COURSE: Technological Systems

UNIT: Engineering Design-Cardboard Chair Design

# INTRODUCTION

**Annotation:**

Students will learn to design a product with restrictions and constraints. They will demonstrate the use of simple tools. They will understand the importance of team work.

**Grade(s):**

| | |
|---|---|
| | 6th |
| | 7th |
| X | 8th |

**Time:**

Twenty one 50 minute class periods

**Author:**

Sony Gala

**Students with Disabilities:**

For students with disabilities, the instructor should refer to the student's IEP to be sure that the accommodations specified are being provided appropriately. Instructors should also familiarize themselves with the provisions of Behavior Intervention Plans that may be part of a student's IEP. Frequent consultation with a student's special education instructor will be beneficial in providing appropriate differentiation. Many students (both with and without disabilities) who struggle with reading may benefit from the use of text reading software or other technological aids to provide access to printed materials. Many of these are available at little or no cost on the internet.

# FOCUS STANDARDS

## GPS Focus Standards:

**ENGR-TS-2- The students will develop an understanding of how the design process is used to develop a technological system.**

a) Identify the steps of the design process

b) Identify how systems are used in a variety of settings

c) Illustrate how the systems model is utilized in the production of goods

d) Construct and work with a variety of systems, including Engineering, Electronics, Manufacturing, and Energy

**ENGR-TS-7- Students will develop leadership skills and work ethics.**

a) Demonstrate work ethics within the classroom and lab environment

## GPS Academic Standards:

**M7G3** – Students will use the properties of similarity and apply these concepts to geometric figures.

**M8P3**- Students will communicate mathematically.

a) Organize and consolidate their mathematical thinking through communication.

b) Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.

## National / Local Standards / Industry / ISTE:

STEM STANDARDS:

**ENGR-STEM 2** – Students will identify the impact of engineering and technology within global, economic, environmental, and societal contexts.

**ENGR-STEM 3** – Students will design technological problem solutions using scientific investigation, analysis and interpretation of data, innovation, invention, and fabrication while considering economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability constraints.

**ENGR-STEM 4** – Students will apply principles of science, technology, engineering, mathematics, interpersonal communication, and teamwork to the solution of technological problems.

**ENGR-STEM 5** – Students will select and demonstrate techniques, skills, tools, and understanding related to energy and power, bio-related, communication, transportation, manufacturing, and construction technologies.

**ENGR-STEM 7** – Students will develop leadership and interpersonal problem-solving skills through participation in co-curricular activities associated with the Technology Student Association

# UNDERSTANDING & GOALS

### Enduring Understandings:

- Students will understand that the engineering design process is used in the real world to solve similar problems.
- Some knowledge of both mathematics and science is essential in the process.
- Students will understand that the strength of material changes with the change in shape of material.
- Students will create orthographic drawings of the product.
- Students will use measurement skills and create scale models

### Essential Questions:

- How is the engineering design process used in designing and developing a product?
- What are loads? How do they act on a structure?
- Why is orthographic drawing important during the design phase?
- What skills are used in the engineering design process?

### Knowledge from this Unit:

- List the steps in the engineering design process
- Describe the steps in the engineering design process.

### Skills from this Unit:

- List and implement the engineering design process
- Create orthographic drawings
- Build ¼ scale models

# ASSESSMENTS

### Assessment Method Type:

_____ Pre-test
_____ Objective assessment - multiple-choice, true- false, etc.
__ Quizzes/Tests
__ Unit test
_X_ Group project
_____ Individual project
_____ Self-assessment - May include practice quizzes, games, simulations, checklists, etc.

_____
__ Self-check rubrics
_X_ Self-check during writing/planning process
__ Journal reflections on concepts, personal experiences and impact on one's life
__ Reflect on evaluations of work from teachers, business partners, and competition judges
__ Academic prompts
__ Practice quizzes/tests

X Subjective assessment/Informal observations
__ Essay tests
X__ Observe students working with partners
X_ Observe students role playing

_____ Peer-assessment
__ Peer editing and commentary of products/projects/presentations using rubrics
__ Peer editing and/or critiquing

X Dialogue and Discussion
__ Student/teacher conferences
_X_ Partner and small group discussions
__ Whole group discussions
__ Interaction with/feedback from community members/speakers and business partners

_____ Constructed Responses
__ Chart good reading/writing/listening/speaking habits
__ Application of skills to real-life situations/scenarios

_____ Post-test

## Assessment(s) Title:

Engineering Design Portfolio

¼ scale model of Cardboard Chair

Cardboard Chair

## Assessment(s) Description/Directions:

- Include all research information, ideas, sketches and drawings.
- ¼ scale model chair must match the orthographic drawings and the cardboard chair.
- Teacher will evaluate cardboard chair by sitting in it for at least 90 seconds.

