



## 2017 MDOT Bridge Competition Guidelines Grades 11 and 12

### **The TRansportation and Civil Engineering (TRAC) Program**

**THE PURPOSE OF TRAC:** The TRAC program is an inventive way of introducing students to the wide variety of career opportunities available in the field of engineering. The program teaches secondary students how to apply a variety of math and science concepts to common engineering problems occurring in transportation systems. The TRAC program is also designed to allow the students to identify and evaluate the social and environmental impacts associated with the development of new transportation systems within their communities.

**PROGRAM DESIGN:** TRAC is designed to be an extended activity created from the Transportation Research Activities Center or TRAC PAC 2. The TRAC PAC 2 includes electronic components to collect and analyze data, and software programs to graph results and test a series of models. The developed activities are designed to show students how to use the tools listed above to solve real-life problems associated with transportation.

### **COMPETITION FOR Grades 11 and 12**

#### **The Competition:**

The bridge competition is designed to be an extended activity created from the TRAC PAC 2 Bridge Builder module. This event is designed to allow students the opportunity to develop a **Truss Through Tied Arch** that will be tested for strength-to-weight ratio. Student teams from Grades 11 and 12 will be competing against other MS student teams from across the state. Interested teams should fill out the attached application and submit it prior to the deadline of **November 1, 2016**. [Please note there is a maximum limit of 5 competition entries per school.] MDOT TRAC Headquarters will send a TRAC Challenge Entry Kit to each team to begin their project. Only materials included in the kit supplied by TRAC Headquarters can be used in the construction of the bridge. The kit will be shipped by **December 2, 2016**, and will include **Balsa Wood, Wood Glue, and String**.

Other materials needed not provided in kit:

- Bentley PowerDraft Free Student Software and Student Guide (download link below)
  - <http://www.bentley.com/BentleyWebSite/Tools/library.aspx?id=2ee1c054>
  - [http://ftp2.bentley.com/dist/collateral/docs/microstation\\_powerdraft/MicroStationPowerDraftV8iStudentGuide.pdf](http://ftp2.bentley.com/dist/collateral/docs/microstation_powerdraft/MicroStationPowerDraftV8iStudentGuide.pdf) BENTLEY DRAWINGS ARE NOT REQUIRED FOR THE STATE COMPETITION, HOWEVER, THEY ARE ENCOURAGED.
  - If the PowerDraft software cannot be downloaded, one copy on disk per school can be requested from Linda Clifton ([lclifton@ashto.org](mailto:lclifton@ashto.org))
- Calculator
- School Supplies

After completing the project, each team is required to submit two (2) proposal copies to Carol Killough, the MDOT facilitator. Do not send the bridge itself, but you **must include pictures of the bridge (prototype or final)**. The proposal must be postmarked no later than **February 15, 2017**. Winners will be notified by **March 15, 2017**. All entries become the property of MDOT TRAC and will not be returned. From those proposals, teams will be chosen to attend the MDOT TRAC Challenge Competition Finals on April 11, 2017, at the Muse Center in Pearl, MS. At the Finals, teams will present a 10 minute PowerPoint presentation and structurally test their bridges against teams from other states to determine the winning bridge.

### Who Can Enter?

- Students must be in grades 11<sup>th</sup> and/or 12<sup>h</sup>.
- Teams must be composed of three members, no less, no more.

### The Problem:

The goal of this competition is to develop a **Truss Through Tied Arch** that will carry as much weight as possible while weighing as little as possible (strength-to-weight ratio). Each team is to research the bridge type, design and conduct experiments to test for strength-to-weight ratio, and then design a bridge resulting from those experiments. The teams construct a bridge **made only with the materials provided** in the MDOT Challenge Entry Kit. As a part of the Design Competition, the team is required to develop a report portfolio describing the design and testing of the bridge. Bentley PowerDraft CAD software designs are encouraged but not required for the state competition.

