizes results in team journal of entire class.

### Criteria for Success

- Team members listen and develop ideas from other teams' responses.
- Teams have a framework from which to develop their design process.

### Resources

- Handout: Timeline Chart
- Design criteria previously established

## Student Availability Times

Name \_\_\_\_\_

Phone \_\_\_\_\_

Major \_\_\_\_\_

Fill in the blanks when you are available to work on team projects

	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
7:30 a.m.							
8:30 a.m.							
9:30 a.m.							
10:30 a.m.							
11:30 a.m.							
12:30 p.m.							
1:30 p.m.							
2:30 p.m.							
3:30 p.m.							
4:30 p.m.							
5:30 p.m.							
6:30 p.m.							
7:30 p.m.							
8:30 p.m.							
9:30 p.m.							
10:30 p.m.							