

TRAC (Revised 10-25-2011)
Michigan Design and Build Bridge Challenge Guidelines
Grades 9 and 10 – Drawbridge
2011-2012

The TRansportation and Civil Engineering (TRAC) Program

THE PURPOSE OF TRAC: The TRAC program is a new and inventive way of introducing students to the wide variety of career opportunities available in the field of engineering. The program teaches 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 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 9 and 10

The Competition:

The Michigan Design and Build Bridge Challenge is designed to be an extended activity created from the TRAC Bridge Builder module. This event is designed to allow students the opportunity to create a report portfolio, develop and construct a bridge, test for strength to weight ratio, learn to use Power Draft CAD Software and create and present a PowerPoint presentation. Student teams from grades 9 and 10 will be competing against other TRAC teams from Michigan. Interested teams should fill out the attached application and submit it prior to the deadline of **November 15, 2011**. The Michigan Department of Transportation (MDOT) will send a TRAC Challenge Kit to each team within 14 days of receipt of their application. Only materials included in the kit can be used in the construction of the bridge. All kits will be shipped by **November 29, 2011** and will include the following:

- Lego Gears
- Popsicle Sticks
- Balsa Wood
- Dowel Rods
- Wood Glue
- String
- Power Draft CAD Software by Bentley Systems, Inc. including an instructional video on how to use the software to complete your CAD drawing.

Other materials needed (must provide your own):

- Calculator
- School Supplies

After completing the project, each team is required to submit two (2) report portfolio copies to the MDOT. Do not send the bridge itself. The report portfolio must be postmarked no later than **Thursday, March 1, 2012**. All entries become the property of MDOT and will not be returned. Report portfolios will be judged and if determined complete, the team will be invited to compete in the Michigan Bridge Challenge in Lansing. Teams will be notified by **March 16, 2012**.

Teams submitting **complete** report portfolios will be invited to compete in the 4th Annual Michigan Design and Build Bridge Challenge at the Lansing Center on **April 30, 2012**. The invitation to compete in the competition includes: Mileage (0.362 cents per mile) to and from the competition, overnight accommodations (two rooms per team and advisor) the evening before the event, Bridge Challenge polo shirts (must be worn at the competition), and breakfast and lunch at the Bridge Challenge.

To compete in the Michigan Design and Build Bridge Challenge, each team must have a complete, constructed bridge and a PowerPoint presentation (7 to 10 minutes in length). Any deviations between the bridge design submitted in the report portfolio and the complete, constructed bridge must be detailed in the PowerPoint presentation. If a team attends the competition and does not have both a complete constructed bridge and a PowerPoint presentation, or any member is not wearing the Bridge Challenge polo shirt (clearly visible), that team will not be reimbursed for contest expenses.

Who Can Enter:

- Only schools involved in the Michigan TRAC program can enter the competition.
- Students must be in 9th and/or 10th grades.
- Teams must be composed of three members, no less, no more. Team member changes will be allowed up until **February 20, 2012**. Team member changes after **February 20, 2012** will be considered on an individual basis. Each student can be a member of only one team.

The Problem:

The goal of this competition is to develop a drawbridge that will carry as much weight as possible while weighing as little as possible (strength-to-weight ratio). The bridge must easily open and close (ease of operation) using mechanical methods. Each team is to design and conduct experiments to test for mechanics of operation and strength-to-weight ratio, and then design a drawbridge resulting from those experiments. The teams will construct a drawbridge made only with the materials provided in the TRAC Challenge Kit. As a part of the Design Competition, the team is required to develop a report portfolio describing the design, testing, and operation of the drawbridge. The bridges will be weighed and strength tested during the competition to calculate strength-to-weight ratio. Each drawbridge will be tested for mechanics of operation and checked for design specifications according to the rules.

The Challenge:

An engineer's job is to not only design a safe bridge to carry heavy 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 heavy load, but has a low 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:

The bridge must meet the specifications listed below or penalties, up to disqualification, will be applied for each requirement that is not met.

