Teaching with Primary Sources—MTSU

BUILD YOUR OWN HISTORIC STRUCTURES USING COMPUTER AIDED DESIGN (CAD)

Grades: 7-8
Subjects: Career and Technical Education: Inventions & Innovations, Technological Systems; and Mathematics
Time Required: 5 to 10 class periods
Author: Perry F. Louden, Jr., Rockvale Middle School, Rutherford County Schools

OVERVIEW
In this lesson students will become familiar with CAD; research a historic structure (building, monument, house, etc.); sketch a 2D design of the structure; convert the actual length, width, and height (LWH) of the structure to a scale of .025; and build a scale model of the structure. This lesson will take approximately 10 class periods (5 if you leave off the scale models) and should be done in teams of two or three students.

UNDERSTANDING GOAL
The goal of this lesson is to study the dimensions and architectural features of historic structures.

OBJECTIVES
The learner will:
• become familiar with CAD using a program such as Auto CAD LT, FloorPlan, InstantArchitect, Google Sketch Up or other program.
• research a historic structure such as a building, house, monument, etc. from the Built in America collection on the Library of Congress Web site.
• make a hand sketch of the structure and print a CAD drawing.
• utilize math skills to convert from a larger scale to a smaller scale.
• build a scale model of a structure using Balsa wood and place as many features of the original structure on it as possible.

INVESTIGATIVE QUESTION
How does the architectural design of a building provide stability and aesthetic appeal?

CURRICULUM STANDARDS
7th Grade: Computer Technology: Literacy and Usage
4.1: Students will use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences
4.2: Students will use a variety of media and formats to communicate information and ideas effectively to multiple audiences.
7.4.1: Students will use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences using multimedia authoring programs to create linear or non-linear projects incorporating text, audio, video, and/or graphics.

(Continued on p. 2)
**Materials**

- Handouts:
  - Historic Structure Project Overview
  - Picture Analysis Response Sheet
  - Library of Congress Historic Structure Investigation Sheet
  - Structure Conversion Worksheet
  - Self and Peer Evaluation
- Project Portfolio - 3 prong binder or folder (each student needs one)
- CAD Program: InstantArchitect, FloorPlan, AutoCAD, Google SketchUp (free), etc.
- Graph Paper
- Balsa wood: 1/8”x1/8”x36” pieces; 3”x1/16”x36” pieces
- Cutting tools: hobby knife, small hand saw, or other appropriate cutting tool
- Ruler
- Glue: instant glue, wood glue, hot glue or other fast drying glue

**Library of Congress Primary Sources**


**Curriculum Standards (Cont.):**

7th Grade: Mathematics

7.G.A.1: Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

8th Grade: Computer Technology: Literacy and Usage

4.1: Students will use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences

4.2: Students will use a variety of media and formats to communicate information and ideas effectively to multiple audiences.

8.4.1: Students will use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences using multimedia authoring programs to create linear or non-linear projects incorporating text, audio, video, and/or graphics, and creating a document using a variety of media and formats to communicate information and ideas effectively.

5. DETAIL OF TWO-STORY FRONT PORCH, FROM SOUTHEAST - McGavock House, 3130 McGavock Pike, Donelson.

4. WEST (REAR) ELEVATION (left side) AND SOUTH SIDE, FROM SOUTHWEST - McGavock House, 3130 McGavock Pike, Donelson, Davidson County, TN [n.d.]
PROCEDURE

Day 1: Introducing the Project -
Students complete the Picture Analysis Response Sheet while examining the pictures of the Tennessee State Capitol. Reviewing the Response Sheet, explain the project to the students. The investigative question and goal are shared with students and can be referred to anytime during the lesson. Go to https://www.loc.gov/item/tn0034/ and examine the bibliographic page, then examine all the images, drawings and data sheets with the students. Define aesthetic appearance and describe how a building’s structure contributes to its stability (e.g., arches, triangulation, steel trusses and girders, etc.) Hand out the Historic Structure Project Overview sheet which is the cover page in the student portfolio. Place the Picture Analysis Response Sheet behind the Overview sheet in the student portfolio.


If students know the structure that they want to research, they should type the name of it in the search box on the left side. (Note: the survey is selective, so not all well-known buildings or structures will be on it.) If they do not have a structure in mind, use the “Browse by” and select Subject or Place, then select a structure from the list provided. Once students have located their structures, they are to complete the research questions on the Investigation Sheet; research the architectural drawings of their structures and find the actual dimensions of their structures; and then print one of the photographs of their structures and any architectural drawings and place them in their portfolios.