Each bridge will be checked for design according to the rules. The bridges will be weighed and strength tested during the competition to calculate strength-to-weight ratio.

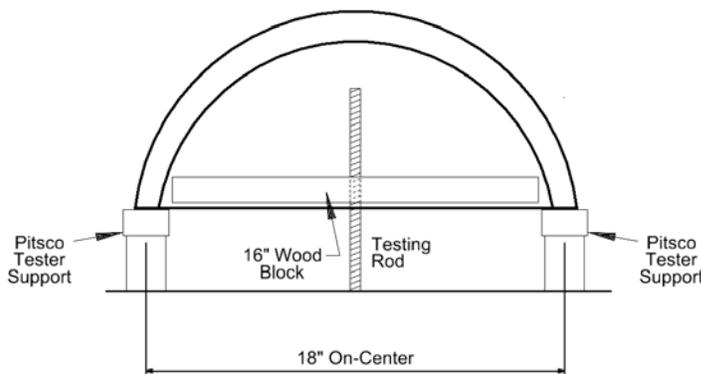
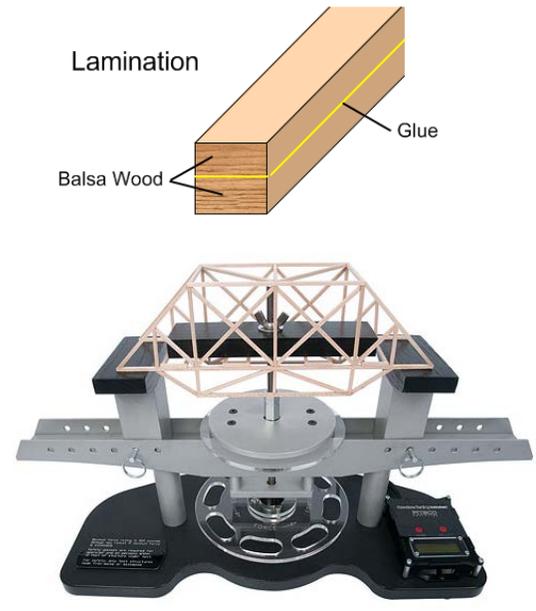
### The Challenge:

An engineer's job is to not only design a safe bridge to carry required loads, but also to make sure that it is cost effective (use less materials). To simulate this process, teams will use the following strength-to-weight ratio calculation to develop a bridge that carries a high load relative to the bridge weight. Strength to weight ratio is determined by dividing the maximum load carried by the weight of bridge.

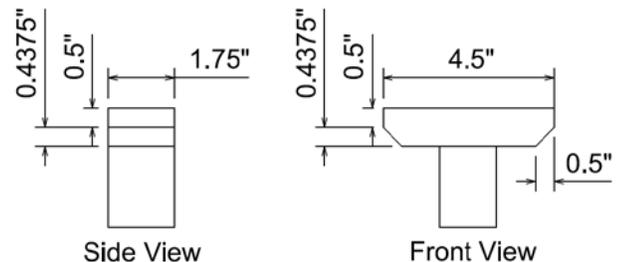
**Example:**     Maximum load = 120.0 pounds  
                  Bridge weight = 20.0 grams  
                  Ratio = 2724.0  
                  [(120 pounds x 454g/pound) / 20 g]

