**Objective:** To become a civil engineer and assist in designing a Truss Bridge to carry a two-lane highway across a river valley using the West Point Bridge Designer 2003 Software.

**Warm Up:** Name 2 bridges in the tri-state region.

**Materials:**

* West Point Bridge Designer 2003 Software ([http://bridgecontest.usma.edu](http://bridgecontest.usma.edu))

* Computer Lab access for 2 -3 Days

* BACKGROUND INFORMATION FOR STUDENTS

**Background Information:** The following information is available on the West Point Bridge Designer Website.

a. The bridge may cross the valley at any elevation from the high water level to 24 meters above the high water level.

b. If the elevation of the bridge deck is below 24 meters, excavation of the river banks will be required to achieve the correct highway elevation. The highway must have a slope of no more than 1:10. The bottom of the roadway cut must be at least 20 meters wide, and the side slopes can be no more than 2:1.

c. To provide clearance for overhead power lines (shown above), the highest point on the bridge may not exceed an elevation 28.5 meters above the high water level (4.5 meters above the top of the river banks).

d. The bridge substructure may consist of either standard abutments (simple supports) or arch abutments (arch supports). If necessary, the bridge may also use one intermediate pier, located near the center of the valley.
e. Each main truss can have no more than 50 joints and no more than 120 members.

f. The bridge will have a flat, reinforced concrete deck, 15 centimeters thick and supported by transverse floor beams spaced at 4 meter intervals. (See Component Parts of a Truss Bridge for more information about these terms.) To accommodate these floor beams, your structural model must have a row of joints spaced 4 meters apart at the level of the deck. These joints are created automatically when you begin a new design.

g. The bridge deck will be 5 meters wide, such that it can accommodate two lanes of traffic.

h. The deck will be covered with an asphalt wearing surface 5 centimeters thick.

4. Member Properties

a. Materials. Each member of the truss will be made of either carbon steel, high-strength low-alloy steel, or quenched and tempered steel.

b. Cross-Sections. The members of the truss can be either solid bars or hollow tubes. Both types of cross-sections are square.

c. Member Size. Both cross-sections are available in a variety of standard sizes.

5. Loads: The bridge must be capable of safely carrying the following loads:

a. Weight of the reinforced concrete deck.

b. Weight of the asphalt wearing surface.

c. Weight of the steel floor beams and supplemental bracing members (assumed to be 12.0 kN applied at each deck-level joint).

d. Weight of the main trusses.
e. Weight of one standard H20-44 truck loading per lane, including appropriate allowance for the dynamic effects of the moving load.

6. Structural Safety: The bridge will comply with the structural safety provisions of the 1994 LRFD AASHTO Bridge Design Specification (Load and Resistance Factor Design), to include:

   a. Material densities

   b. Load combinations

   c. Tensile strength of members

   d. Compressive strength of members

7. Cost: The cost of the design will be calculated using the following cost factors:

   a. Material Cost:

      Carbon steel bars - $2.10 per kilogram

      Carbon steel tubes - $3.15 per kilogram

      High-strength steel bars - $2.80 per kilogram

      High-strength steel tubes - $3.90 per kilogram

      Quenched and tempered steel bars - $4.00 per kilogram for

      Quenched and tempered steel tubes - $5.30 per kilogram for

   b. Connection Cost: $150.00 per joint

   c. Product Cost: $500.00 per product

   d. Site Cost:

      Reinforced concrete deck - $7,000 per 4-meter panel

      Standard abutments (simple supports) - $7,000 each
Footing for arch abutments - $3,250 each

Arch abutment walls - $1,750 per meter high per abutment

Footing for pier - $4,000 each

Pier - $1000 per meter high

**Procedure:**

1) Students will be working in teams of 3-4 on building a bridge online. They will be using the [West Point Bridge Designer 2003 Program](http://www.bridgecontest.usma.edu) that is available online at www.bridgecontest.usma.edu.

2) Have the students read the directions silently and then read them aloud to ensure that the students understand the directions.

3) The student’s objectives are to build a bridge that can carry its own weight plus the weight of a truck loading. They also have to keep the cost of the project as low as possible.

4) Students will have 2 class periods to complete this project – saving their project after the first day.

5) If possible students can submit their projects online for unofficial judging.

6) Each student will save their final bridge project onto a disk. Share each bridge with the class using a TV-Ator or projector and compare the weights and costs of each bridge.

**Evaluation:** Observation of group work on bridge and review of final project.