Part One: Buildings, Neighborhoods & Towns
Lesson Three: Structures, Systems & Materials in Historic Buildings

By Charles M. Yarborough

Grade Levels
4 – 12 Teachers should adjust/select activities appropriate for the age and ability of their students.

Objectives
- Using historic buildings in your community, students will sharpen their powers of observation and develop research skills.
- Students will learn to become aware of their local environment and structural elements in historic buildings.
- Students will learn about systems in historic buildings.
- Students will learn about materials in historic buildings.
- Students will learn to identify the role of engineers and craftsmen in preserving historic buildings.
- Students will explore how historic buildings were heated and cooled.

Mississippi Curriculum Connections
- Mississippi Studies (4th grade) Framework – Competencies 1,3, & 5
- Mississippi Studies (9th grade) Framework – Competencies 1, 2, 3, 4, & 5

Materials Provided Online www.mississippiheritage.com
- Glossary of Structural Elements
- Architecture Style Guide
- What Makes This Building Historic?
- Instructions for Creating an Architectural Grab Bag

This project has been made possible with funding from the American Architectural Foundation, the Mississippi Arts Commission and the Mississippi Humanities Council.

For the Teacher
Architects and builders must have a firm understanding of appropriate structures, systems and materials to be used in the construction of a building. Successful preservation efforts also must employ an understanding of the structural systems and materials originally employed in the construction of historic buildings.

This lesson plan will offer your students exercises and activities that will give insight into principles of building construction. Additionally, students will gain an understanding of the qualities of construction materials that determine structural limits and possibilities for historic buildings.

Opening the Lesson
Give each student the *Glossary of Structural Elements* provided on www.mississippiheritage.com. Divide students into groups of four or five people, then give each group the name/definition/illustration of one or more structural elements to be covered in class. Challenge each group to illustrate the structural element(s) they've been given by acting out each element. Require that all students in the group be utilized in each illustration.

To act out:	Post and Lintel	Arch	Compression Ring
	Tension Ring	Dome	Barrel Vault
	Column	Cantilever	Buttress
	Flying Buttress	Truss	

As students act out each element, ask if they can identify a structure from the natural world that provides an example of that element. Some possible examples: hill = dome; tree trunk = column; tree branch = beam, cantilever. Reiterate that students will learn about basic structural elements of building in the coming lessons.

Developing the Lesson

Constructing Examples of Structural Elements
In this portion of the lesson, students will build examples of some basic structural elements in order to increase their understanding of these elements.

The Column
Using toilet paper or paper towel tubes or rolled up paper, demonstrate that a paper column lying on its side is weak by placing a heavy book on it. Then stand another paper column on end and demonstrate that it can support the same book.

Working in small groups (depending upon how many paper columns are available), have students place four tubes of equal size in a square several inches apart. Students should predict how many books the columns will support and then carefully stack books on top of the columns. Once the columns collapse or become too high or unstable to be safe, have students estimate the

weight of the books. Have students weigh the books and compare to the weight of the columns.

Using the *Architecture Style Guide* provided on www.mississippiheritage.com, introduce the three orders of Greek columns (Doric, Ionic, and Corinthian). You could also use images of local landmarks.

Have students draw a column and design its capital, encouraging them to use any decoration they would like. Have them make a model of their column and name their capital with a paragraph explanation of the type of building where they would employ their column. Display the column models.

The Cantilever

Using books or blocks, demonstrate a cantilever and discuss where students might find examples of the cantilever in our built environment (balconies, stairways, etc.).

Working small groups (depending upon how many books/blocks are available), have students construct a cantilever to support two objects, one light and significantly heavier. Discuss the different needs to support the heavier load.

Working in small groups, have students construct a wall with a corbelled (cantilevered) arch opening. Explain this is an early, simple form of constructing an opening in a wall.

The Post and Lintel

Using toilet paper or paper towel rolls or rolled up paper for posts and a block, ruler, book, or some other easily found object for a lintel (beam), demonstrate the post and lintel, explaining its usefulness for creating openings in wall.

Working in small groups, have students construct a wall with a post and lintel opening. Show slides/computer images of ways the post-and-lintel method is used in architecture.

The Arch

Using Styrofoam, florist foam, or some other similar substance, cut an arch. Slice out wedges (voussoirs), and be sure the keystone has a vertical axis. For younger students, the teacher may want to do the cutting. Older students should be supervised. Working in small groups, have students construct an arch using the voissoirs and a piece of paper to form a scaffold for support until the keystone is put in place. Students may decorate the voussoirs or the keystone.

The Buttress

Using exactly four books or blocks, challenge students working in small groups to construct a model with two walls and a sloped roof. After students have worked for a few moments (and likely met with frustration!), offer them four additional blocks to complete the task. Students are likely to discover that buttresses will solve the problem of falling walls. If not, illustrate and explain the function of buttresses to counteract the outward thrust of heavy roofs and walls.

The Truss

Using wooden craft sticks with small holes punched in each end and paper fasteners, challenge students working in groups to join the sticks together to form rigid shapes. They should discover shortly that the triangle is the only shape that fulfills the requirement of rigidity.

Have each group of students build four short series of triangles to form trusses. Discuss what uses they might find for their trusses-possibilities include towers, bridge supports and walls.