If the physical dimensions are available, students should write them on the sketch. If not, they should use a guess estimation with a regular one-story building having a height of 15 ft., a width of 20 ft., and a length of 20 ft. They should also add details such as construction materials (concrete, brick, wood, steel), porches, pillars, and roofing style (shingle, flat tar, metal). Each student should place the sketch in the student portfolio.
Days 3-4: **Learning CAD** - Students become familiar with Computer Aided Design (CAD) programs. After accessing the program, read in the program manual the Introduction to the program section in chapter 1; complete the tutorial section. After students are familiar with the program, they are to create a CAD drawing of their structures, print out the designs, and place them in their project portfolios.

Days 5-9: **Designing and Constructing a Scale Model** - Have students convert the actual length, width, and height (LWH) of the structure to a scale of .02 using the Structure Conversion Worksheet. Then have them add the scaled dimensions to the structure design beside the original dimensions and place both the conversion worksheet and sketched design sheet back in their portfolios.

Students will build a scale model of their structures using balsa wood, hand tools, and hot glue. Organize the activity into these 4 steps:

- **Step 1 - Framing**
  Use Balsa sticks and make a frame. Measure each stick according to your Structure Conversion Sheet specifications.

- **Step 2 - Siding and Walls**
  Use Balsa boards for the sides. Measure them with a ruler and cut, then hot glue pieces in place.

- **Step 3 - Roofing**
  Use Balsa sticks for the roof.

- **Step 4 – Finishing Touches**
  Put on details such as doors, windows, porches, etc.

Day 10: **Reflecting on the project** - Student teams give a presentation of their completed buildings to the class and discuss its history, design, and how its architectural design provides stability and aesthetic appeal. Additionally, students complete the **Self** and **Peer Evaluation**.

---

**EVALUATION**

- As student teams complete each step of the process, the teacher will check their work for completeness, correctness and thoroughness and then initial their project overview sheet. Upon completion of the final step, the teacher will ensure that the students’ scale models are visually similar to the pictures available of their historic structures. Teachers will need the Historic Structure Project Overview Sheet. Students complete the self and peer evaluation.

**EXTENSION**

- Students can build the structures found in a particular area such as a city square, Washington D.C, etc. and build a scale model of the entire area including roads, sidewalks, trees, and other features.

- Compare and contrast building materials and methods of building from the time students’ historic structures were built and modern-day materials and methods.
HISTORIC STRUCTURE PROJECT OVERVIEW

Name _______________________________________

You are construction engineers for Tennessee Engineering Enterprises (TEE).
Your boss has given you an assignment to research a historical building and construct a scale model of the structure.
You will present your results to the TEE board of directors.

*Place all materials in your Project Folder*

Introducing the Project:
Complete the Picture Analysis Response Sheet: “State Capitol…..Nashville, Davidson County, TN”
Date Completed ____________ Checked ____________

Researching a historical structure from the Library of Congress Web site from step 2 of the procedure:
a. Find a structure from the Library of Congress and print images and drawings of the exterior and the interior of the structure.
Date Completed ____________ Checked ____________

Learning about CAD (Computer Aided Design):
Using FloorPlan, Instant Architect, or Google SketchUp, read the Introduction page and complete the Tutorial section to become familiar with the program. Practice making buildings or houses and print at least one design.
Date Completed ____________ Checked ____________

Designing and Constructing a Scale Model of the Structure:
a. Complete the Structure Conversion Worksheet and sketch the dimensions of your structure on an Entry Sheet.
Date Completed ____________ Checked ____________
b. Using a CAD program, make a computer aided 2D design of your structure.
Date Completed ____________ Checked ____________
c. Build your structure using your CAD design and balsa wood following the Building Your Structure handout.
Date Completed ____________ Checked ____________

Reflecting on the Project:
a. Give a presentation about your completed structure to the class including its historical significance, its structural support, and its aesthetic design.
Date Completed ____________ Checked ____________
b. Complete the Self and Peer Evaluation form.
Date Completed ____________ Checked ____________
PICTURE ANALYSIS RESPONSE SHEET: “STATE CAPITOL…..NASHVILLE, DAVIDSON COUNTY, TN”

Name ________________________________            Period ________  Grade __________

2. Read the bibliographic page, and then click on the picture to the left. What year was the picture taken? __________
3. Under the picture on the left, click on the “JPEG (105kb)” tab.
4. Explore the picture using the control key and + and – keys on your keyboard and the scroll bars.
5. Complete the chart below:

