

WAMC Lab

Math Concept(s): Measurement, length, width, height, subtraction, adding fractions

Source / Text: Backstage Handbook, Paul Carter

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Date: 6/25/24

Attach the following documents:

- Lab Instructions-Student Handout
- Summative Assessment Slip

Short Description (Be sure to include where in your instruction this lab takes place):

- Students will model the construction of two different types of scenic flats and understand the differences and purposes for each. This lab follows instruction on types of lumber and manufactured wood, their nominal sizes versus actual sizes, and the *Making A Cut List Lab*.

Lab Plan

Lab Title: *Modeling Broadway Flats versus Hollywood Flats*

Prerequisite skills: The students should have an understanding of imperial measurements, measurement tools (tape measure, scale rule, square), right angles, and squares. Students should have successfully completed the *How to Make A Cut List Lab* assessment and have their cut list from that lab.

Lab objective: In this lab, students will use scale to measure and cut model-making materials to demonstrate their understanding of proper construction of two different types of scenic flats and the differences between the two.

Standards: (Note SPECIFIC relationship to Science, Technology, and/or Engineering)

Mathematics K–12 Learning Standards:

- G-MG.1 Use geometric shapes, their measures, and their properties to describe objects
- G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.

Standards for Mathematical Practice:

- Make sense of problems and persevere in solving them.
- Reason abstractly and quantitatively.
- Model with mathematics.
- Use appropriate tools strategically.
- Attend to precision.

<https://www.wa-appliedmath.org/> (Reading, Writing, Speaking & Listening):

- ELA-SL.2 Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.

[K-12 Science Standards/Engineering](#)

- HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

[Technology](#)

- 4.a. Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.
- 4.d. Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.

[Leadership/21st Century Skills:](#)

21st Century Interdisciplinary themes (Check those that apply to the above activity.)			
<input type="checkbox"/> Global Awareness	<input checked="" type="checkbox"/> Financial/Economic/Business/Entrepreneurial Literacy	<input type="checkbox"/> Civic Literacy	
<input checked="" type="checkbox"/> Health/Safety Literacy	<input checked="" type="checkbox"/> Environmental Literacy		
21st Century Skills (Check those that students will demonstrate in the above activity.)			
LEARNING AND INNOVATION <u>Creativity and Innovation</u>	INFORMATION, MEDIA & TECHNOLOGY SKILLS <u>Information Literacy</u>	LIFE & CAREER SKILLS <u>Flexibility and Adaptability</u>	Productivity and Accountability
<input type="checkbox"/> Think Creatively	<input checked="" type="checkbox"/> Access and Evaluate Information	<input type="checkbox"/> Adapt to Change	<input type="checkbox"/> Manage Projects
<input checked="" type="checkbox"/> Work Creatively with Others	<input checked="" type="checkbox"/> Use and manage Information	<input type="checkbox"/> Be Flexible	<input checked="" type="checkbox"/> Produce Results
<input type="checkbox"/> Implement Innovations	<u>Media Literacy</u>	<u>Initiative and Self-Direction</u>	<u>Leadership and Responsibility</u>
<u>Critical Thinking and Problem Solving</u>	<input type="checkbox"/> Analyze Media	<input checked="" type="checkbox"/> Manage Goals and Time	<input type="checkbox"/> Guide and Lead Others
<input type="checkbox"/> Reason Effectively	<input type="checkbox"/> Create Media Products	<input type="checkbox"/> Work Independently	<input type="checkbox"/> Be Responsible to Others
<input checked="" type="checkbox"/> Use Systems Thinking	<u>Information, Communications and Technology (ICT Literacy)</u>	<input type="checkbox"/> Be Self-Directed Learners	<input checked="" type="checkbox"/> Be Responsible to Others
<input type="checkbox"/> Make Judgments and Decisions	<input checked="" type="checkbox"/> Apply Technology Effectively	<u>Social and Cross-Cultural</u>	
<input type="checkbox"/> Solve Problems		<input checked="" type="checkbox"/> Interact Effectively with Others	
<u>Communication and Collaboration</u>		<input type="checkbox"/> Work Effectively in Diverse Teams	
<input type="checkbox"/> Communicate Clearly			
<input checked="" type="checkbox"/> Collaborate with Others			

Teacher Preparation: (What materials and set-up are required for this lab?)

Materials

- Graphing paper, pencils, popsicle sticks, easy balsa wood cutter tools, scissors, cardstock/index cards, glue sticks, white glue, copies of pages 276-279 (parts of a flat diagrams) of the Backstage Handbook text, copies of the Lab Instructions-Student Handout, and copies of the Summative Assessment Slip.

Set-Up Required:

- Have full-size flats at the front of the room for real-world demonstration/application. Lay the materials at the front, have teams organize a leader to come up and gather the supplies listed in their Lab Instructions.