## SPECIFICATIONS FOR THE TRUSS THROUGH TIED ARCH:

- The materials provided in the kit are the **ONLY** materials to be used when building the bridge structure. Using chemicals to modify to the structural properties of the balsa wood or using different glue than provided will result in judges recording zero (0) weight held.
- The instrument used for testing will be the Pitsco Structures Testing Instrument as seen on the right.
- Lamination shall be permitted one layer thick as shown in the picture on the right.
- Connections can be butt joints, miter joints, or notched joints. Lap splices are permitted, but no greater than 1/8 of an inch. String may be braided and attached using only materials in the kit.
- The bridge must be designed where the center of the ends of the truss arch are at the center of the Pitsco Supports (see detail below). The upper chord shall be shaped as the arc of a circle, but does not have to be one single piece of wood.
- Maximum width of the bridge will be 4.5 inches.
- A block of wood that is 16 inches long by 2 inches wide by 1 inch high must be able to be pushed across the bridge deck.
- Tester supports will be placed at 18 inches on center. Support dimensions are shown below.
- The bridge shall only touch the top of the Pitsco Tester Supports as seen in the diagram below. If the bridge touches any other part of the tester body, judges will record zero (0) weight held.
- The bridge deck must have a 3/4 inch hole in mid-span to allow a 5/8 inch testing rod to pass through and attach to a 16 inch block of wood for strength testing as seen in the picture to the right and the diagram below. **The rod must be able to pass through the full height of the bridge.**



**Tester Detail**  
Not representative of required design  
Use only for dimension reference



**Support Detail**

## **PROPOSAL FORMAT:**

The information below gives an indication of what the judges are looking for in each section. **The proposal must contain all of the sections outlined below or will not be considered for the competition.** Pay special attention to the required sections below and the proposal assessment on page 10.

### I. BRIDGE PROPOSAL (See Page 10 for Assessment)

- A. Proposal Format: The written proposal should be typed, double-spaced using a size 12 font of either Arial or Times New Roman on 8.5 x 11 paper with all pages numbered, 1” borders all around. Sections must be in order of the outline below:
- B. Timeliness: Proposals received after the deadline will not be accepted.
- C. Proposal Presentation: Portfolio **MUST** contain all the sections outlined below:

**I. Title Page.** Include name of challenge, team name, and logo, name of school or organization, names of students, name of teacher or advisor.

**II. Table of Contents.**

**III. Summary (abstract).** Clearly and concisely stated. (At least ½ page, no more than two pages)

**IV. Introduction.** Indicate the team name, team members as well as the background of each member.

**V. Body.** The main part of the report. This may be divided into several sections (such as Design, Development, etc.). In general, this part should:

- a) Explain the scientific principles behind your design.
- b) Describe the challenges you encountered in designing your bridge
- c) Include Data Tables, Graphic Representation of Tests, and supporting Calculations page.
- d) Include scaled drawings of preliminary and final bridge designs.
- e) Include at least five (5) pictures of team work during bridge design and construction, along with a picture of the constructed bridge (prototype or final).
- f) Explain how you tested your design, and the improvements this led you to make.
- g) Describe the challenges that you encountered in building your bridge and how you solved these problems. Include safety precautions, building methods, etc.

**VI. Conclusions (and Recommendations).** How successful is your project? What did you learn by taking part?

**VII. Acknowledgments.** List the names of the adults who assisted you in the project with a brief description of what they did. Include a certification, signed by all student team members and adults assisting, stating that: “We hereby certify that the majority of the ideas, design, and work was originated and performed by the students, with limited assistance by adults, as described above.”

**VIII. Bibliography.** List all references used, including Internet, books and magazines.

**IX. Appendices.** They must include:

- A. Scheduling and Accomplishments.** Show on a time line, or similar method, how you scheduled your project. Include *brief* records of meetings, telling how you managed the scheduled.
- B. Daily Journal.** Progress reports of day-to-day work on the project, including date, performance and comments from each team member.

