THE CAPITAL WHEEL AT NATIONAL HARBOR™

TEACHER RESOURCE GUIDE

GRADES 9-12: THE WILSON CONNECTION

THECAPITALWHEEL.COM ★ 116 WATERFRONT STREET, NATIONAL HARBOR, MD 20745 ★ 301-842-8650

WELCOME TO THE CAPITAL WHEEL!

ARRIVAL AND ENTRY

Please allow ample time for parking and obtaining tickets. To secure your group tickets, please contact us at 301-842-8650 or info@iconattractions.com.

SAFETY

To have the best adventure possible, please abide by all safety precautions posted and given by our staff. If you have any questions during your experience, please speak to any member of our team.

ADDITIONAL INFORMATION

For information on The Capital Wheel and our education programs, visit our website: www.thecapitalwheel.com

DIRECTIONS

We are conveniently located at National Harbor, just a 15-minute drive or water taxi ride from the heart of the nation's capital.

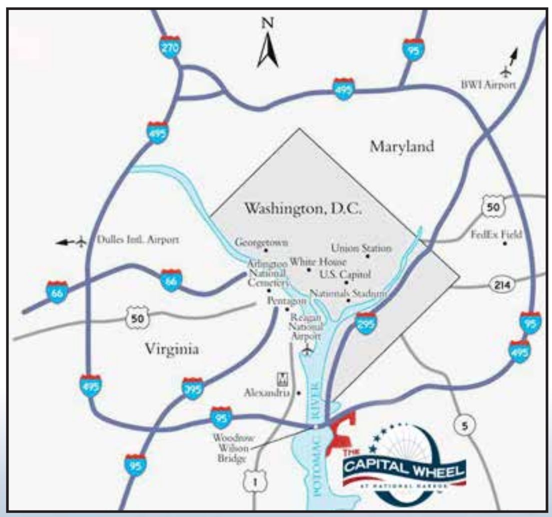
Just minutes away from all three area airports, The Capital Wheel at National Harbor is directly accessible via the Woodrow Wilson Bridge, the Capital Beltway, I-95, I-495 and I-295—with interchange and multi-lane fly-off ramps exiting exclusively into the community from Maryland, Virginia and D.C. We're right on the water ... yet a world away.

EDUCATIONAL OBJECTIVES

Formally design and construct an efficient bridge capable of spanning a set distance while receiving an every increasing load. Once completed, celebrate your success with a spin on The Capital Wheel!

SCIENCE STANDARDS:

NGSS Correlation:
HS-ETS1-1, HS-ETS1-2, HS-ETS1-3, HS-ETS1-4
Common Core Correlation:
ELA/Literacy: RST.11-12.7, RST.11-12.8, RST.11-12.9
Mathematics: MP.2, MP.4



THE WILSON CONNECTION!

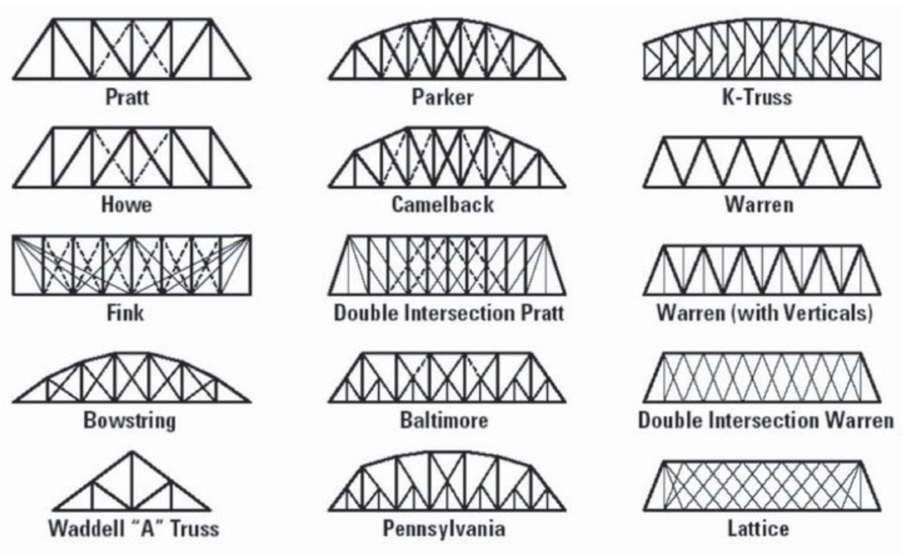
MASS A measure of the amount of matter in an object.

TENSION FORCE force that is transmitted through a string, rope, cable or wire when pulled tight by forces acting upon its ends.

NORMAL FORCE the supporting force exerted upon an object that while it is in contact with another stable object.

DESIGN EFFICIENCY RATIO amount of an object that is held divided by the mass of the supporting object in grams.

TYPES OF TRUSS BRIDGES



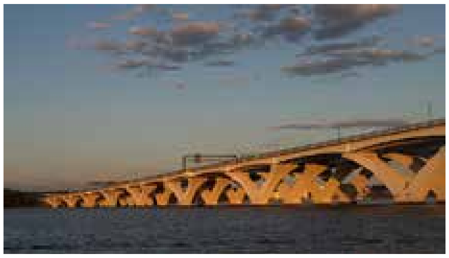
THE WILSON CONNECTION!

JUST TO THE north of the Capital Wheel you will spot an iconic and familiar sight: The Woodrow Wilson Bridge. Named after the United States of America's 28th President the bridge serves as a unifying conduit for the region, connecting Maryland, Virginia and Washington, D.C.