The Dome

Using pipe cleaners, construct the frame of a dome, including rings attaching the ribs of the dome to prevent collapse. Place a load of some kind on top of the dome to demonstrate its structural strength under a load.

Toothpick and Marshmallow Construction

Give students working in groups or individually toothpicks and marshmallows to make any kind of structure. Set requirements to use all the materials or work non-stop for a set amount of time.

Compare the results. Whose structure is the most stable? Is it based upon a system of triangles?

Have students compete to create the highest structure, the most stable structure, the largest structure or some other interesting criteria. Or challenge students to construct a bridge that will support a book or some other load-the possibilities are limited only by you and your students' creativity! Display the final products.

Building with Newspaper Logs
Have students roll up newspapers or butcher paper sheets into "logs" taped in the middle to create at least ten each. Then, using tape to join the logs together, have students working in groups (large or small, depending upon teacher preference) design and build a structure large enough for a person to get into or to enclose a desk or some other large object.

The structures will likely be excellent illustrators of several basic structural elements.

Compare the Human Body to a Building
Ask students to consider how our bodies might be compared to our buildings. Do we have "elements" that are similar to the structural elements of buildings?

Teachers can lead the discussion comparing the two:

Façade	=	Face
Door	=	Mouth
Windows	=	Eyes and ears
Exterior walls	=	Skin
Structural framework	=	Skeleton
Electrical system	=	Nervous system
Plumbing system	=	Digestive & excretory systems
Ventilation	=	Respiratory system

Have students select one of the human body/building comparisons and write a paragraph answering the following: What are the similarities and differences between these two elements or systems?

Comparing Architectural Materials
Have students working in small groups locate/identify materials within their school that are: rough, smooth, shiny, soft, hard, rigid, flexible, opaque, translucent, transparent, heavy and lightweight.

Have the students do rubbings of some of the materials or photograph them digitally. For each example answer the following questions:

- What is the material?
- Where did you find this material?
- What is the purpose/use of this material in this place?
- What qualities of this material make it appropriate for this location?
- What would be a clearly inappropriate location for this material?

Have students share one or two of their rubbings/photos and findings with the rest of the class. The teacher or a visiting architect, builder or structural engineer should lead the discussion regarding the choice of appropriate materials for specific spaces and uses.

Structural Elements Help Moderate Temperatures
Using the *Architecture Style Guide* materials provided on www.mississippiheritage.com or other images of historic buildings, have student identify cupolas, tall windows, porches, shutters/blinds, chimneys (suggesting fireplace locations), transoms and raised pier construction details.

Explain that, before air conditioning, people understood that hot air rises and took advantage of that understanding as they attempted to cool buildings in a southern climate like Mississippi's. Cupolas, high ceilings, tall windows and transoms each played a role in maximizing air flow through a building by allowing avenues for the escape of hot air as it rose as well as the entrance of cooler air nearer the floor or ground to replace it. Builders also took advantage of prevailing breezes as they sought to maximize the airflow through their buildings, frequently positioning buildings to face the prevailing natural winds.

Another cooling strategy involved maximizing the amount of shade available in a building while not obstructing air flow. Toward that end, many historic buildings utilize extensive porches and shutters or blinds.

Discuss the role that porches, pier construction, shutters/blinds, fireplaces, stoves, high ceilings, transoms, tall windows and brick walls play in keeping a building warm or cool.

Have students write a paragraph explaining how these cooling techniques are not present in modern homes.

Assessing Student Learning
Teachers may develop assessment opportunities in addition to the following:

- Students should learn the basic vocabulary of structural principles.
- Students should construct models of various structural elements.

- Students should write a paragraph comparing the human body and a building.
- Students should create rubbings of materials and evaluate their appropriate uses.
- Students should write a paragraph explaining how cooling techniques used in historic buildings are not present in modern homes.
- Students should participate in various classroom discussions.

Extending the Lesson

The possibilities for extending the lesson are limited only by the desire, time and creativity of the teacher and students. Some possible extensions include:

- Take students on a field trip to area historic buildings. Identify the various structural elements covered in these lessons.
- Students could create photographic collages of structural elements in historic buildings in their area or across the state.
- Students could prepare a lesson/presentation on structures, systems and materials in historic buildings for a group of younger students in another class or for a parent or community group.
- Invite an architect or structural engineer to visit the class.
- Using the *Instructions for Creating an Architectural Grab Bag* provided on www.mississippiheritage.com, have students create a kit of historic building materials.

Curriculum Developed by

Mississippi Heritage Trust
PHYSICAL: 600 East Amite Street, Suite 201
Jackson, MS 39201
MAILING: P.O. Box 577, Jackson, MS 39205
PHONE: 601-354-0200
FAX: 601-354-0220
EMAIL: info@mississippiheritage.com
ONLINE: www.mississippiheritage.com

Author: **Charles M. Yarborough**

As a native Mississippian, Charles M. Yarborough has long been an advocate for educating young people about the history and architecture of our state. A teacher at the Mississippi School for Mathematics and Science since 1995, Charles regularly involves his students in preservation activities, including the performance project *Tales from the Crypt*, which was awarded the 2005 Governor's Award for Excellence in the Arts, and an architecture scavenger hunt of historic Columbus. Charles was named History Teacher of the Year for Mississippi in 2007.