Teams chosen to attend the 2017 TRAC Bridge Finals will present to a panel of judges comprised of various MDOT employees. Each team will be expected to make a PowerPoint presentation and be able to answer questions from the panel of judges about their entry. Supporting materials may be presented to the judges. Judges will examine each entry to make sure it fits the specifications given in the rules. The bridge brought to competition must be similar to the bridge submitted in the portfolio. The criteria below outline the competition fundamentals:

- A. DESIGN DRAWINGS (10% of the total score): Portfolio drawings must at minimum show elevation view of the side and end, along with plan view of the top of the bridge. Bridge dimensions and labels of the views are required. Drawings must be on 8 ½” x 11” paper and displayed at the competition. Drawings will be given a maximum of 100 points:
  - 50 points for minimum requirements stated above
  - 50 points for greater detail of bridge components (showing member thickness, details of joint types, detailed labeling of components, etc.)
- B. ORAL PESENTATION (30% of the total score): Teams will present a 10-minute PowerPoint presentation (a deduction is assessed if over 10 minutes). A rubric on page 11 has been provided for the presentation as a guide.
- C. PERFORMANCE (60% of the total score): Achievement of performance goals and stability of construction. Bridges will be weighed and then tested on the Pitsco structural tester. Results will be used to calculate strength-to-weight ratio. Any bridge not meeting the specifications on page 3 will result in judges recording zero (0) weight held.

#### **Awards:**

Teams chosen to attend the MDOT Bridge Competition will compete for a gift card of:

**First Place Team: \$600**

**Second Place Team: \$300**

**Third Place Team: \$150**

Each team that sends in a Proposal will receive a Certificate of Participation from MDOT TRAC Headquarters.

## PREPARING FOR COMPETITION

**Form a team of interested students or friends.** Discuss the challenges and design specifications. Teams are limited to only three (3) students. Each team must have at least one teacher or other adult to help and advise, though a single adult may be advisor to more than one team.

**Study the rules.** The individual challenge documents and the grading criteria will give important information, which must be followed if your team is to achieve the best results. Failure to adhere to the rules could lead to penalties, or even disqualification. If any of the information is not clear, please call for additional help.

**Plan the timing of the project.** Ensure that everyone in the team knows the date for submission of the written report, and recognizes that this means that all major development work should be finished before this date.

**Keep records of meetings and working drawings carefully**, and give members of the team responsibility for different sections of the final report.

**Notes to Adults:** MDOT would like to stress that **the work on all phases of the project is to be done by the students**. Adult assistance is to be limited to:

- Mentoring
- Basic guidance of the students
- Teaching engineering, mathematical and scientific principles applicable to the project
- Guiding students in research
- Assisting in the production of the report and preparation of the drawings
- Overseeing the manufacturing stages of the project

Guidance should be in the form of asking questions, (leading questions, if necessary) to promote creative thinking by the students to identify the scientific and engineering principles involved.

***Encourage students to consult creditable web sites and other resources*** to help with the project.

***Encourage students to test and improve their designs.*** A good way to begin is for each student to design and/or construct a rough prototype. Test it and make improvements.

## BRIDGE COMPETITION SCHEDULE

- 1) Applications due **November 1, 2016**.
- 2) Packets will be shipped to teams by the TRAC office by **December 2, 2016**.  
Packets will include:
  - Balsa Wood
  - Wood Glue
  - Information packetIf packets are not received by December 14, please email [carol.killough@yahoo.com](mailto:carol.killough@yahoo.com)
- 3) Proposals are due **February 15, 2017** (do not include the Bridge).
- 4) Notification of finalists by **March 15, 2017**.
- 5) Finals will be held at the MS MDOT Bridge Competition in Muse Center at Hinds Community College, Pearl, MS on **April 11, 2017**.

**APPLICATION**  
**2017 TRAC TRUSS BRIDGE COMPETITION**  
**Grades 11 and 12**

**Return to Carol Killough by November 1, 2016**

*We have read the challenge documents and the guide to entry, and we want to register.*

Name of Adult Advisor \_\_\_\_\_

Team Name \_\_\_\_\_

Team Members Name & Grade Levels

1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

School or Group \_\_\_\_\_

Address \_\_\_\_\_

Work Phone \_\_\_\_\_ Home Phone \_\_\_\_\_

Cell Phone \_\_\_\_\_ Fax Phone \_\_\_\_\_

E-mail address (required) \_\_\_\_\_

NOTE: Each leader working with different teams at the same school should send a separate application form for each team. Copy this form as necessary. If you do not have the team members' names by the due date, just state that on the application and send that information when it is available.