## Attachments for Assessment(s):

**Chair Rubric**

**Engineering Design Portfolio Rubric**

# LESSON PLANS

## Introduction:

1. **Identify the Standards. Standards should be posted in the classroom for each lesson.**

   **ENGR-TS-2: The students will develop an understanding of how the design process is used to develop a technological system.**

a. Identify the steps of the design process
b. Illustrate how the systems model is utilized in the production of goods
c. Construct and work with a variety of systems, including Engineering, Electronics, Manufacturing, and Energy

**ENGR-TS-7: Students will develop leadership skills and work ethics.**

a. Demonstrate work ethics within the classroom and lab environment

### 2. Review Essential Questions.

- How is the engineering design process used in designing and developing a product?
- What are loads and forces? How do they act on a structure?
- Why is orthographic drawing important during the design phase?
- What skills are used in the engineering design process?

### 3. Review Vocabulary

- Alternative solutions
- Model
- Prototype
- Design Portfolio
- Load
- Static
- Dynamic
- Orthotropic
- Center of Gravity
- Orthographic
- Scoring
- Efficiency

## • LESSON 1: INTRODUCE STUDENTS TO THE ENGINEERING DESIGN PROCESS (DAY 1)

1. Show the PowerPoint **Engineering Design Process**, let students copies the eight steps.
2. Discuss each step with the students.
3. Inform them that they will create an engineering design portfolio. This portfolio contains all eight steps.
4. Students may maintain a folder to keep their information.
5. Each step should be hand written and all drawings and sketches must be in pencil.

## • LESSON 2: INTRODUCE STUDENTS TO THE CHAIR DESIGN PROJECT (DAY 2)

1. Show PowerPoint **Chair Design**, slides 1 -4, discuss the problem, restrictions and constraints.
2. Students will form groups and begin steps 1 and 2 of the Engineering design process.
3. Each person in the group is assigned a duty, however remind them that each student is equally responsible to design and build the cardboard chair.

## • LESSON 3: DISCUSS LOADS, JOINTS, TYPES OF MATERIALS AND STRENGTH OF MATERIALS (DAY 3)

1. Students will research the problem through class discussions.
2. Show slides 5 -8 from PowerPoint **Chair Design**.
3. A Load is the weight of an object on a structure.
    a. A Load may be static or dynamic. Static loads do not change, for example: the walls in a room is a static load, it does not change. Dynamic load changes, for example: a desk or bed in a room is a dynamic load. As long as a person is still on the chair the load is said to be static. If the person moves around while sitting the load is dynamic.
4. Remind students that they cannot use any form of adhesives for the chair.
5. Talk to them about making joints using slots and slits in the cardboard.
6. Joints in a chair are where two or more pieces of cardboard come together to hold the structure.
7. Slots should be cut carefully so they are straight, parallel and the exact width of the material that will fit into them.
8. Corrugated cardboard is an orthotropic material.
    a. It is stronger both in compression and tension. Materials that have grains or lines running in one direction are said to be orthotropic. Cardboard is strongest along its orthotropic lines, it is important to cut cardboard along its lines.

## • LESSON 4: REVIEW DISCUSSION (DAY 4)

1. Post the questions from the PowerPoint **Chair Design** slide 7-8.
2. Allow groups to discuss and answer questions.
3. The document handler in each group collects and maintains all work competed so far.
4. Hand out small pieces of cardboard, allow students to observe grains and strength of material.

## • LESSON 5: STUDENTS WILL EXPLORE AND RESEARCH IDEAS WITH THE USE OF THE INTERNET (DAY 5)

1. Show slide 9, PowerPoint **Chair Design**.
2. Allow students to explore the Building big website
3. View a short video on cardboard chair designed by a student
4. Use Google images to view cardboard chairs

## • LESSON 6: STUDENTS WILL BEGIN BRAINSTORMING IDEAS (DAY 6)

1. Show slide 10, PowerPoint **Chair Design**.
2. Students will need rulers, measuring tapes, drawing paper and graph paper.

## • LESSON 7: STUDENTS WILL CONTINUE BRAINSTORMING IDEAS (DAY 7)

1. Show slide 11, PowerPoint **Chair Design**.
2. Ask students to sketch using three view drawings.
3. Students will need rulers, measuring tapes, drawing paper and graph paper.

## • LESSON 8: STUDENTS WILL WORK WITH DIMENSIONS OF A STANDARD CLASSROOM CHAIR (DAY 8)

1. Show slides 12, PowerPoint **Chair Design**.
2. Allow groups to measure the class room chair in inches
3. Discuss the height of the seat from the floor.
4. Discuss shapes and size of back and seat of chair.
5. Allow each group to fill in the table from slide 12.
6. The document handler in each group collects and maintains all work competed so far.

## • LESSON 9: STUDENTS WILL DECIDE ON DIMENSIONS FOR THEIR CARDBOARD CHAIR (DAY 9)

1. Show slides 13, PowerPoint **Chair Design**.
2. Students in a group must decide on dimensions for their cardboard chair. They may refer to the table from the standard classroom to finalize dimensions.
3. Fill the table from slide 13.
4. Each group must convert each measurement to its quarter value.
5. Explain to students that they will use these numbers to build a quarter scale model of the actual chair.