- The materials provided in the kit are the **ONLY** materials to be used when building the bridge structure; however, additional materials may be used for decorations or visual aids.
- All team members must wear the provided Bridge Challenge polo shirt (clearly visible).
- Lamination (gluing two pieces of wood along their longitudinal length to increase strength) is not permitted. Acceptable joints are: butt joints, miter joints, and notched joints.
- The balsa wood used to construct each bridge must be only one layer thick. At the joints, more than one layer may be required. Joints may not exceed one-half inch in thickness overlap. A multi-layered joint may not exceed one-half inch in length.
- End to end, the **length of the entire bridge must be 15 inches**.
- The **maximum height** of the entire bridge shall be **12 inches** in the closed position.
- The **moveable span** shall be a **minimum of 12 inches**.
- The **clear span** (open area with no physical obstructions) must be **between 9 and 12 inches**.
- **Maximum clearance** underneath the bridge must be no more than **2 inches** when the bridge is in the closed position.
- A block of wood 4 inches high x 2 inches wide must be able to pass under the bridge when the bridge is in the open position.
- A **block of wood that is 2 inches wide by 1 inch high must be able to be pushed smoothly across the bridge while the bridge is closed**; however, a bridge deck is not required.
- **Tester supports** will be placed at **12.75 inches on center**. Drawbridge must have supports suitable for placement on Pitsco di2000 Structure Tester.
- Only the drawbridge supports can make contact with the tester. In addition, the bridge can only make contact with the top surface of the tester supports (Tester support dimensions are 4.5 inches wide by 1.75 inches long).
- The **bridge deck must allow for a 5/8" diameter testing rod to pass through** the center of the bridge and attach to a 6" block of wood testing as seen in the picture to the right and the diagram on page 4.



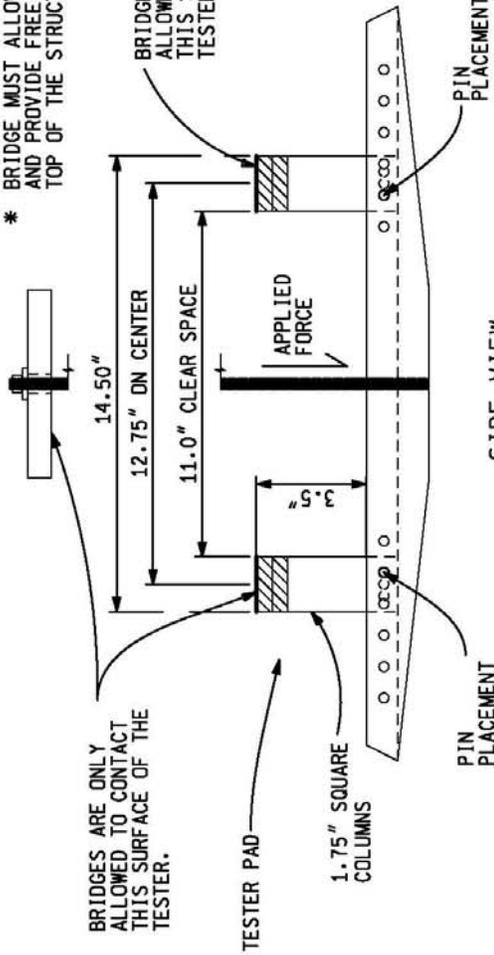
**Note: A list of frequently asked questions can be found at: www.michigan.gov/mdot-trac.*

FILE NAME:

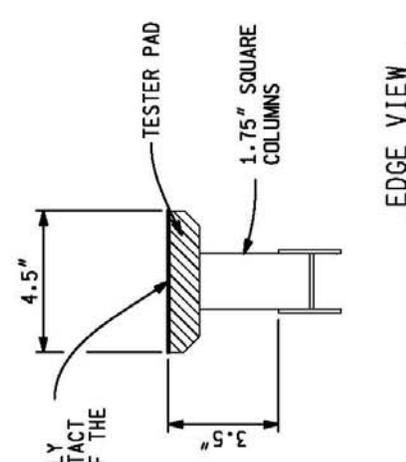
LAST CORRECTION BY: JAD

DATE:

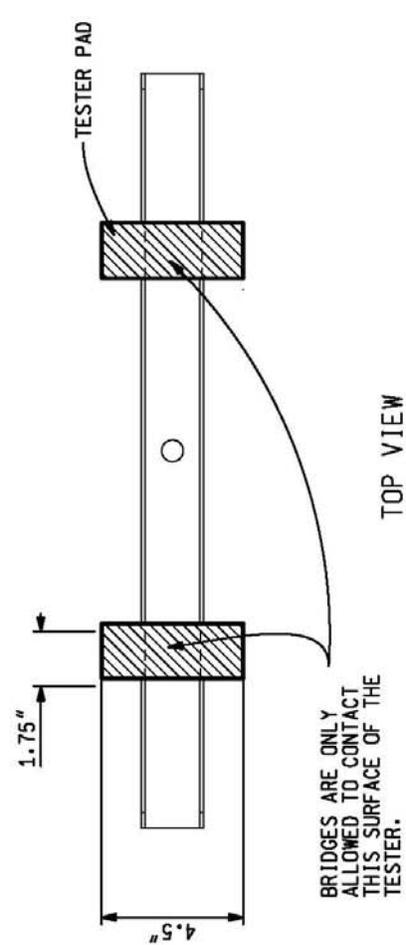
* BRIDGE MUST ALLOW ACCESS TO POSITION THE LOAD BLOCK ASSEMBLY AND PROVIDE FREE SPACE FOR THREADED ROD TO PASS THROUGH THE TOP OF THE STRUCTURE.