***Return completed form to:***

*Carol Killough*

*645 Hwy. 4 W*

*Booneville, MS 38829*

*Carol.killough@yahoo.com*

PROPOSAL ENTRY FORM  
2017 TRAC BRIDGE COMPETITION  
Grades 11 & 12

Return to Carol Killough by February 15, 2017

Enclosed you will find the Report Portfolio for:

Name of Adult Advisor\_\_\_\_\_

Team Name\_\_\_\_\_

Team Members Name & Grade Levels (Team members must be in 9<sup>th</sup> or 10<sup>th</sup> grade)

1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

School or Group\_\_\_\_\_

Address\_\_\_\_\_

Work Phone\_\_\_\_\_ Home Phone\_\_\_\_\_

Cell Phone\_\_\_\_\_ Fax Phone\_\_\_\_\_

E-mail address (required)\_\_\_\_\_

**Return completed form to:**

Carol Killough

645 Hwy. 4 W

Booneville, MS 38829

[Carol.killough@yahoo.com](mailto:Carol.killough@yahoo.com)

**PROPOSAL ASSESSMENT**  
**2017 TRAC BRIDGE COMPETITION**

Grades 11 & 12

Proposal Format

- |                                                                   |            |                        |
|-------------------------------------------------------------------|------------|------------------------|
| <input type="checkbox"/> Typed                                    | (1 point)  |                        |
| <input type="checkbox"/> Double Spaced                            | (1 point)  |                        |
| <input type="checkbox"/> 12 Point Font (Arial or Times New Roman) | (1 point)  |                        |
| <input type="checkbox"/> All pages on 8.5 x 11 paper              | (1 point)  |                        |
| <input type="checkbox"/> Information is in the proper order       | (1 point)  |                        |
| <input type="checkbox"/> All pages are numbered                   | (1 point)  |                        |
| <input type="checkbox"/> Style and presentation                   | (3 points) |                        |
| <input type="checkbox"/> Mechanics                                | (3 points) |                        |
| <input type="checkbox"/> Visuals                                  | (3 points) | Score _____/ 15 points |

Proposal Presentation

- |                                                               |             |                          |
|---------------------------------------------------------------|-------------|--------------------------|
| <input type="checkbox"/> Title page                           | (1 point)   |                          |
| <input type="checkbox"/> Table of Contents                    | (1 point)   |                          |
| <input type="checkbox"/> Summary (no more than 2 pages)       | (5 points)  |                          |
| <input type="checkbox"/> Introduction                         | (1 points)  |                          |
| <input type="checkbox"/> Body                                 |             |                          |
| <input type="checkbox"/> Sections identified                  | (1 points)  |                          |
| <input type="checkbox"/> Scientific principles of the design  | (5 points)  |                          |
| <input type="checkbox"/> Design challenges                    | (5 points)  |                          |
| <input type="checkbox"/> Tables, Graphs, Calculations         | (10 points) |                          |
| <input type="checkbox"/> Detailed scaled drawings             | (15 points) |                          |
| <input type="checkbox"/> Photos during and after construction | (10 points) |                          |
| <input type="checkbox"/> Testing and improvements             | (5 points)  |                          |
| <input type="checkbox"/> Solving challenges                   | (5 points)  |                          |
| <input type="checkbox"/> Conclusion                           |             |                          |
| <input type="checkbox"/> Recommendations                      | (3 points)  |                          |
| <input type="checkbox"/> Success of the project               | (5 points)  |                          |
| <input type="checkbox"/> What was learned by taking part      | (4 points)  |                          |
| <input type="checkbox"/> Acknowledgements                     |             |                          |
| <input type="checkbox"/> Adults involved                      | (1 points)  |                          |
| <input type="checkbox"/> Description of what the adults did   | (1 points)  |                          |
| <input type="checkbox"/> Certification and signatures         | (1 points)  |                          |
| <input type="checkbox"/> Bibliography                         | (1 points)  |                          |
| <input type="checkbox"/> Appendices                           |             |                          |
| <input type="checkbox"/> Schedule on a timeline or similar    | (5 points)  |                          |
| <input type="checkbox"/> Daily Journals (must be legible)     | (20 points) | Score _____ / 105 Points |