## • LESSON 10: DRAW ORTHOGRAPHIC DRAWINGS OF THE CHAIR (DAY 10 – 11)

1. Use quarter scale measurements to draw the front view, top view and side view of the card board chair. Use graph paper.
2. Drawings should be neat and labeled.

3. Students must use graph paper, ruler and pencil.

4. Show slide 14, PowerPoint **Chair Design**.

5. The document handler in each group collects and maintains all work competed so far.

## • LESSON 11: BUILD A 1/4 SCALE MODEL WITH POSTER PAPER (DAY 12 – 15)

1. Show slide 15, PowerPoint **Chair Design**.

2. Provide each group with a sheet of poster paper.

3. Talk to each group about their orthographic drawing, the ¼ scale model must look like the drawing.

4. Ask groups to create patterns from their drawings on the poster paper, cut out patterns, and build the chair.

5. Show how to score poster paper to create straight folds.
   **Scoring** is the term applied to the process that places a crease in paper stocks allowing the material to be folded.

6. Students may use a ruler to score the poster paper.

7. Groups must complete the ¼ scale chair before building the cardboard chair.

8. If the design fails completely, this is where students must make changes and redo graph drawings.

## • LESSON 12: MATERIAL HANDLING AND SAFETY (DAY 16)

1. Each group receives two sheets of cardboard.

2. Establish a method for handling cardboard at the beginning and end of class.

3. Assign work areas for each group.

4. Ask each group to mark their cardboard sheets.

5. Material handler from each group is responsible for checking out tools at the beginning and end of class.

6. Inform students that measuring tapes and box cutters will be counted before the class is dismissed.

7. Students using box cutters must wear safety gloves.

8. Material handler must check out large pieces of scrap cardboard to use as a base mat when cutting out cardboard sheets. This prevents cuts and scratches on the floor tile.

## • LESSON 13: TEAMS WILL BUILD CARDBOARD CHAIRS (DAY 17 – 20)

1. Show slide 16, from the PowerPoint **Chair Design**
2. Remind students about safety.
3. Hand out materials.
4. Ask students to refer to their orthographic drawings and measurement table from slide 13.
5. Students must use full scale measurements in inches.
6. Allow students to draw chair patterns and cut them out.
7. Assemble chair.

## • LESSON 14: TEST AND EVALUATE (DAY 21)

1. Calculate the efficiency of the chair.
2. As each group completes the chair, weigh the chair in pounds.
3. Tell students your weight.
4. Efficiency of the chair is the weight of the teacher (pounds) divided by the weight of the chair (pounds). Higher the number, higher the efficiency of a structure.
5. Next, teacher will check chair for sturdiness before sitting in it for 90 seconds.
6. Each group will turn in the engineering design portfolio.
7. The portfolio contains all work maintained by the document handler.
8. All work must be arranged in the order described in the engineering design process.

## • ATTACHMENTS FOR LESSON PLANS

1. Short video on cardboard chair designed by a student
   http://www.teachersdomain.org/resource/phy03.sci.engin.design.zchair/
2. Use Google images to view cardboard chairs
3. Building Big site shows strengths of different materials
   http://www.pbs.org/wgbh/buildingbig/lab/materials.html

- **NOTES & REFLECTION:**

Demonstrate to the students that a sheet of notebook paper holds more weight when the shape changes. Use two support ends such as video tapes. Place sheet of paper between the tapes. Place a jumbo paper clip. The paper falls. Fold the sheet like a paper fan. Place between the two tapes. Place several paper clips to show that the paper can hold more weight.

# CULMINATING PERFORMANCE TASK

### Culminating Unit Performance Task Title:

Students will design, build and test cardboard chairs. Details are included in the lesson plans.

# UNIT RESOURCES

### Web Resources:

1. Short video on cardboard chair designed by a student
   http://www.teachersdomain.org/resource/phy03.sci.engin.design.zchair/
2. Use Google images to view cardboard chairs
3. Building Big site shows strengths of different materials
   http://www.pbs.org/wgbh/buildingbig/lab/materials.html

### Materials & Equipment:

- graph paper
- rulers
- tape measures
- calculators
- utility knives
- box cutters
- safety gloves
- cutting mats
- poster board
- cardboard sheets or cardboard boxes

### What 21st Century Technology was used in this unit?

| | | | | | |
|---|---|---|---|---|---|
| X | Slide Show Software | | Graphing Software | | Audio File(s) |
| | Interactive Whiteboard | | Calculator | | Graphic Organizer |
| | Student Response System | | Desktop Publishing | | Image File(s) |
| | Web Design Software | | Blog | | Video |
| | Animation Software | | Wiki | | Electronic Game or Puzzle Maker |
| | Email | X | Website | | |