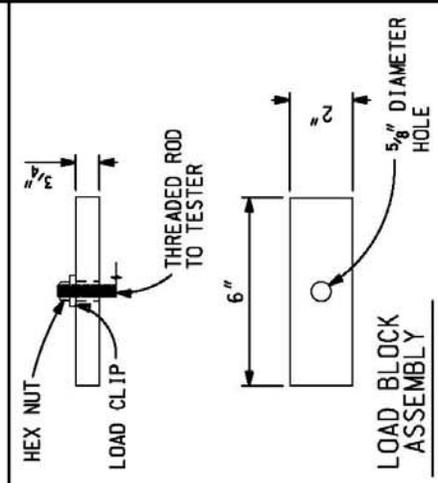
SIDE VIEW



EDGE VIEW



TOP VIEW



LOAD BLOCK ASSEMBLY

****FOR 9th & 10th GRADE DRAWBRIDGE****

2012 DRAWBRIDGE (9&10) PITSCO TESTER			
DATE	SCALE	CONT. SEC.	JOB NO. SHEET NO.
09/29/11	1 = 5	TRAC	

Scoring:

The information below gives an indication of what the judges are looking for in each section.

1. BRIDGE REPORT PORTFOLIO

Students need to fulfill all the criteria for each section.

- A. Report Portfolio Format: The written report portfolio 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. All sections should be labeled in the report.
- B. Timeliness: Report Portfolios received after the deadline will not be accepted.
- C. Report Portfolio Presentation: Report portfolios 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. (No more than two pages)

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

V. Body. This may be divided into several sections (such as Design, Development, etc.).

In general, this part should include:

- a) Explain why you designed your drawbridge the way you did.
- b) Explain the scientific principles behind your design.
- c) Include Data Tables, Graphic Representation of Tests, and supporting Calculations page.
- d) Describe the challenges you encountered in designing your bridge.
- e) Include scaled drawings of preliminary and final drawbridge designs.
- 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 drawbridge 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 in this challenge?

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.

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.

II. BRIDGE COMPETITION FINALS

Teams chosen to attend the 2012 Michigan Design and Build Bridge Challenge will present a PowerPoint presentation to a panel of judges comprised of high level engineers. Each team will be expected to be able to answer questions from the panel of judges about their entry. All CAD drawings used in the PowerPoint presentation must have been created using the Bentley Power Draft CAD Software. Judges will examine each entry to make sure it fits the specifications given in the rules. The criteria below outline the competition fundamentals:

A. BRIDGE DESIGN & CONSTRUCTION:

- Meets competition specifications
- Safety and performance
- Quality of construction
- Ease of operation

B. ORAL PRESENTATION: *Explanation of Project.* 10 minutes maximum. A rubric on page 9 has been provided for the presentation as a guide. (50% of total team score)

C. PERFORMANCE: *Achievement of performance goals and stability of construction.* Bridges will be weighed at the beginning of the competition and tested on Pitsco structural tester. Results will be used to calculate strength-to-weight ratio. (50% of total team score)

Awards:

Teams chosen to attend the Michigan Design & Build Bridge Challenge will compete for Visa Gift Cards/Awards:

- First Place Team: \$450
- Second Place Team: \$300
- Third Place Team: \$225
- Fourth Place Team: \$150

PREPARING FOR COMPETITION

Form a team of interested students or friends. Discuss the challenges and design specifications. Teams are limited to 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 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 up to disqualification. If any of the information is not clear, please call for additional help.

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

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

Notes to Adults: TRAC 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 library books 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 15, 2011**.
- 2) Kits will be shipped to teams by **November 29, 2011**. Kits will include:
 - Lego Gears
 - Popsicle Sticks
 - Balsa Wood
 - Dowel Rods
 - Wood Glue
 - String
 - Power Draft CAD Software by Bentley Systems, Incorporated. All CAD drawings must use this software.
 - Information packet
- 3) Report Portfolios are due **March 1, 2012** (do not include the Bridge).
- 4) Notification of successful team report portfolios will be completed by **March 16, 2012**.
- 5) Design and Build Bridge Challenge, **April 30, 2012**, at the Lansing Center in Lansing. The teams will be staying over night at the Radisson Hotel in Lansing on **April 29, 2012**.