Design and Construction

- |                                                               |             |                        |
|---------------------------------------------------------------|-------------|------------------------|
| <input type="checkbox"/> Achievement of design specifications | (30 points) | Score _____/ 30 points |
|---------------------------------------------------------------|-------------|------------------------|

TOTAL SCORE: \_\_\_\_\_/150 Points

**GUIDELINES**  
**TRAC BRIDGE COMPETITION 2016-17**  
**Oral PowerPoint Presentation: Bridge Competition**

Team Name \_\_\_\_\_

NOTE: This is a rubric for to help for the preparation of the presentation. Oral presentation has a possible score of 100 points. Each category will be judged on a scale from 1 to 20 points.

CATEGORY	20 ●	15 ●	10 ●	5 ●	0 ●	Sub-Score
<b>Content</b>	Covers topic in-depth with details and examples. Subject knowledge is excellent.	Includes essential knowledge about the topic. Subject knowledge appears to be good.	Includes essential information about the topic but there are 1-2 factual errors.	Content is minimal OR there are several factual errors	Did not fulfill requirements	_____/20
<b>Mechanics</b>	No misspellings or grammatical errors.	Three or fewer misspellings and/or mechanical errors	Four misspellings and/or grammatical errors.	More than 4 errors in spelling or grammar.	Did not fulfill requirements	_____/20
<b>Organization</b>	Content is well organized using headings or bulleted lists to group related material.	Uses headings or bulleted lists to organize, but the overall organization of topics appears flawed.	Content is logically organized for the most part.	There was no clear or logical organizational structure, just lots of facts.	Did not fulfill requirements	_____/20
<b>Presentation</b>	Interesting, well-rehearsed with smooth delivery that holds audience attention.	Relatively interesting, rehearsed with a fairly smooth delivery that usually holds audience attention.	Delivery not smooth, but able to hold audience attention most of the time.	Delivery not smooth and audience attention lost.	Did not fulfill requirements	_____/20
<b>Attractiveness</b>	Makes excellent use of font, color, graphics, effects, etc. to enhance the presentation.	Makes good use of font, color, graphics, effects, etc. to enhance to presentation.	Makes use of font, color, graphics, effects, etc. but occasionally these detract from the presentation content.	Use of font, color, graphics, effects etc. but these often distract from the presentation content.	Did not fulfill requirements	_____/20
<b>Total Sub-Score</b> ____/100 <b>Over 10 Minutes: (-20 points)</b> ____ <b>TOTAL SCORE</b> ____						

## 2017 TRAC BRIDGE COMPETITION Suggestions and Helpful Hints

1. Students should be prepared for questions at the end of the presentation. These questions may be concentrated in the following topics. However, note that the judges are free to ask any question about any topic. Therefore, each team should be prepared.
  - a) Choice of design
  - b) Civil engineering careers related to bridges
  - c) Safety
  - d) Impacts of bridges
  - e) Lessons learned
2. Stay organized and keep track of time limits.
3. If you have a question, ASK. You can contact [Carol Killough at carol.killough@yahoo.com](mailto:carol.killough@yahoo.com)
4. Contact your DOT engineers. They will answer many of your questions.
5. Check out other bridges in your area or around the world
6. **Include detailed information in the team portfolio. Remember, your portfolio is what determines if your team is selected to come to national competition.**
7. RESEARCH
8. Be sure to check your rubric, if you cannot check off every item, your portfolio is incomplete.