STRUCTURAL MODEL

OVERVIEW

Participants model a through bridge of the Howe, Pratt, or Warren truss style for destructive testing. Teams should prepare by fabricating several structures to evaluate which style to use in competition.

CHALLENGE

Participants research and design a model to build using the supplied materials; they also will prepare drawings to reflect their preparation. Teams will have two (2) hours to fabricate their entry from the prepared drawings. Bridges will be submitted, with drawings, for evaluation and destructive testing.

ELIGIBILITY

Participants are limited to one (1) team of two (2) members per chapter.

SAFETY

Participants are required to provide and wear safety-approved eyewear for this event. Prescription eyewear must have side shields to be considered safety eyewear. Should a team member remove his/her eyewear, s/he will be reminded once to replace it. If there is a second infraction, the team will be asked to leave the competition. Sunglasses are not suitable eyewear.

TIME LIMITS

A. Participants have two (2) hours to complete their structure.

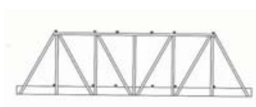
B. The time clock starts when the length of the structure is announced.

ATTIRE

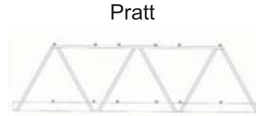
TSA competition attire, as described in the Competitive Events Attire section of this guide, is required.

Howe, Pratt, and Warren are the most common styles of truss bridges. Over the years, several railroads have added extra members to the basic truss bridge to meet their needs and, therefore, are sub-styles included with the railroad name. Examples would be the Baltimore (Pratt) truss and the Pennsylvania-Petit (Pratt) truss. Examination of the sub-style bridges may provide insight into a winning entry.)

Howe



Pratt



Warren

PROCEDURE

A. Participants report to the event area at the time and place stated in the conference program.

B. Teams are checked in (using the registration list) and seated at work tables.

C. Time begins when the length of the structure is announced. Teams will place the supplied identification sticker to the correct drawing when the length is announced.

D. No one may leave the event area without the permission of the event coordinator.

E. When their structure is completed, an adhesive sticker noting the team's number is placed by the team on the structure for identification.

F. Participants must remove pins or other clamps before submitting the structure for evaluation. Structures with temporary clamps or pins left in the structure are not tested.

G. Each qualified structure is destructively tested and the test result is recorded. Public viewing of the stress test is allowed.

H. Ten (10) finalists are announced at the awards ceremony.

It is essential that students and advisors routinely check the TSA website (www.tsaweb.org) for updated information about TSA competitive events. This information is found on the website under Competitions/Updates and Clarification. When students participate in any TSA competitive event, they are responsible for knowing of updates, changes, or clarification related to that event.

REGULATIONS

A. At check-in, students will present a construction drawing for each designated length.

1. The three (3) drawings of the student-selected structure will be on 11" by 17" paper; these will include:
    a. One drawing of the 12" structure
    b. One drawing of the 13" structure
    c. One drawing of the 14" structure
    d. Each drawing will have a minimum of a front and end view with proper dimensions for fabrication.

e. Each drawing will have a schedule of parts with part identification label, quantity, dimensions and length (noted in columns and rows). See the example that follows.

Part identification	Quantity	Dimensions	Length
A	12	1/8 X 1/8	3
B	4	1/8 X 1/8	14
C	4	1/8 X 1/4	12
D	6	1/8 X 1/4	14

f. The drawings may be finished sketches, board drawings, or computer-generated drawings. The drawings must be full scale to aid in fabrication.

B. Participants are required to provide their own tool box (with identification [school name, address, and advisor cell phone number]), which should not exceed twenty (20) inches (508 mm) length x ten (10) inches (254 mm) width x ten (10) inches (254 mm) height. The box must contain all items needed to fabricate the solution. The following is a suggested list:

1. Cutting devices; NONE may be electric
2. Adhesives
   a. aerosol and electric applicators are not allowed
   b. a bottle of Uncure or Debonder is recommended
3. Temporary fastening devices
   a. straight pins
   b. clamps
   c. tape
4. A cutting surface that prevents table-top marring
5. Rulers, straightedges, and/or measuring scales
6. Abrasives sheets, sponges, boards
7. Marking devices (pens, pencils, etc.) and sharpener
8. Sheet of wax paper, as large as is needed for the competition
9. Pliers, wrenches, nut drivers, as needed
10. Safety glasses and side shields, as required

