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
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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: Inventions & Innovations
1.4 Demonstrate the ability to work professionally with others.
4.1.2 Understand various types of technical graphics and drawings.
4.1.3 Sketch various types of technical graphics and drawings.
5.6.1 Create a two-dimensional drawing of the design solution.

8th Grade: Technological Systems
1.4 Demonstrate the ability to work professionally with others.
4.3 Design and build a structural system.
4.3.2 Use tools, materials, and machines safely to fabricate a simple system.

(Continued on p. 2)
Curriculum Standards (Cont.):

8th Grade: Technological Systems (Cont.):
4.3.2 Build a structure to hold the most load with the least amount of materials.
4.3.3 Test and critique your structural system.
5.1.3 Use tools to process materials into a useful technological system.

7th Grade: Mathematics
GLE 0706.4.3 Understand and use scale factor to describe the relationships between length, area, and volume.
0706.1.7 Explain and demonstrate how scale in maps and drawings shows relative size and distance.
0706.1.8 Recognize the applications of scale factor by exploring blueprints, shadow measuring, and scale models.

Library of Congress Primary Sources

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
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 http://www.loc.gov/pictures/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.

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**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.
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:

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<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>
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6. What materials do you think this building was constructed from?

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
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