Design of a One-Handed Shovel

Background: As technology advances we are increasingly able to provide effective and ergonomic ways to assist those with physical disabilities. This includes but is not limited to providing:

a. Wheelchairs for those with severe spinal cord injuries,
b. Hip, knee and shoulder replacements for those whose joints have been damaged or worn out, and
c. Artificial limbs to those that may have lost an arm or leg.

In a local hardware company’s attempt to better serve their community, they would like your assistance in the research and development of a snow shovel that can requires only one hand for normal, comfortable use.

Design Objective: Design and demonstrate a prototype for a one-handed (single-arm) snow shovel. Each design team will give a summary presentation including a demonstration of the prototype (see Deliverable #5). A design report including peer evaluations will be submitted as well (see Deliverable #6).

Shovel Constraints:

1. Shovel must be safe. (no sharp extruding objects i.e. screws)
2. Shovel must help customer lift at a rate comparable to that if they shoveled two-handed.
3. Maximum Weight of Shovel Adaptation: 2 lbs

Additional Constraints:

1. Materials: Each team will be provided with one standard snow shovel that will be modified for use with one arm. Materials for prototype and final product construction may include standard craft materials and throwaways or recyclables, such as empty containers, beverage cups/containers, string, wire, etc. Additional construction materials may be purchased, including adhesives and fasteners (screws, bolts and nuts) as long as the total charges do not exceed the maximum allowable budget.

2. Tools: Construction of the prototype and final product may employ typical hand tools used in crafting. Hand tools such as pliers, wire cutters, saw, and screwdrivers are allowed; hot glue guns are allowed. Power tools and machine tools are not allowed.

3. Cost: The cost of materials used to construct the prototype and modify the shovel for the final product should not exceed $30.00 U.S.

Teams: Teams will be self-selected (form your own teams) and consist of 3-5 members each.
Deliverables: (all report deliverables must be prepared according to the attached guidelines)

1. **Progress Report #1: Specifications (due 9/28, 10 points):** Based on the Design Objective stated, additional constraints placed on the design, and other information gathering your team has done, submit a Progress Report that includes:

   a. A brief summary of the societal context for your product –i.e., the societal situation that you are responding to by developing this product. Describe who will benefit from your design, how your design will be marketed or distributed, and how your design will impact society at large. For information cited include at least one reference.

   b. A list of specifications that includes a) the performance requirements of the design and b) the constraints on the design; and

   c. Any additional performance goals and constraints that may be identified by your team (include an explanation for these additional items).

   *Don’t forget to include economic, sustainability, and humanistic issues when you describe your product specifications and constraints.

2. **Progress Report #2: Results of Brainstorming; Identification and Evaluation of Possible Design Strategies; Preferred Approach (due 9/28, 10 points):** Submit a Progress Report in which you:

   a. Present the results of your brainstorming process;

   b. Identify and evaluate possible design strategies (describe capability of various alternatives to meet your criteria);

   c. Describe the preferred approach; and

   d. Explain why this approach was selected and other approaches eliminated.

   A formal brainstorming process will be conducted in class using the methods outlined in Chapter 2, Section 5 of Engineering and Society with a summary similar to that shown in Example 2. **Deliverables 1 & 2 may be combined into one document.**

3. **Progress Report #3: Design of Prototype (due 10/17, 10 points):** Provide a Progress Report containing:

   a. A one page (or less) summary of the main features of the prototype design (this should be understandable by the “average” person, much like a patent disclosure);

   b. A scaled drawing showing the main features and dimensions of the prototype design (either hand sketches or computer-aided drawings are acceptable, but drawings must be to scale and hand drawings must be of professional quality; rough sketches prepared without measurements or a straight edge (ruler) will not be accepted).
4. **Progress Report #4: Build and Test Prototype (due 10/31, 25 points):** Provide a Progress Report in which you present:
   a. A clear description of the test procedures;
   b. A summary of the test results (both qualitative and quantitative);
   c. Conclusions drawn from the testing; and
   d. A brief summary and explanation of any design modifications resulting from the testing process. *Optional: Include a photo showing build and test.*

5. **In-Class Presentation and Final Product Demonstration (7 minutes): Design Iterations; Final Design and Prototype; Presentation and Prototype Demonstration (due ca. 11/30, TBA, 25 points):** Prepare and present a PowerPoint presentation lasting 7 minutes that includes:
   a. A summary of your prototype design (original design, and design iterations, and prototype design);
   b. A summary of the main features and advantages of your prototype;
   c. A summary of your test procedures and results including design modifications;
   d. A description of the final design; and
   e. A demonstration of the final product showing that it meets the following requirements. *While all team members must be present, it is not a requirement that all team members speak.*

10 points for performance:

1. Shovel can be held horizontally with one arm;
2. Shovel can transfer packing peanuts from point A to point B (established in class);
3. Shovel can transfer sand (or snow if available) from point A to point B.
   - 0 points: (0/3 of above)
   - 3 points: (1/3 of above)
   - 6 points: (2/3 of above)
   - 10 points: (3/3 of above)

6. **Final Report** (due 12/9, 20 points): Submit a final report that is prepared according to the attached guidelines. Deliverables submitted previously (or materials included in them) may be included as appendices and referred to in the main body of the report for details.