For any questions, please contact:

Jan Pohl
Michigan TRAC Program Manager
P.O. Box 30050
Lansing, MI 48909
pohlj@michigan.gov
517-373-9571

**Michigan Bridge Challenge
Oral PowerPoint Presentation Scoring Rubric**

CATEGORY	25	20	15	5
<i>Content</i>	<i>Covers topic in-depth with details and examples. Subject knowledge is excellent.</i>	<i>Includes essential knowledge about the topic. Subject knowledge appears to be good.</i>	<i>Includes essential information about the topic but there are one to two factual errors.</i>	-
<i>Appearance</i>	<i>Content is well organized using headings or bulleted lists to group related material. Makes excellent use of font, color, graphics, effects, etc. to enhance the presentation. No misspellings or grammatical errors.</i>	<i>Uses headings or bulleted lists to organize, but the overall organization of topics appears flawed. Uses font, color, graphics, effects, etc. to enhance the presentation. Three or fewer misspellings and/or mechanical errors.</i>	<i>No clear or logical organizational structure, just a lot of facts. Use of font, color, graphics, effects, etc. but these often distract from the presentation content. Four misspellings and/or grammatical errors.</i>	-
<i>Oral Presentation</i>	<i>Interesting, well-rehearsed with smooth delivery that holds audience attention.</i>	<i>Relatively interesting, rehearsed with a fairly smooth delivery that usually holds audience attention.</i>	<i>Delivery not smooth, but able to hold audience attention most of the time.</i>	-
<i>Timeliness</i>	<i>Seven to 10 minutes.</i>	<i>Up to one minute under/over.</i>	<i>Up to two minutes under/over.</i>	<i>Up to three minutes under/over.</i>

NOTE: This is a rubric to help with the preparation of the presentation. Oral presentation will count towards 50 percent of the total team score for the competition. This rubric will be used by the judges to score the presentations. The remaining 50 percent of the team score will be determined by the outcome of the specification measurements and the strength-to-weight ratio calculations.

TRAC BRIDGE COMPETITION 2011 - 2012
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.
 - 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 Jan Pohl 517-373-9571
4. Check out other bridges in your area or around the world.
5. RESEARCH



TRAC PROGRAM REGION COORDINATORS



TRAC PROGRAM MANAGER

Jan Pohl
517-373-9571
pohlj@michigan.gov

SUPERIOR

Julie Van Portfliet
906-786-1830 ext. 317
vanportflietj@michigan.gov

NORTH

Tony Olson
989-731-5090 ext. 341
olsont1@michigan.gov

GRAND

Shelly Vongphasouk
616-451-3744
vongphasouks@michigan.gov

BAY

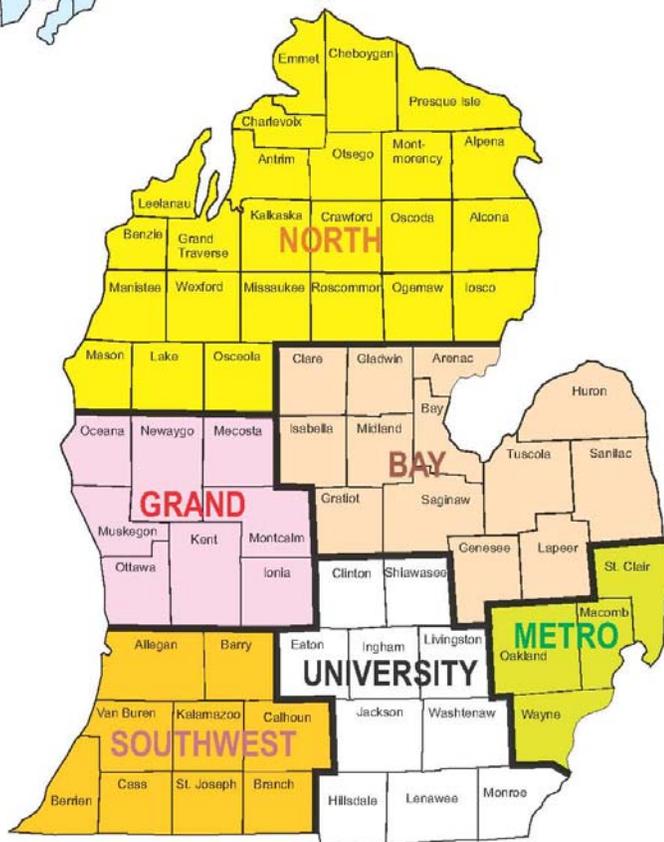
Selena Friend
989-754-0878 ext. 226
friends@michigan.gov

Rachel Phillips
989-754-0878 ext. 240
phillipsr6@michigan.gov

METRO

DeAnteThompkins
248-483-5100
ThompkinsD@michigan.gov

Kim Avery
313-375-2401
averyk@michigan.gov



SOUTHWEST

Brenda Kragt
269-337-3913
kragtb@michigan.gov

UNIVERSITY

Justin Droste
517-324-2243
drostej@michigan.gov

Prepared by MDOT Graphic Design & Mapping graphics\executive\TRAC Program\Region Coordinator Map.cdr 08/11 CJ