C. Teams will pick up the following supplied consumable materials

1. twelve feet (12') of ⅛" by ⅛" balsa wood
2. eight feet (8') of ⅛" by ¼" balsa wood to be used as horizontal member
3. Three structure labels (they may not be used as part of the structure) are required for:
   a. the structure
   b. the selected drawing
   c. the evaluation sheet/rubric

D. Structural dimensions:

☑ Bring the tools you need and leave the rest behind. Transporting and checking in will be made simpler with smaller and lighter tool boxes.

1. A length of twelve, thirteen, or fourteen inches (12", 13", or 14") will be provided by the coordinator
2. The minimum internal structure width is 2".
3. The minimum internal structure height is 3".

E. **Lamination of the material is prohibited.**

F. Joints are to be glued together with the adhesive.

1. An adhesive spread past ¼" of the joint will be penalized.
2. Coating of structural members with adhesive is prohibited.

G. The structure must rest on the top of the abutments.

H. No part of the structure may extend below the plane of abutment or touch the face of the abutments.

I. The bottom of the test block must rest three eighths of an inch (3/8") above the plane of abutment.

J. The center of the structure must provide clear passage for the ½" test rod. The test rod connects vertically to the testing device.

K. Public viewing is permitted when the structures are destructively tested. Video recording and photography is permitted only of a participant's own entry.

EVALUATION

A. All structures will be evaluated using the official rating form/rubric before testing. Deductions of twenty percent (20%) of the greatest weight held in the event are given for noncompliance. The rubric will be used to check and record compliance to the regulations for the following:

1. A team of two (2) members
2. Appropriate safety glasses
3. Tool box
4. Structure style correctly identified and modeled as either
   a. a through Howe
   b. a through Pratt
   c. a through Warren
5. Drawings:
   a. Correct paper size
   b. Correct dimensions for fabrication
   c. Complete schedule
   d. Reflects the model
6. Structure dimensions:
   a. Internal height (by passing the balsa body blank from end to end)
   b. Internal width (by passing the testing block from end to end)

c. Length of the load bearing cord, which is the announced length (with a gauge) of the coordinator's selection

B. All structures are destructively tested by attaching a testing device of the coordinator's choice to the test block and adding resistance until the structure fails.

1. The test block is three quarters of an inch (¾") thick, two inches (2") in width and six inches (6") less than the drawn length with a one half inch (½") hole in the center of the top face to accommodate the testing device. Therefore, the length block will be:
   a. Six inches (6") for the twelve inch (12") length
   b. Seven inches (7") for the thirteen inch (13") length
   c. Eight inches (8") for the fourteen inch (14") length
2. Structures will be tested by setting the tester to a span of two inches (2") less than the announced length and centering the testing block inside the structure. Therefore, the tester will be set to:
   a. Ten inches (10") for the twelve inch (12") length
   b. Eleven inches (11") for the thirteen inch (13") length
   c. Twelve inches (12") for the fourteen inch (14") length
3. Structures are NOT tested if:
   a. Pins are still in place
   b. The center is blocked
   c. There is any lamination
   d. There is failure to fabricate a through-style structure
   e. Structural members are coated with adhesive
   f. The team does not have required drawings
   g. There is failure to follow two (2) regulations

C. Finalist tabulation will be completed and submitted following the destructive testing. No posting of finalists is made for this event.

1. In 2014, finalists will be listed in descending order of the weight held after deductions have been taken. If a single violation of the regulations is observed and recorded, twenty percent (20%) of the <u>greatest failure weight in the competition</u> will be deducted from the participant's failure weight.
2. In 2015, finalists will be listed in descending order by highest numeric efficiency. To determine efficiency:
   a. The structure is weighed before testing and the weight is recorded on the rating form/rubric to two (2) decimal places.
   b. An increasing load is applied to the structure via the test block until the structure fails.
   c. The failure weight is recorded on the rating form. If a violation of the regulations is observed, twenty percent (20%) of the greatest failure weight in the competition

will be deducted from the participant's failure weight as a penalty and recorded.

d. The efficiency is determined by the recorded failure weight (FW#) in pounds multiplied by 4.54 (which will give the failure weight in kilograms) divided by the structure weight (SW) in grams. The product will be kilograms of failure weight per gram of material. Efficiency = (FW# x 4.54)/SW
e. The efficiency is rounded off to three (3) decimal places and recorded on the rating form.
f. The entry with the highest numeric efficiency is the winner. In case of an efficiency tie, the greatest weight held by the tied entries will be declared the winner.

