Overall Goal

To design and fabricate a 20 foot, tenth scale bridge out of smaller steel members, connected by nuts and bolts, that can support 2,500 lbs and be assembled quickly.

Major Rule Changes

- Cantilever portion is now an option
- 2 temporary piers are allowed ($30,000 each)
- There are no longer “Assemblies”
- “Tools” cannot be placed on the temporary pier
- Lateral tests are now limited to ½”
- 2 lateral tests and 2 vertical tests

Categories of Competition

- Display
  - Appearance of bridge, including balance, proportion, elegance, and finish. Quality of fabrication, including welding, shall not be considered because some bridges may be fabricated professionally rather than by students.
  - A poster describing the design is also required. The poster shall present information specified in the official rules.
  - Display is the tie breaker for all categories of competition. Judges shall not declare ties in display.
- Construction Speed
  - The bridge with the lowest total time will win in the construction speed category.
    - Total time is the time required for construction modified by construction penalties prescribed in 9.4, 10.4, and 10.8.1 of the official rules.
- Lightness
  - The bridge with the least total weight will win in the lightness category.
    - Total weight is the weight of the bridge plus weight penalties prescribed in 8.2, 9.3, 9.5, and 10.4.2 of the official rules. Temporary piers, decking, tools, lateral restraint devices, and posters are not included in total weight.
- Stiffness
  - The bridge with the lowest aggregate deflection will win in the stiffness category.
    - Aggregate deflection is determined from measurements as prescribed in 11.5 of the official rules.
• Construction Economy
  o The bridge with the lowest construction cost (Cc) will win in the construction economy category.
  o Construction cost is computed as
    - \( C_c = \text{Total time (minutes) } \times \text{number of builders (persons)} \times 50,000 \text{ ($/person-minute)} + $30,000 \text{ for each temporary pier that is staged for construction} + \text{load test penalties ($)}\)

• Structural Efficiency
  o The bridge with the lowest structural cost (Cs) will win in the structural efficiency category. Structural cost is computed as
    - For a bridge that weighs 303 pounds or less,
      - \( C_s = \text{Total weight (pounds)} \times 10,000 \text{ ($/pound)} + \text{Aggregate deflection (inches)} \times 1,000,000 \text{ ($/inch)} + \text{load test penalties ($)}\)
    - For a bridge that weighs more than 303 pounds,
      - \( C_s = \lbrack \text{Total weight (pounds)} \rbrack^2 \times 33 \text{ ($/pound2)} + \text{Aggregate deflection (inches)} \times 1,000,000 \text{ ($/inch)} + \text{load test penalties ($)}\)
    - The scoring spreadsheet computes aggregate deflection as the sum of DbL, DbR, and DcL

• Overall Performance
  o The overall performance rating of a bridge is the sum of construction cost, structural cost, and utility relocation charge (Cc + Cs + $150,000 if AC footings are declared). The bridge achieving the lowest value of this total wins the overall competition.
    - AC footings declares no cantilever while AB footings declares a cantilever portion. See Construction Site Detail.

Load Determination

• Immediately before timed construction of the first bridge, the head judge rolls a die to determine the magnitude and location of loads illustrated by the Vertical Loading Plans. For each possible result S of the roll, Table 1 gives the load distribution and dimension for positioning a decking unit. The same locations and loads will be used for all bridges in the same conference competition.

Table 1: Determination of Wb, Wc, and M

<table>
<thead>
<tr>
<th>S</th>
<th>Wb (lb.)</th>
<th>Wc (lb.)</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1900</td>
<td>600</td>
<td>5'-6&quot;</td>
</tr>
<tr>
<td>2</td>
<td>1900</td>
<td>600</td>
<td>6'-6&quot;</td>
</tr>
<tr>
<td>3</td>
<td>1900</td>
<td>600</td>
<td>8'-6&quot;</td>
</tr>
<tr>
<td>4</td>
<td>1700</td>
<td>800</td>
<td>5'-6&quot;</td>
</tr>
<tr>
<td>5</td>
<td>1700</td>
<td>800</td>
<td>6'-6&quot;</td>
</tr>
<tr>
<td>6</td>
<td>1700</td>
<td>800</td>
<td>8'-6&quot;</td>
</tr>
</tbody>
</table>
- The die is rolled again. If $S$ for this second roll is even, the left and right sides of the bridge are relative to travel from the A end to the C end. If $S$ is odd, the left and right sides are relative to travel from C to A. The same designations will be used for all bridges in the same conference competition.