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

- Students will work in pairs or trios and follow the lab directions having them *interact effectively with others* and be *responsible to others*.

Cooperative Learning:

- For this lab, students will divide the tasks to take responsibility for parts of the construction of each model flat.

Expectations:

- Students will use box cutters/scissors safely

Timeline:

- Preparation of the materials (measuring and cutting popsicle sticks and card stock) will take 10-15 minutes. Assembly of the model flats will take 15-20 minutes.

Post Lab Follow-Up/Conclusions:

Discuss real world application of learning from lab

- How are the two flats built differently? Why can't we just route the skin off if it hangs over the sides of a slightly crooked frame? What happens to the whole set (or future sets) if a stock flat is measured imprecisely or not square?

Career Applications

- Any which require problem-solving or basic construction principles.

Optional or Extension Activities

- After building model flats and students have safety training with a compound miter saw and pneumatic stapler, students can build life-size stock scenic flats for a production or theatre department inventory.

SUMATIVE ASSESSMENT SLIP

1. Assessment: If each square of graph paper on your model flat faces is $\frac{1}{4}$ ", what scale are these flats in? Circle the correct answer:

$\frac{1}{4}$ " Scale $\frac{1}{2}$ " Scale 1" Scale 8" Scale

2. Since our popsicle sticks are modeling 1x3 lumber, are the sticks in the same scale as the graph paper above?
 - a. Yes
 - b. No. The scale of the popsicle sticks are: _____
3. Which theorem says two right triangle Cornerblocks cut from a single square of Luan will be the exact same size and angle?
 - a. Side-Side-Side (SSS) congruence
 - b. Right Angle-Hypotenuse-Side (RHS) rule
 - c. Angle-Side-Angle (ASA) congruence
 - d. All of the above
4. On the back, describe when using Broadway flats is more beneficial for a show than Hollywood AND when we would use Hollywood over Broadway.

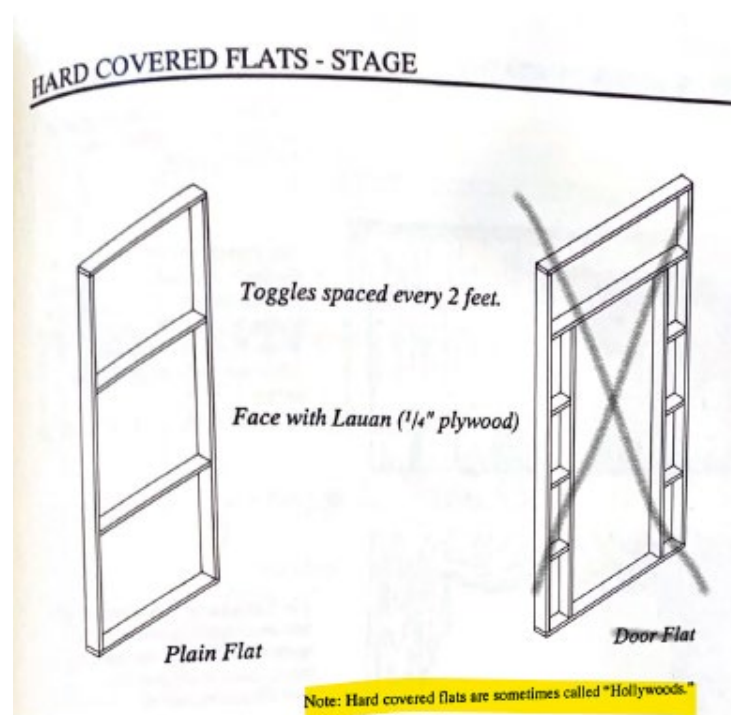
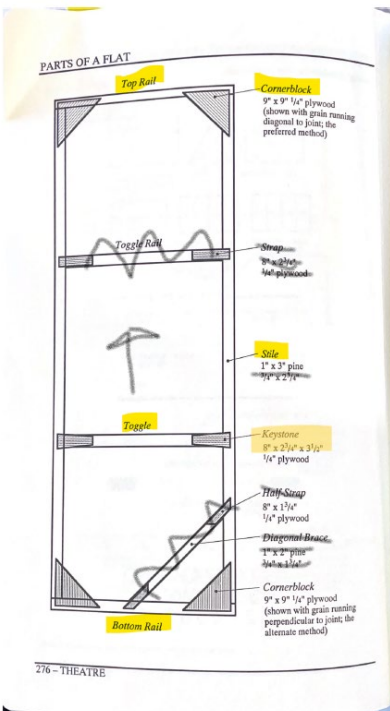
<https://wa-appliedmath.org/>

Lab Instructions - Student Handout:

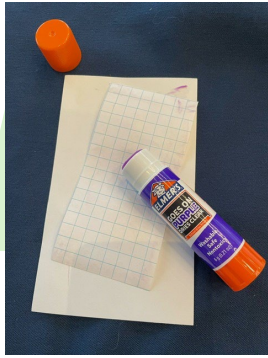
Step 1: Gather Materials & Supplies

- Your Cut List from the Cut List Lab
- Pencils & rulers for each group member
- 1 pair of scissors
- 1 easy balsa wood cutter tool (share with neighboring groups)
- 1 bottle of white glue
- 1 sheet of graph paper
- 2 index cards
- 10 popsicle sticks

Step 2: Use the "Parts of a Flat" pages 276 & 279 from the Backstage Handbook. Vocab: **Face, Rail, Stile, Toggle, Cornerblock, & Keystone.** *NOTE: Our 1"x3" Pine comes in the now standard actual size $\frac{3}{4}$ " x $2\frac{1}{2}$ ", NOT $\frac{3}{4}$ " x $2\frac{3}{4}$ " as the Broadway flat's stile is labeled on page 276. If building stock, we space toggles every 2 feet as depicted. If building for shorter-term, we may use only one toggle and cut the depicted Broadway flat's Toggle Rail + Straps and Diagonal Rail + Half Straps to save time and resources. While Broadway flats can be "soft-cover" made out of stretched muslin and painted, our stock of Broadway flats are hard-cover with $\frac{1}{4}$ " Lauan to make them more durable long-term.*

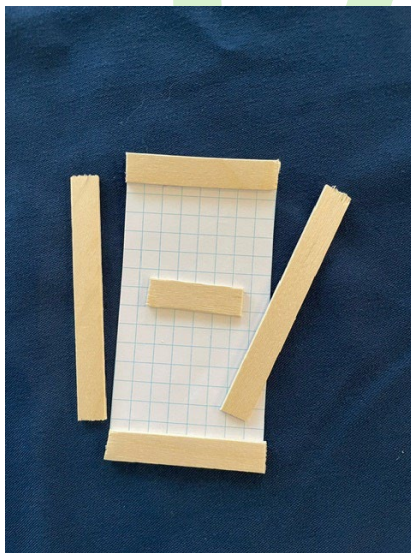
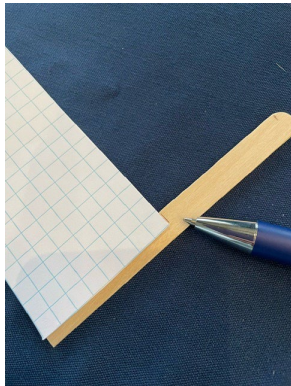


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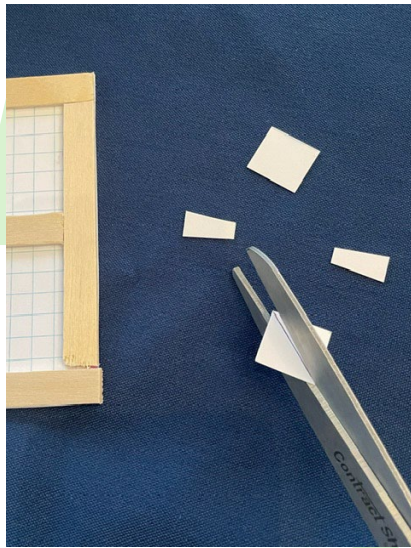


Step 3: Cut two, 8 square x 16 square rectangles from the **graph paper** to represent 4' x 8' sheets of $\frac{1}{4}$ " Lauan for the **Skins** of our two flats. Use a glue stick to glue each graph paper rectangle to an **index card** and carefully trim each to the size of the graph paper.

Step 4: Begin with you **Broadway Flat's Cut List**. Using the **graph paper** as a scale rule, measure and mark 4' (in scale) on two **popstick sticks** as your **Rails**. Use the **easy balsa wood cutter tool** to cut the Rails to size.

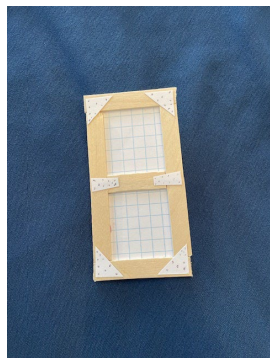


Step 5: Because the popstick sticks are out of scale with the rest of the model, we will subtract the actual width of a stick's face from the top and bottom of our 8' flat (in scale) to get the measurement of our two **Stiles**. Do the same to get the measurement for one **Toggle**. Cut all three pieces and arrange them on one of the graph paper flat **Skin**.