IN THIS CHALLENGE students will design and test their own bridge connecting them to the same engineering and design principles used by the civil engineers who constructed the Woodrow Wilson Bridge. Like the Woodrow Wilson Bridge students bridges must be load bearing. During evaluation student bridges will receive a mass on the center top of its structure. Once loaded, student bridges will be assessed for their strength-to-weight ratio or (efficiency). Bridges that are able to hold a greater mass, while remaining lighter, will record higher efficiencies.

A USEFUL TOOL for students in this engineering endeavor is the understanding and application use of the various type of bridge design. Bridge design types include but are not limited to: truss, suspension, arch and beam (the beam design is not permitted). For this challenge unless dictated by the event supervisor, students will develop truss bridges.

REMEMBER that in this challenge the goal for students is to assemble a bridge which can span a gapped distance (decided by the event supervisor) while supporting an ever increasing load. This can be modeled in variety of ways, however simply setting the bridge between two desks for the span and using a lightweight cup placed on top of the bridge to receive the load is recommended.



VOCABULARY

MASS: A measure of the amount of matter in an object.

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OBJECTIVE:

Formally design and construct an efficient bridge capable of spanning a set distance while receiving an every increasing load.

SUGGESTED MATERIALS (PER TEAM)

- Computer Aided Design Software or Graph Paper (Examples: http://www.sketchup.com, www.tinkercad.com)
- 10-12 Sticks of Balsa/Basswood or Spaghetti Sticks
- Quick Dry Construction Glue
- Heavy Marbles or Lead Weights
- Small Paper or Plastic Cups (For Judging)
- Stopwatch (For Judging)
- Metric Ruler (For Judging)

COMPETITION

After receiving their materials, each team of students (2-4 suggested) will be given time to first complete a formal analytical model of their bridge. Once the event supervisor has consulted with the group and approved their design, students may receive their material for construction. It is suggested that students receive at least two separately timed attempts to demonstrate their device. The goal for each attempt is to span a set distance and hold as much of an ever increasing weight as possible. Of the two attempts, only the attempt with the greatest mass amount held will be reported for scoring.

This process is not prescriptive, meaning that it does not have to be followed exactly as written. It is just a tool to help guide your students to a more productive engineering experience.

BEFORE YOU START

Consider providing students with the opportunity to think through their process before they take action. This will allow them the best opportunity to use their time and materials efficiently, thereby maximizing their results!

The Engineering Design Process is a useful tool in helping students processes their ideas:

- Ask Questions
- Research
- Generate Ideas
- Sketch Desired Design Requirements
- Plan
- Build a Prototype
- Test & Observe
- Improve & Redesign

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EVALUATION

At the end of construction time (30-60 min.), students will test their devices under the instruction of their event supervisor. Before the device is tested, the supervisor should confirm that it has been safely constructed and poses no harm to onlookers. Students may use any of their given materials to construct their device. (Use of additional materials beyond the suggested list are at the discretion of the event supervisor).

Team Number	Student Names	Team developed and submitted an approved design of their bridge either as a 3D Model or graphical illustration (Y/N) Teams with "no" are not qualified to compete	Height of Bridge (cm)	Amount of Mass Held	Mass of Bridge *	Efficiency Score = Mass held / Mass of bridge
1						
2						
3						
4						
5						

** In the event of a tie, the team with the lightest bridge will be declared the winner. If a tie still exists after this, the tallest bridge will be considered the winner.*

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REFLECTION:
After the event have students discuss/write about the following:

1. How did you and your teammates decide to approach solving the problem presented in this challenge?
2. What was the best thing about your design? What would you have changed and why?
3. There are many bridge types (Suspension, Truss, Beam, etc.) Compare/Contrast the bridge type of the Wilson Bridge to the one your team designed.
4. If you had an unlimited budget what kind of bridge would you build?
5. What was the main concept or idea you learned from this experience today?

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REFERENCES:
PhysicsClassroom.com
http://www.kingsford.org/khsweb/staff/Bertoldi/physicsvoc/phy1.htm http://dictionary.reference.com/, http://www.nextgenscience.org/msps-e-energy
http://www.britannica.com/technology/simple-machine, http://www.engineeringtoolbox.com/power-d_1289.html, http://pghbridges.com/basics.htm,
https://www.teachengineering.org/engrdesignprocess.php

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EXTEND:

Solve the following:

Design Efficiency = Mass Held (g) / Mass of Bridge (g)

1. The mass of a bridge is 1,200 g. Its Design Efficiency is 4.16. What is the amount of the mass held?

2. A bridge has a mass of 1,500 g and holds a mass of 2,225 g. What is the bridgeâ€™s Design Efficiency?

3. A bridge has a mass of 30 g and a Design Efficiency of 167. What is the amount of the mass held?

4. A bridge holds a mass of 3,000 g and has a Design Efficiency of 214.28. What is the mass of the bridge?

5. A bridge has a mass of 700 g and holds a mass of 4,000 g. What is the bridgeâ€™s Design Efficiency?

REFERENCES:

PhysicsClassroom.com
http://www.kingsford.org/khsweb/staff/Bertoldi/physicsvoc/phy1.htm http://dictionary.reference.com/ http://www.nextgenscience.org/msps-e-energy
http://www.britannica.com/technology/simple-machine http://www.engineeringtoolbox.com/power-d_1289.html http://pghbridges.com/basics.htm
https://www.teachengineering.org/engrdesignprocess.php