STEM INTEGRATION

This event has connections to the STEM areas noted below. Please refer to the STEM INTEGRATION section of this guide.

Science, Technology, Engineering, Mathematics

LEADERSHIP SKILLS

Leadership skills promoted in this event:

- Critical thinking: Students make the best possible use of limited resources to build a structure. Use leadership lessons: *Fact or Fiction* and *Thinking Like Tarzan*
- Problem solving: Students build a structure to meet required specifications. Use leadership lessons: *Implementation Ideas* and *Including Everyone*
- Teamwork: Students work with a partner to build a structure. Use leadership lessons: *Find Someone Who...* and *Match Face*

Additional leadership skills promoted in this event:

- Communication
- Decision making
- Evaluation
- Organization

TSA AND CAREERS

This competition has connections to one or more of the career areas featured in the TSA AND CAREERS section of this guide. Use *The 16 Career Clusters* chart and the *TSA Competitions and Career Clusters* grid as resources for information about careers.

CAREERS RELATED TO THIS EVENT

Architect
Civil engineer
Engineering technician
Mathematician
Structural iron and steel worker

STRUCTURAL MODEL
EVENT COORDINATOR INSTRUCTIONS

PERSONNEL

A. Event coordinator, one (1), who will oversee
   1. Check-in
   2. Fabrication
   3. Structure check-in
   4. Evaluation
   5. Testing
   6. Submission of results to CRC

B. Monitors, one (1) for every ten (10) teams to hand out materials and observe during the fabrication and check-in phase of the event; this phase is approximately three (3) hours

C. Event evaluators, two (2) or more to evaluate the entries following the construction session; this phase is approximately three (3) hours

D. Testing session
   1. Two (2) assistants to verify entries and record results from testing
   2. Two (2) judges, one (1) to position the entry and one (1) to control the breaker
   3. Two (2) runners, one (1) to take the entries to the evaluation table and one (1) to remove the entry

MATERIALS

A. Coordinator's notebook, containing:
   1. Event guidelines, one (1) copy each for the coordinator and evaluators
   2. Official rating forms as needed
   3. List of entries with finalist report
   4. List of evaluators/assistants
   5. Marking pens for evaluators
   6. ID# stick-on tags to identify entries
   7. Timer
   8. First aid kit with strip bandages
   9. Results envelope

B. The following supplies will be provided to each team:
   1. Consumable materials:
      a. twelve feet (12') of ⅛" by ⅛" balsa wood

   b. eight feet (8') of ⅛" by ¼" balsa wood to be used as horizontal members
2. Labels (they may not be used as part of the structure)
   a. One (1) for the structure
   b. One (1) for the selected drawing
   c. One (1) for the rating form/rubric

C. Tables with adequate space for construction of structures and two (2) chairs for each team

D. Table and chairs for evaluators

E. Test device for destructive testing of structures, and a test hook

RESPONSIBILITIES

A. Upon arrival at the conference report to the CRC room and check the contents of the coordinator's notebook. Review the event guidelines, locate the required supplies, and check to see that enough evaluators/assistants have been scheduled.

B. Inspect the area or room in which the event will be held for appropriate set-up, including room size, chairs, tables, outlets, etc. Notify the event manager of any potential problems.

C. One (1) hour before the event is scheduled to begin, meet with your evaluators/monitors to review time limits, procedures, and regulations. If questions arise that cannot be answered, speak to the event manager before the event begins.