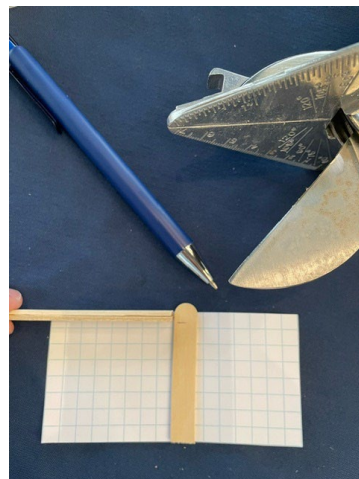
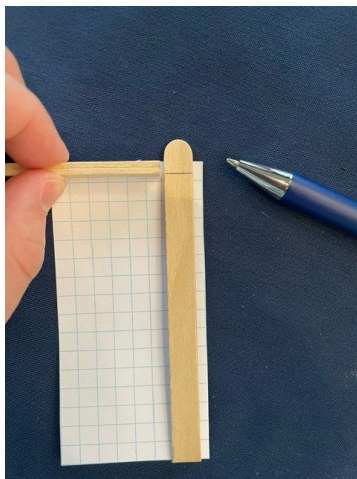
Step 6: Use **graph paper** to measure and mark 2.5 x 2.5 squares on **index card scraps** to make two squares. Cut each square into two **isosceles right triangles** to make your four **Cornerblocks**. For practical purposes, instead of measuring, find two scraps of index card and cut two **Keystones** to fit across the **Toggle** and **Stile** joints of the popsicle sticks. When building proper flats, we would measure and cut the Keystones according to your cut list and the dimensions on page 276 of the Backstage Handbook.

Step 7: Glue your Broadway Flat frame model together using the Cornerblocks and Keystones. Make 5 dots in the “X” pattern on each half of each joint to represent staples. Glue your frame to the graph paper/index card **Skin**. You now have a scale model of a 4x8 Broadway flat!



NOTE: In real life, you would attach your first corner block using a T-Square to make sure the joint is square. You'd proceed joining the three remaining corners. Once the frame is built, we would either glue and staple a muslin soft cover or use a Lauan hard cover skin. Sometimes, for paint purposes, we'll stretch a muslin soft cover OVER a hardcover!

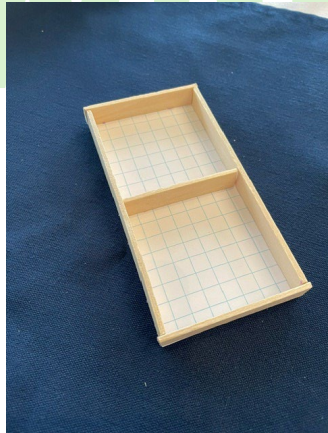
Step 8: Repeat the process above using your Cut List to note the differences in dimensions required to build a Hollywood flat. When it comes time to assemble the frame, use white glue for each joint.



*NOTE: When building a Hollywood frame in real life, we would use **wood glue** on our first corner joint and secure it with **18 gauge 7/16" crown 1.5" pneumatic framing staples**. We'd continue around the flat gluing and stapling the remaining corners, making sure we are constructing properly with the **Top and Bottom Rails** sandwiching the **Stiles** in between. Finally, we'd add the **Toggle(s)** inside and across the true center of the flat*

*frame. The frame will not yet be square! We'll square it to the **Skin** using muscle force!*

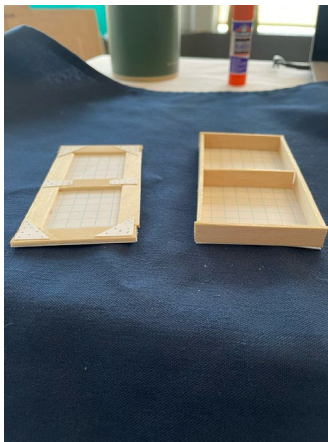
Once mostly dry, dab dots of glue on the edges of the frame and place the index card/graph paper **Skin** on top. Gently push the top and bottom **Rails** one way or the other to force the frame to match the square corners of the **Skin**.



NOTE: When building a Hollywood flat in real life, we will do this same process of squaring the frame to the Lauan skin while the glue is still wet and BEFORE we fasten with staples. First we zig zag glue across all edges of the frame, then we set the Lauan skin on top.

*We adjust the frame to ensure the **Bottom Rail** is flush and centered to the Rail edge of the **Skin** on top, then we secure JUST THE BOTTOM RAIL with 1" Quarter Crown Pneumatic Staples through the face of the skin and into the frame, every 12" or so.*

*Next, we force the frame left or right so an adjacent **Stile** is flush to the Skin. Once we ensure the frame squared to that corner of the skin, we staple through the Skin into the Stile forming a perfectly square frame. Continue stapling around the flat across the Top Rail the remaining Stile.*



*Finally, measure and snap a **chalk line** of the location of the Toggle(s) underneath and staple through to secure those.*