Technology Engineering and Design
Performance-based Measurement
Structure Design Challenge

Student Instructions

Structure Design/Build/Test

OBJECTIVE

Design, build, and test the most structurally efficient (holds the most weight) model truss structure.

MATERIALS NEEDED

- 1/8” × 1/8” balsa wood
- Balsa wood sheet, 1/16” thick
- Any type of glue
- Hobby knife, utility knife, balsa wood cutter, etc.
- Cutting mat, if needed

DIRECTIONS

- Draw a computer-generated sketch of the structure to scale.
- Submit a PDF of the structure sketch.
- Using the sketch, create a model of the structure from your materials.
- Test the structure.

DESIGN/BUILD/TEST CRITERIA

- Minimum clear span of 8”
- Maximum bridge length of 12".
- The bridge deck must extend the entire length of the bridge and maintain a "vehicular roadway" without any obstruction (2" wide × 2" high).
- The bridge deck shall be the full width of the “vehicular roadway” and extend the entire length of the bridge’s **longest** dimension
- The bridge deck shall be level (or flat).
- The bridge deck shall be constructed using a single solid balsa wood sheet. The balsa wood sheet used for the deck must be 1/16" thick.
- The bridge deck should be the full width of the “vehicular roadway” and extend the entire length of the bridge’s longest dimension
- The bridge shall be a minimum of 2" wide and must allow a 2"× 2" cube to be passed along the length of the bridge ("vehicular roadway" with no obstructions,

referenced above)

- Gussets, dowels and mitered joint connections are allowed, but only at the joint areas. They can be **no thicker than "** and **no larger than 1/2 square inch in area**.
- Individual members shall be constructed of a single piece of balsa wood
- The bridge must allow a 3"×3" cube to be passed beneath it at mid-span, measured while the end supports are resting on a flat surface
- The bridge must be freestanding.
- There must be a 1/2" hole at mid-span in the bridge deck to allow for testing. There must be no obstructions below the hole that would prevent the passage of the testing rod.
- A 1 ½ " wide × 3" long × 1/2" thick loading plate will be positioned over the hole in the deck at midspan and placed directly on the balsa wood deck.
- A testing rod will fit through the 1/2” hole in the balsa wood deck and attach to the loading plate.
- Bridges will be loaded initially with only the bucket and testing apparatus. Dry sand will be added after the initial loading until the bridge collapses.

DESIGN/BUILD/TEST CONSTRAINTS

- Laminated members are not allowed.
- The bridge must not weigh more than 30g.
- The bridge deck shall not be curved or arched.
- A bridge may not be coated with any material (i.e. paint, stain, or glue).
- There will be no use of steel bars to elevate the plate above the deck.
- The bridge shall contain no member wider than 1/8" nor deeper than 1/8".

EVALUATION

See the Bridge Design/Build/Test Evaluation Rubric.

Digital Portfolio

BACKGROUND

Digital portfolios are electronic collections of learning artifacts intentionally curated to showcase a student's accomplishments and growth over time. A combination showcase/reflective portfolio enables students to show their best work and document connections between course materials and personal experiences.

OBJECTIVE

Create a digital portfolio that documents the Engineering Design Process steps used when designing, building, and testing the structure. Include a reflection for each step in the design process.

ENDURING UNDERSTANDING

Documenting the Engineering Design Process of designing, building, and testing the structure will reinforce course concept mastery. The process of reflection allows students to appreciate and better understand the why of the concepts.

MATERIALS NEEDED

- Computer with Internet connection
- Slideshow presentation software
- USB storage drive
- Past best work
- Portfolio checklist
- Portfolio rubric

DIRECTIONS

Organize the steps from the Engineering Design Process used when designing, building, and testing the structure. You will organize the documentation in a digital portfolio using a slide presentation platform such as PowerPoint, Google Slides, or Prezi. You will also reflect on each step of the Engineering Design Process used when designing, building, and testing. After submitting a copy for evaluation, you will present your portfolio to an audience assigned by the teacher.