**Material and Component Specifications**
- Steel is defined as an iron alloy that is strongly attracted to the magnet provided by the host chapter. **Some grades of steel are not magnetically attractive.** All parts of the bridge must be made out of magnetic steel.
- A member shall not exceed overall dimensions of 3'0” x 6” x 4”. That is, it shall fit into a right rectangular prism (i.e., box) of those dimensions.

**Structural Specifications**
- The bridge shall have exactly two decking support surfaces, each of which is contiguous over the full length of the bridge so that decking could be placed to bear on them anywhere along the span.
  - Decking support surfaces shall contact the tops of the two notches in the template for the full length of the bridge during the verification procedure
  - Decking support surfaces shall be free of holes, splits, separations, protrusions, and abrupt changes in elevation or slope.
- The bridge shall not extend more than 5’0” above the ground or river.
- The bridge shall not be wider than 5’0” at any location along the span.
- The decking support surfaces shall be no more than 2’7” above the surface of the river or ground at any location along the span
- Decking support surfaces shall be at least twenty feet long, regardless of whether footings A and B or footings A and C are declared.
- The clearance shall be at least 1’6” high, measured from the surface of the ground or river. Parts of members, nuts, and bolts, shall not extend below this limit.

**Construction Regulations**
- There shall be no more than six builders.
- A tool shall not weigh more than fifteen pounds. Welding machines and tools requiring external power connections, batteries, or other internal energy supplies shall not be used during timed construction.
- There shall be no more than two temporary piers. Each temporary pier shall fit inside a 1’6” diameter cylinder of any length, not weigh more than fifteen pounds, and retain its original dimensions. Wheels and rollers are permitted if they rotate about concentric axes so that dimensions of the temporary piers are not changed.
- A builder shall not cross from the ground on one side of the river to the ground on the other side.
- Builders start without tools, nuts, and bolts, which may be passed from one builder to another after timed construction begins. Similarly, temporary piers may be passed from builder to builder. There shall be nothing within the construction site that is not in a staging yard.
**Load Test Instructions**

- Judges shall observe sway carefully during vertical load testing. If sway exceeds 1”, loading shall cease and load shall be removed carefully.
- Judges shall observe vertical deflections carefully. If any deflection measurement exceeds 3”, loading shall cease and load shall be removed carefully.
- **First Lateral Load Test**
  - A fifty-pound lateral pull is applied and sway is measured on the left side of the bridge, 9’0” from the end of the decking support surface at the A end of the bridge. The test is failed if sway exceeds 1/2”.
- **Second Lateral Load Test**
  - A fifty-pound lateral pull is applied and sway is measured on the left side of the bridge. The pull is applied as close as possible to the end of the decking support surface at the C end of the bridge. If the measuring device cannot be placed at that point, it may be shifted laterally to a feasible location between the ends of the decking support surfaces. The test is failed if sway exceeds 1/2”.
- **First Vertical Load Test**
  - (1) Initialize the sway measurement device.
  - (2) Initialize the two deflection measuring devices at DbL and DbR, or record the initial readings.
  - (3) Competitors place the Wb load.
  - (4) Record the final readings for DbL and DbR.
- **Second Vertical Load Test**
  - (1) Load Wb remains in place.
  - (2) Do not initialize the sway measurement device or the deflection measuring devices at DbL and DbR.
  - (3) Initialize the deflection measuring device at DcL, or record the initial reading.
  - (4) Competitors place the Wc load.
  - (5) Record the final reading for DcL.