<table>
<thead>
<tr>
<th>What do you observe?</th>
<th>What prior knowledge helps you understand what you see?</th>
<th>What questions do you have about the picture?</th>
</tr>
</thead>
<tbody>
<tr>
<td>____________________</td>
<td>________________________</td>
<td>____________________________</td>
</tr>
<tr>
<td>____________________</td>
<td>________________________</td>
<td>____________________________</td>
</tr>
<tr>
<td>____________________</td>
<td>________________________</td>
<td>____________________________</td>
</tr>
<tr>
<td>____________________</td>
<td>________________________</td>
<td>____________________________</td>
</tr>
<tr>
<td>____________________</td>
<td>________________________</td>
<td>____________________________</td>
</tr>
<tr>
<td>____________________</td>
<td>________________________</td>
<td>____________________________</td>
</tr>
<tr>
<td>____________________</td>
<td>________________________</td>
<td>____________________________</td>
</tr>
<tr>
<td>____________________</td>
<td>________________________</td>
<td>____________________________</td>
</tr>
<tr>
<td>____________________</td>
<td>________________________</td>
<td>____________________________</td>
</tr>
<tr>
<td>____________________</td>
<td>________________________</td>
<td>____________________________</td>
</tr>
<tr>
<td>____________________</td>
<td>________________________</td>
<td>____________________________</td>
</tr>
</tbody>
</table>

6. What materials do you think this building was constructed from?
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
LIBRARY OF CONGRESS HISTORIC STRUCTURE INVESTIGATION WORKSHEET

Name ___________________________________________  Period ______  Grade _____

You are a construction engineer for Tennessee Engineering Enterprises. Your boss has given you an assignment to research a historic building and construct a scale model of the structure.

- If you know the structure that you want to research, type the name of it in the search box on the left side. If that doesn’t work, use the “Browse by” (on left side) and select “Subjects” or “Geographic”, then select one from the list provided. Make sure your selection includes architectural drawings. Find the structure and complete the research questions below.

On the Bibliographic Page:
What is the title of your photograph? _____________________________________________
Does it state who the Creator(s) was? _______  If so, who? ___________________________
Does it state the Date Created/Published? _________  If so, when? _____________________
What is the Medium (type of photograph)? __________________________________________
Is there a summary? _________  If so, what information does it give?__________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________

- Under the picture, click on the “JPEG (1??kb)” tab. Explore the picture using the control key and + and – keys on your keyboard and the scroll bars.

What do you observe in the picture? _____________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________

What building materials was the structure constructed with? _____________________________
_____________________________________________________________________________
_____________________________________________________________________________

What gives this structure stability? _________________________________________________
_____________________________________________________________________________
What makes this structure aesthetically pleasing to look at?

What questions do you have about this photo?

• Research other information about your structure using the Library of Congress Web site or other Internet sites.

What additional information did you find and if available, what are (were) the dimensions of your structure?

• Print out a photograph of your structure and its architectural drawings, and then place them in your student portfolio.
STRUCTURE CONVERSION WORKSHEET

Name __________________________ and __________________________

1. Estimate the size of your building using the following information:
   - 1 story building is 15 ft tall (Height)
   - 2 story building is 30 ft tall
   - Single unit building is 20 ft (Width)
   - Double unit is 40 ft wide
   - Estimate the number of 15 ft sections from front to rear to determine (Length)

   L (Length): ________ ft
   W (Width): ________ ft
   H (Height): ________ ft

2. Convert from feet to inches
   How many inches in a foot? _____ in
   Length: _____ ft x ______ in = _______ in
   Width: _____ ft x ______ in = _______ in
   Height: _____ ft x ______ in = _______ in

3. Scale down your model
   Length: _____ in x 0.02 = _______ in
   Width: ______ in x 0.02 = _______ in
   Height: ______ in x 0.02 = _______ in

4. Draw the dimensions of your scale model below and label measurements for LWH:
**HISTORIC STRUCTURE STUDENT EVALUATION**

Name ______________________________

The name of the structure that I researched is ___________________________________________
It is (was) located at _________________________________________________________________

Three things that I learned about this structure are:
1) _____________________________________________________________________________
2) _____________________________________________________________________________
3) _____________________________________________________________________________

I like _____________________________________ the best because ___________________________

_______________________________________________________________________________
_______________________________________________________________________________

I felt __________________________________was the most challenging because_______________

_______________________________________________________________________________
_______________________________________________________________________________

I did well at _____________________________________________________________________

I need to improve on _____________________________________________________________

I feel that I performed the duties of my position            Well      Okay      Poorly

My overall teamwork was                           Good      Average   Poor
HISTORICAL STRUCTURE PEER EVALUATION

Your Name ____________________________ Your Partner’s Name __________________________

He/She did best at ______________________________________________________________
____________________________________________________________________________

She/He needs to improve on ______________________________________________________
____________________________________________________________________________

He/She performed Well Okay Poorly