   *Note: The self- and peer-evaluations (described below) must be completed by each team member using the attached form and submitted with the final report for the final design project to be considered “complete” and project grades computed and assigned!!*

   **Grading:** Each team member will receive an individual score for the project, computed according to the attached grading procedure and rubric. In most cases, each member of a team will receive the same score. Occasionally, however, someone will simply not put forth much effort or will contribute virtually nothing to the project and this will be clear from the peer evaluations. Such individuals will receive a lower score, accordingly.
Team Design Project Reporting Guidelines

Progress and Final Reports do not need to be extensive, but must convey the necessary information in a clear, concise manner. One group member will be responsible for the final written portion of each of the 5 deliverables (the 4 progress reports and the final report). The designated person will change for each new deliverable. This method is to provide each student with a chance to have technical writing practice in the course.

All reports are to be typed in 11 or 12 point font, with 1-inch margins and page numbers bottom center or bottom right. Hand-written reports will be returned with a 0 grade. Calculations, where present, can be hand-written, but must follow the same guidelines for that of typed fonts. (However, use of an Equation Editor is strongly recommended.) When possible print all reports double sided.

Each Report must contain a Title Page with the following information:

- Title (e.g., Progress Report #3: Design of Prototype)
- Date
- Team Members (names with signatures)
- Group member responsible for writing the report

The Final Report should be roughly 5 to 6 pages long excluding sketches, drawings, appendices, figures, tables, etc.). Deliverables submitted previously (or materials included in them) may be included as appendices and referred to in the main body of the report for details. A word of caution: if a progress report was poorly graded, do not include this as an appendix – rather, correct your mistakes as you re-write these sections in the final report document.

In addition to the Title Page, the Final Report must contain the following sections:

1. Introduction (introduce the design problem at hand; use a minimum of one paragraph but not more than one page)
2. Design Criteria and Performance Standards (briefly summarize; include technical, societal and economic constraints)
3. Prototype Design Summary (summarize the process used to design prototype and the results of that process)
4. Build and Test (describe the building and testing procedures; include results and modifications)
5. Prototype Demonstration (summarize results of the in-class demonstration)
6. Recommendations (present recommendations for improving the design for “commercial development”)
7. Appendices (include calculations, sketches and drawings, progress reports, figures and tables that are not embedded in the text)
# Team Design Project Final Report Grading Rubric

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<th>Weight</th>
<th>Points (1-10)</th>
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<tr>
<td><strong>Introduction</strong></td>
<td>Design problem clearly defined</td>
<td>0.1</td>
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<tr>
<td><strong>Completeness</strong></td>
<td>All required report sections are included; materials submitted as earlier progress reports that are included as appendices are briefly described in text and clearly located in appendix; incomplete or weak progress report information is sufficiently improved in the appropriate sections of the final report</td>
<td>0.5</td>
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<tr>
<td><strong>Demonstration</strong></td>
<td>Process and results of in-class demonstration are clearly described</td>
<td>0.2</td>
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<td><strong>Recommendations</strong></td>
<td>Brief; potential improvements are discussed that would enable wide scale production and implementation</td>
<td>0.1</td>
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<tr>
<td><strong>Appendices</strong></td>
<td>Extra materials well organized, appropriate, and easy to interpret</td>
<td>0.2</td>
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<tr>
<td><strong>Professional presentation and communication, Mechanics</strong></td>
<td>Text, graphics, drawings and tables neat and generated with appropriate computer tools; Tables, figures, drawings, calculations are used appropriately and effectively</td>
<td>0.3</td>
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<tr>
<td><strong>Organization, Focus</strong></td>
<td>Logical flow of material between sections that aligns with basic design process; Purpose of report overall, and each section, clearly defined; Reasonable number of section headers to guide reader</td>
<td>0.3</td>
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<tr>
<td><strong>Grammar, paragraphs, spelling</strong></td>
<td>Sentence structure concise and appropriate for technical communication No spelling, tense or plural/singular agreement errors</td>
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**Total points: (max 20)**
Team Design Project Overall Grading Procedure:
(Descriptions apply to max positive or negative points)

A. **Group Assessment:** The product of 0.75 and the sum of point allocations for deliverables 1 through 6 ______ (maximum 75 points)

B. **Individual Assessment (25 points; points assigned based on peer evaluation and at the discretion of the instructor)**

   Team member contributed at or above average for the group ______ (maximum 25 points);

   or Team member did not do anything ______ (minimum of \(-1 \times\) total of A. Group Assessment, so that project grade = 0);

   or somewhere in between the above __________ (between -75 and 25).

C. **Project Grade = Score for A + Score for B**

   ____________ (maximum 100 points)
Team Design Project Self-Evaluation and Peer Evaluation Form

This form must be completed in confidence at the completion of the project by each team member on the project team, and submitted with the project in individually signed and sealed envelopes.

Please rate the contribution toward the team project of each team member in your group including your own. Provide a score between 0 and 10 for each member and then elaborate on what particular each member contributed. Feel free to write additional comments at the bottom of the form.

Estimated Time Required
Time You Actually Spent
To Complete Project (hours): __________ on Project Tasks (hours): __________

Group: ___________

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<th>Name</th>
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Comments on team contributions/performance:
__________________________________________________________________________
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Signature and Date: ________________________________________________________

Name (print): ____________________________________________________________