D. Check-in should begin at least thirty (30) minutes before the scheduled start of the event.

E. Upon check-in, teams must submit the items below. Any team that fails to comply will not be allowed to participate.
1. Toolbox (verify 10" by 10" by 20" dimensions)
2. Drawings (verify there are drawings of each length)
3. Protective eyewear (verify safety requirements are met)

F. For participants who violate the rules, the decision either to 1) deduct twenty percent (20%) of the total possible points or 2) disqualify the entry, must be discussed and verified with the evaluators, event coordinator, and CRC manager, who all must initial either of these actions on the rating form.

G. Begin the event at the scheduled time or when all teams present have checked in. All participants and evaluators should be in the room at this time. In order to compete, participants must be on the entry list or must have approval of the CRC chairperson. If a participant's team number is not on the entry list, the manager should check with registration to verify the entry. Teams will be allowed to fabricate an entry but will not be evaluated until registration for the event is verified.

H. When teams have been seated, materials have been distributed, and the length dimension has been announced, the stop watch begins to count down the two (2)-hour time limit. Participants may leave when the structure is finished and checked in according to the coordinator's directions.

I. As the team's structure is completed, participants are responsible for placing an adhesive sticker with the team's ID# on the structure, the drawing, and the rating form.

J. Place structures in a secure area to dry and make sure they are not tampered with before testing.

K. Evaluate each structure to make sure it meets the specifications noted and record the evaluation on the provided rating form/ rubric.

L. Destructively test each structure and record the greatest weight supported before failure.

M. Public viewing is permitted during the destructive testing period. Video recording is permitted only of each participant's own entry.

N. Submit the finalist report, including a ranking of the ten (10) finalists, and all related forms in the results envelope to the CRC room.

O. If necessary, manage security and the removal of materials from the event area.

Team ID# ____

STRUCTURAL MODEL

2014 & 2015 OFFICIAL RATING FORM **MIDDLE SCHOOL**

Place an X in the noncompliant or compliant box, as appropriate for each regulation. One (1) noncompliant mark receives a 20% deduction. Two (2) noncompliant marks result in disqualification. With fourteen (14) compliant marks, the structure is submitted without deduction.

STRUCTURE CHECK-IN	NONCOMPLIANT		COMPLIANT	
Time	Entry submitted after time expired.		Entry submitted within time limit.	
Drawing	Drawing is not on 11"x17" paper.		Drawing is on 11"x17" paper.	
	Drawing is not the specified length.		Drawing is the specified length.	
	Drawing does not match the structure submitted.		Drawing matches the structure submitted.	
	Drawing is not of a Howe, Pratt, or Warren truss.		Drawing is of a Howe, Pratt, or Warren truss.	
Drawing schedule	A column or row is missing.		All columns and rows are included.	
Schedule length	Length of two (2) samples is not correct.		All samples are correct in length.	
Schedule quantity	Incorrect quantity in two (2) samples.		Correct quantity in all samples.	
Structure	The length is incorrect.		The length is correct.	
Test blank passage	The test blank does not pass.		The test blank passes.	
Adhesive (glue)	Glue extends more than 1/4" from joint.		Glue extends less than 1/4" from joints.	

REGULATIONS	NONCOMPLIANT		COMPLIANT	
Any of the regulations below marked noncompliant will automatically eliminate the structure from consideration or final testing.				
Team of two (2) members	Only one (1) team member is present.		Both team members are present.	
Safety eyewear	The team does not have safety eyewear.		Both members of the team have appropriate safety eyewear.	
Tools and fabrication supplies	Inappropriate tools or supplies are brought to the event.		Appropriate tools and supplies are brought to the event.	
The structure was not tested because:				
There are two (2) or more noncompliant marks.				
Pins or temporary fasteners are left in the structure.				
The center is blocked.				
The test block is unable to be placed.				
The structure contains laminated members.				
The structure is not a through-style structure.				
Structural members are coated with adhesive.				
The structure does not reach the abutments of the tester.				

Structural Model (continued)

Record the mass in grams of the structure (2015 only).	
Record the failure weight	
Deduction reduction of 20% of greatest competition failure weight.	
Failure weight after deduction.	
According to Evaluation C.2. , efficiency to three (3) decimal places (2015 only).	

Comments:

I certify these results to be true and accurate to the best of my knowledge.

Evaluator

Printed name: ____ Signature: ____