PORTFOLIO TIPS

1. **Organization**: Your portfolio should be comprised of a title slide, a reflective introduction/summary, a table of contents, work samples, reflections for each artifact, and a conclusion. You must have a logical explanation for the order in which your portfolio work is presented. Typically, you may want to stick with a chronological order, but sometimes other criteria are more important. Decide on an overall design for your portfolio: layout, color scheme, and choice and placement of graphics. Do not overload your pages with photographs or other graphics; they can create a cluttered look and greatly increase the time a page takes to load. Be sure to follow copyright laws if you are using graphics other than ones you have personally created.

2. **Completeness**: Use the Engineering Design Process graphic to ensure you have documented all required steps in the design process for the structure design, build, and test. Check and double check all criteria and constraints to avoid omitting important required elements.

3. **Neatness**: Pay attention to spelling, grammar, and formatting errors as a neat, organized portfolio is impressive. Being organized and neat will help you in future projects.

4. **Visual appeal**: Include images, 3D models/sketches, and other interesting materials that exemplify your design process and structural engineering skills.

5. **Variety of artifacts and supporting materials**: A student who plans to showcase their portfolio for future employers may go above and beyond the minimum requirements for a portfolio. Show interest in the assignment by adding relevant supporting materials to your portfolio, such as research on structures, graphics, etc.

PORTFOLIO CRITERIA

1. Use slideshow presentation software to create the portfolio
2. The portfolio must include:
    a. Title slide with name of course, student name, date
    b. Introduction/Summary that provides insight/interest to the viewer
    c. Table of contents that links to the slide listed, including Reflection
    d. Documentation for each step of the structure design, build, and test
    e. Reflection for each step of the design, build, and test
    f. Conclusion statement–What have you learned during this process? This course? How has your skill set evolved? Personal growth?
    g. Link each slide back to the table of contents
3. Additional work/design samples used to enhance understanding may be included.
4. Design the portfolio using the principles and elements of design.
5. Submit a copy for assessment.
6. Students will present their portfolio to the class or other intended audience.

PORTFOLIO CONSTRAINTS

1. Slide elements such as background, borders, font, and buttons will be limited to three colors.
2. All structure design, build, and test documentation must be original works.

EVALUATION

See the Digital Portfolio Evaluation Rubric.

Presentation

PRESENTATION TIPS

- Be prepared.
- Stay within the time limit.
- Know the subject matter of your talk.
- Do not read from notes or slides.
- Speak slowly and clearly.
- Make eye contact with the audience.
- Be enthusiastic in order to engage your audience.
- Be prepared to answer questions in a clear and concise manner.

ORAL PRESENTATION CRITERIA

- Begin with an introduction/overview.
- The order of the presentation should match the order of the portfolio.
- Speak clearly and at a volume that everyone in the audience can hear.
- End the presentation with a conclusion/reflection.

ORAL PRESENTATION CONSTRAINTS

The recommended length of time for the presentation is three to eight minutes, this time includes answering questions from the audience.

EVALUATION

See the Oral Presentation Evaluation Rubric.

Structure Design/Build/Test Evaluation Rubric

Student Name_____

Category	Advanced (8 points)	Experienced (6 points)	Developing (4 points)	Incomplete (2 points)	Points
Working Drawing	Drawing is to scale, meets all design specifications, includes dimensions, is neat, and matches the as-built structure.	Drawing is to scale, meets all but one design specification, includes dimensions, is neat, and resembles the as-built structure.	Drawing is not to scale, two or more design specifications are missing, some dimensions are missing, is not neat, and does not resemble the as-built structure.	Drawing is not to scale, is missing more than three design specifications, most dimensions are missing or inaccurate, and does not resemble the as-built structure.	
Structure Construction	The structure is rigid and straight and all pieces are securely fastened; the structure does not move, bend, or wobble when loaded.	The structure is sturdy and pieces are securely fastened; there is minimal movement, bending, or wobbling when loaded.	The structure is stable; pieces may be crooked or not securely fastened; the structure moves, bends, or wobbles when loaded.	The structure is unstable; pieces are crooked or not securely fastened; the structure moves, bends, breaks, or wobbles when loaded.	
Materials	Approved materials were selected, protected, and modified in ways that made them better.	Approved materials were selected, protected, and used effectively.	Approved materials were selected and may be damaged or not used effectively.	Approved materials were damaged, not used correctly, or were randomly chosen.	
Criteria and Constraints	All criteria and constraints were included when designing and building the structure.	All but one criteria or constraint was included when designing and building the structure.	Two criteria and/or constraints were omitted when designing and building the structure.	Three or more criteria and/or constraints were omitted when designing and building the structure.	
Structural Efficiency (amount of weight held)	15+ pounds	12.0–14.99 pounds	5.0–11.99 pounds	Less than 5 pounds	
				Total Points	

Digital Portfolio Evaluation Rubric

Student Name_____

Category	Advanced (8 points)	Experienced (6 points)	Developing (4 points)	Incomplete (2 points)	Points
Required Components	The portfolio includes all required components as listed in the student instructions.	1 required component is missing from the portfolio.	2–3 required components are missing from the portfolio.	4 or more required components are missing from the portfolio.	
Writing Mechanics	Document is free of distracting spelling, punctuation, and grammatical errors; absent of fragments, comma splices, and run-on sentences.	Document has less than 2 spelling, punctuation, and grammatical errors allowing reader to follow ideas clearly. Only 1 fragment or run-on sentence.	Document has more than 2 spelling, punctuation, and grammatical errors not allowing reader to follow ideas clearly. 2 fragmented or run-on sentences.	Document has more than 5 spelling, punctuation, and grammatical errors not allowing reader to follow ideas clearly. More than 2 fragmented or run-on sentences.	
Attractiveness and Organization	The portfolio has exceptionally attractive formatting and well-organized information.	The portfolio has attractive formatting and well-organized information.	The portfolio has well-organized information or good formatting but not both.	The portfolio's formatting and organization of material is confusing to the reader.	
Self- reflection	The self-reflection clearly describes and explains challenges, solutions, and personal growth during the Engineering Design Process.	The self-refection describes challenges, solutions, and personal growth during the Engineering Design Process.	The self-reflection attempts to describe challenges, solutions, and personal growth during the Engineering Design Process.	The self-reflection is unorganized and confusing; it lacks reflection on one or more of the following: challenges, solutions, or personal growth.	

Category	Advanced (8 points)	Experienced (6 points)	Developing (4 points)	Incomplete (2 points)	Points
Ease of Navigating	The document is fully hyperlinked between the Table of Contents and slides. The Table of Contents is well organized and easy to navigate.	Hyperlinks are organized into logical groups. One slide is not linked back to the Table of Contents.	Hyperlinks from the Table of Contents are linked to slides but the Table of Contents lacks organization. Two slides are not linked back to the Table of Contents.	The Table of Contents is plain with few, if any, links. Some links are "broken." Three or more slides are not linked back to the Table of Contents.	
				Total Points	

Oral Presentation Evaluation Rubric

Student Name _____

Category	Advanced (4 points)	Experienced (3 points)	Developing (2 points)	Incomplete (1 point)	Points
Introduction/ Overview	Student clearly states the purpose of the presentation and includes 3 or more statements that will be explained in the presentation.	Student states the purpose of the presentation and includes 2 statements that will be explained in the presentation.	Student does not clearly state the purpose of the presentation or tell the audience what will be presented.	Student does not state the purpose of the presentation, leaving the audience confused.	
Organization	Information is presented in a logical sequence and matches the order of the portfolio.	Information is presented in a logical sequence.	Audience has difficulty following the presentation because information is not presented in a logical sequence.	Audience cannot understand the presentation because there is no organization to the information presented.	
Elocution	Student uses a clear voice and correct, precise pronunciation of terms so that all audience members can hear the presentation.	Student's voice is clear. Student pronounces 1 term incorrectly. Most audience members can hear the presentation.	Student's voice is low. Student pronounces 2 terms incorrectly. Audience members have difficulty hearing presentation.	Student mumbles and incorrectly pronounces 3 or more terms.	
Conclusion/ Reflection	Student clearly summarizes the presentation and brings closure.	Student summarizes the presentation and announces its end.	Student ends the presentation without a conclusion.	Student abruptly ends the presentation without a conclusion.	
				Total Points	

Course Proficiency Score Sheet

Rubric	Total Points Possible	Points Earned
Structure Design/Build/Test	40	
Digital Portfolio	40	
Oral Presentation	16	
Total Points Earned		

Note: Proficiency is met by earning 67 points or above.

Comments: