The Aiken Engineering Challenge is a program supported by the University of Vermont George D. Aiken Lectures that aims to involve young Vermonters in engineering and technology, a topic that long interested Senator Aiken.

Students will build a device to meet an engineering challenge and compete with their device at an event held at UVM. **This year the event will be on Saturday, December 1, at the Davis Center.** The creators of the Champlain Maker Faire and the University of Vermont will host Vermont's statewide K-12 Maker Faire and workshops the same day as the Aiken Challenge.

This challenge is an achievable one and can be solved using ordinary hand tools, readily available materials, and components that most schools already have, and for a reasonable cost, but there is real engineering involved. The students will need to analyze the problem, consider a variety of solutions, build a trial device, test it, make improvements, and build a final design that is robust and reliable. The challenge is structured so that almost any team can achieve some success, but it is not easy to win.

Students experience hands-on learning and engineering thought, both necessary to solve any number of contemporary real-world challenges in energy, agriculture, the environment, and communication.

These official rules, a registration page, Q & A System, and other information about the Aiken Challenge are available at: [www.uvm.edu/~cems/TASC/](http://www.uvm.edu/~cems/TASC/).

### 1.0 THE CHALLENGE FOR DECEMBER 1, 2018 - SUMMARY

See the next page for an illustration of the Playing Field and the game.

- The object of the game is to put ping-pong balls in a number of different targets using a "Crane."
- The Committee supplies a plywood base to hold the Targets, the Targets themselves, Corrals to hold the ping-pong balls at the start of the game, two pieces of plywood for the Control Areas, and the balls themselves. The Committee will also place a wooden lattice to define the Playing Field.
- The Team builds a lifting device (the "Crane"), two Controllers, and Linkages to connect the components.
- The score is based on the number of balls placed in the Targets and the difficulty of the individual Targets. There is also a bonus for cooperating with the other team, and a bonus for winning a match. See Section 7.1 for the scoring formula.
2.0 THE PLAYING FIELD

The Playing Field consists of:

- A plywood base on which are mounted six "regular" Targets.
- A Cooperation Target; mounted on the plywood base.
- A White Ball Corral and an Orange Ball Corral, each holding 35 balls of their respective color at the start of the match. The Teams may choose which side of the field to locate their Ball Corral. The Corrals are 1/2" deep.
- A Common Ball Corral, mounted on the plywood base, which holds 10 ping pong balls of each color at the start of the match. Also 1/2" deep.
- Two Device Areas, one for each team, defined by a wooden lattice. The Cranes are placed here.
• Two Control Areas, one for each team, made from a sheet of 1/4" plywood or masonite; the Controllers are placed here. The Teams may choose the position of their Control Area as described in Section 4.0.

A dimensioned drawing of the Playing Field and the Targets are found in Section 10.1 and 10.3 of this document.

Teams are not allowed to mark, attach to, or modify the Playing Field in any way. The floor surface is commercial carpet.

3.0 GAME PIECES (Balls)

The Game Pieces consist of:
• Ping-pong balls in white and orange colors, 38 mm in diameter.

The actual Game Pieces for the event will be provided by the Aiken Challenge Committee.

Game Pieces may not be marked, altered, or added to in any way.

4.0 THE CRANE, CONTROLLERS, AND LINKAGES

Each team shall build a “Crane” to pick up balls from the Ball Corral and deposit them in the various Targets.

The Crane need not look like any commonly held notion of a crane or like the Cranes in Figure 1. Any device meeting the requirements below will be acceptable.

• The size of the Cranes in starting configuration must not exceed 24” x 24” and the volume above. After the game begins the Cranes may extend outside these limits.

• Cranes may be mobile within their Device Area, but no supporting element of the Crane may extend beyond the Device Area at any time. The Judges will not permit a Crane to pick up or score a ball while in violation of this rule, and any balls picked up or scored while in violation will be removed. Cranes may not be fastened to the floor surface and may not damage the floor surface.

Note that this rule applies to the supporting elements of the Crane - pads, wheels, a base. An arm or other element used to score balls may, of course, reach outside the Device Area.

• Each Crane must be operated by two Controllers, each with a significant role in guiding the operation of the Crane, and each with a separate human Operator. The two Operators must rotate from match to match, with a different combination of
Operators for each match to the extent possible; the Operator’s names need to be entered on the scorecard for each match.

The purpose of this rule is to encourage participation in the actual play by all of the Team members.

- A Linkage extends from each Crane to its two Controllers. The Linkage may be mechanical, electrical, or wireless, or a combination thereof.
- The teams may locate their Control Area in any one of three available positions as shown in Figure 3. Once located the Control Area must remain fixed for the duration of the match.
- The Controllers must remain entirely within the Control Area and the volume directly above it at all times (the Control Volume). All control actions must be made within the Control Volume.

This means that you may not, for instance, reach out and directly manipulate the Linkage or the Crane itself. The operator’s hands must remain within the Control Volume when operating the Crane.

There is no requirement that the Controllers be placed directly on the surface of the Control Area. The Controllers may be hand held and/or elevated as long as they remain within the Control Volume during the match.

- Energizing the Cranes:
  - Cranes may be energized by human energy generated at the Controllers and transmitted mechanically or electrically to the Crane from the Controllers through their Linkage.
  - Cranes may be energized by electrical energy transmitted to the Crane from the Controllers through their Linkage. An external power supply of 12 VDC nominal maximum is allowed, connected to the Controller; 110 VAC power will be available to run the power supply.
  - Cranes also may include internal stored energy elements such as springs or elastic cords.
  - Cranes may also include internal stored electrical energy, i.e. batteries.
  - A combination of energy sources is allowed.
  - Devices using vacuum systems or low-pressure air flow will be allowed if they are safe. "Low pressure air flow" means air flow generated with a fan, not a compressor.
  - Unsafe sources of energy, such as chemical energy, electrical energy in excess of 12 VDC (nominal), compressed air, small animals, are not allowed.
  - The entire operation of the Crane must be safe, in the opinion of the Judges. Any issues of safety must be resolved during the initial inspection or prior to the event using the Q & A system. Refer to Section 4.1.
4.1 Safety

Your system cannot pose a danger to your team, others in the venue, or to the floor and walls. If the Judges believe your system is dangerous, you will not be allowed to run until and unless the problem is corrected. A Team may ask for a confidential ruling on their design prior to the event if they wish using the Q & A System.

It is strongly recommended that any team members operating or repairing your device must wear safety glasses, to be supplied by the Team.

5.0 TARGETS AND THEIR POINT VALUES

The general nature of the Targets is shown in Figure 1. A detailed drawing of the Targets and a more complete description are shown in Figure 4, Paragraph 10.3.

- Target A: 8 points per ball, approximate capacity: 5 balls
- Target B: 4 points per ball, approximate capacity: 6 balls
- Target C: 1 point per ball, approximate capacity: 15 balls
- Target D: 6 points per ball, approximate capacity: 13 balls
- Target E: 3 points per ball, approximate capacity: 9 balls
- Target F: 10 points per ball, approximate capacity: 21 balls

6.0 THE MATCH

6.1 The Match Time

A match is 5 minutes and is preceded by a Set-up time of 5 minutes.

6.2 Starting Positions and Set Up

- Teams play in pairs, chosen at random by the Judges, and will play three or four matches, each match against a different opponent. Teams will not be paired against the same opposing Team twice. Teams will not be paired against another Team from the same school.
We will play as many matches as possible within a period of approximately three hours. The number of matches will depend on number of teams registered and the available space at the venue.

- The Judges will place Orange and White ping-pong balls in the Orange and White Ball Corrals, and in the Common Ball Corral. (Refer to Section 1.0 for the number of balls in each location.) There will be no pattern to the ball placement; balls can be anywhere in any of the Ball Corrals.

- Teams place their device in the Device Areas on the Playing Field, and their controllers in the Control Areas. They connect the Linkages between the Cranes and Controllers as necessary. Cranes must be entirely within the Device Areas.

- Prior to the start of each match, one Team, chosen by a coin flip, will randomly draw one of six "Cooperation Cards". The Judges will place the Card in the Cooperation Target to indicate the required pattern of the balls in that target.

![Cooperation Cards](image)

**Figure 2. The Cooperation Cards**

- The Team may use the Set-up time to place and calibrate its Crane. At the end of the five-minute Set-up time the Judges will start the Match.

### 6.3 Game Play

- Both Teams collect balls and place them in the Targets. Each Team **may only manipulate balls of its own color**. A Crane **may** control and manipulate more than one ball at a time.

  If a Crane accidentally or intentionally controls or ingests a ball of the **wrong color** the Judges will direct that Crane only to stop; the opposing Crane continues to play. The Judges will remove the incorrect ball(s) and then allow the Crane to continue. If for any reason the Judges are unable to remove an incorrect ball that Crane will be **disabled for the remainder of the Match**.

Thus, it is important that the design of the Crane allow the balls in its possession to be both **visible and easily removed** by the Judges! This rule will be strictly enforced.
It is very much in your interest **not** to control or ingest a ball of the wrong color.

- Each Crane operates independently. Neither Team shall intentionally interfere with the operation of the other Team’s Crane. Intentional interference will earn a penalty; refer to Section 7.2. Incidental unintentional contact will not be penalized.
- Teams may not intentionally block the access to any Target; intentional blocking will likewise be penalized; refer to Section 7.2.

  “Blocking” means obstructing a Target without making a realistic attempt to score a ball in it.

  In the absence of competition for a Target there is no time limit for obstructing the Target. **If there is competition for a Target** the Team obstructing it must attempt to score within 5 seconds, then again within 5 seconds, and so on. **After 5 seconds without an attempt to score** the Team must yield the Target to the other team.

- Play continues for five minutes or until all the Targets are full of balls, whichever occurs first.

  **Note that the Targets are not** quite large enough to contain all the available balls. Thus, it is to the advantage of a Team to get there first.

- Balls which fall onto the Target platform or the Playing Field on the Team’s side may be retrieved. Balls which fall outside the Playing Field or onto the other Team’s side cannot be retrieved; they are out of play.

- The Cooperation Target is mounted on the Target platform. Teams may cooperate or not, as they see fit; consultation before the Match begins is encouraged. The Cooperation Target has four orange squares, four white squares, and one mixed square. Each Team places **balls of its color** in the appropriate squares, or a ball of either color in the “mixed” square. A ball placed in the wrong color square may be removed **only by the team that placed it**. **Both Teams** will get a bonus if nine balls are placed in the Cooperation Target in the **exact pattern** indicated by the Cooperation Card. In other words, Teams can cooperate to increase both their scores. (Balls in the Cooperation Target **do not** earn regular Target points.)

### 6.4 Adjusting or Repairing a Failed Crane

During a match the Team **may** adjust or repair its Crane, Controller, or Linkages. If necessary for safety, the components must be de-energized. The clock does **not** stop. When making a repair a Team must remain on its side of the field and may not interfere with the operation of the opposing Crane.

### 6.5 Location of Team Members During the Match

During the Set-up Time all Team members, if they wish, may be present within or near the Playing Field.
During the match two team members operate the Cranes from their Controllers. All other Team members must remain in the spectators’ areas.

7.0 Scoring

7.1 Scoring Formula
At the conclusion of the Game Period the balls of each color will be counted in each Target. The score is calculated separately for each Team.

The score is:

\[
S = C \times [ n_{T1} \times pv_{T1} + n_{T2} \times pv_{T2} + n_{T3} \times pv_{T3} + n_{T4} \times pv_{T4} + n_{T5} \times pv_{T5} + n_{T6} \times pv_{T6} ] + W
\]

Where:
- \( S \) = is the score, calculated separately for each team.
- \( C \) = is the cooperation multiplier, either 1 if cooperation has not been achieved, 2 if cooperation has been achieved.
- \( n \) = is the number of balls in each Target.
- \( pv \) = is the point value of each Target.
- \( W \) = is the bonus for winning a match, 75 points for the winning team only.

Note that both teams get the cooperation multiplier if it has been earned.

Each team will play three or more Matches as time permits. The score from a Team's Matches will be totaled to determine the Team's overall score.

7.2 Penalties
- Intentional interference or blocking as described in Section 6.3 will be penalized 50 points for each infraction.
- Teams must remove their Cranes, Controllers, and Linkages from the Playing Field promptly after the end of the Match. Teams that fail to do so, after a 30 second warning, will receive a penalty of 20% of their score for that match.
- A team that damages any Target or part of the Playing Field to the extent that play must be paused will be penalized 100 points for each infraction.

If the Judges notice any other violation of a rule during play the offending Team will be stopped, and the matter resolved with the team. The clock does not stop.
8.0 THE TOURNAMENT

8.1 Engineering Design Presentation (optional)

Each team has the option to make a 10-minute verbal and poster presentation describing their Crane and its control method. Teams wishing to make a presentation must opt-in by sending an e-mail to jimwick.vt@gmail.com on or before November 1, 2018 informing the committee of its wish to present. (If you fail to opt-in by that date you will only be able to make a presentation if and when slots are available on event day; there will be no guarantee that you will be able to present.)

Note that two awards, the Engineering Design Presentation Award, and the Modeling, Testing, and Documentation Award will be based on this presentation.

On event day there will be a Presentation Manager and a sign-up sheet where each team may schedule its presentation between Matches.

Your presentation should include:

Each team must provide a poster that describes how their system operates. Each poster should include:

- A description of how your Crane operates (including a diagram).
- Highlight any advantages of your design and why you believe it might be better than the competition.
- Examples of numerical modeling you may have used to design your Crane and/or determine the best strategy.
- Pictures and/or records of tests you performed with the Crane.
- Key features of the systems and of the construction of your Crane and control system and how its design may have been derived from your modeling and testing.
- Your strategy for the competition and how it may have been derived from your modeling and testing.
- How you optimized your system to meet the goals of your strategy.
- Particular challenges which you encountered and your response to those challenges.

The rubric that will be used to score the presentations is listed in Section 10.7.

8.2 Inspection

Prior to their first Qualification Match all Cranes, Controllers, and Linkages must pass Inspection. The emphasis of inspection will be to determine whether the design or operation of your device poses undue hazards for the Team, the Judges, or the spectators. In particular, if you use wireless control, the Judges will review how your system will avoid interference with other teams’ systems.
Teams should use their Inspection time to review with the Judges their plans for energizing and operating their device. The Judges will require that all actions can be accomplished safely and will require the modification of the Crane or operating procedures if necessary before an unsafe Crane can be allowed to run.

Note also that any issues of safety can be resolved prior to the event using the Q & A system www.uvm.edu/~cems/TASC/.

8.3 The Qualification Matches

There will be several Playing Fields as necessary to allow all contestants to complete the Matches within about three hours.

Each Team will play three or four Qualification Matches:

- A 5-minute Set-up Period for whatever the team wishes to do for set-up, calibration, and tests. Teams do not need to use the full 5 minutes for set-up. However, any remaining time will not be added to the Match.

- 5 minutes for the Match during which balls are scored. This time must start no later than 5 minutes from the start of the Set-up Period. Teams shall indicate to the Judges when they wish to begin their Match. The match ends after 5 minutes, or when all Targets are full, whichever is first.

The team must remove their Cranes, Controllers, and Linkages from the Playing Field promptly after the end of the Match. Teams that fail to do so, after a 30 second warning, will receive a 20% penalty of their score for that match; refer to Section 7.2.

8.4 Playoff Round

There will be a Playoff Round.

The four teams with the highest calculated scores in the Qualification Matches will be paired randomly to play one match for each pair. The winners of these matches will play a final match for the championship.

Scoring is as for the Qualification matches except there will be no Cooperation Bonus; the Cooperation Target will be inoperative.

8.5 Awards

The award categories and number of awards will be defined based on the number of registered teams as of November 1, 2018. There will be at least the following award categories:

- Top three teams in the Payoff Round
- Top Middle School Team in Playoff Round (if none then top qualifier)
- Engineering Design Presentation Award
- Modeling, Testing, and Documentation Award
A team may win more than one award.

9.0 Miscellaneous Provisions

- Teams:
  - Teams may consist of at least two but not more than five members.
  - Team members must be in grades 5-12; there are no age restrictions.
  - Teams will be either High School or Middle School Teams. "Middle School" means what the school district considers middle school; if the district does not designate a middle school then grades 5, 6, 7, and 8 will be considered middle school for this competition. All members of a middle school team must be in middle school, but a high school team may include middle schoolers.
  - Team members from more than one school or organization may participate on the same team. Groups such as home-schoolers, Boy Scouts, Girl Scouts, 4H groups, and ad-hoc groups are encouraged to participate.
  - An adult is required to be the team advisor; the advisor does not need to be a teacher.

- The total number of teams participating will be limited to the first 40 teams that register on or before November 1, 2018. The registration form is on the website at www.uvm.edu/~cems/TASC/.

- A scoresheet will be filled out by the Judges for each match. The Judges are responsible for bringing scoresheets to the Scoring Judge. Refer to Section 10.6 for a sample scoresheet.

- Questions about the Rules or anything else regarding the Aiken Challenge may be submitted to: jimwick.vt@gmail.com. We will try to post questions and answers promptly, but sometimes a question will require the review of the full Committee and may take a few days.

- If you have specific questions but you do not wish to reveal details of your design, you can request a confidential reply. Since answers to new questions will normally be posted as part of the Q & A System, please identify any confidential question as "confidential reply requested" so that we do not accidentally post it.

9.1 October Report Bonus

It is helpful to the Aiken Challenge Committee to know about the emerging designs prior to the event. Therefore, any team which submits a brief description of their Crane, Controllers, and Linkages together with snapshots on or before November 1, 2018 will receive 100 bonus points. To receive bonus points your submission must be reasonably clear and understandable. It must include information on the construction of your Crane, your probable control method, and at least one example of a spreadsheet you have made to analyze the challenge. All submissions will be held in strict confidence. Submissions should be made to: jimwick.vt@gmail.com.
You **may** continue to change and develop your design after you have made this submission.

## 10.0 Appendices

### 10.1 The Playing Field

The figure below shows the Playing Field. The field is defined by a wooden lattice as shown.

![Diagram of the Playing Field](image)

**Figure 3 The Playing Field**
10.2 Practice Fields

We will attempt to set up a practice area with a set of Targets. This will depend on how crowded the room becomes. Teams will be encouraged to bring extra targets for use in practicing.

10.3 Construction of the Targets

The diagram below shows the dimensions and the construction of the Targets.

![Diagram of Target Construction]

**Figure 4 Construction of the Targets**

The Targets and the Common Ball Corral are mounted on a 3/4" plywood base, approximately 48" x 6" (the Target platform). The base has stabilizers mounted on the ends, outside the Playing Field, to prevent the Targets from tipping over.
Targets A, B, D and E are made from deli containers, 16 oz. or 32 oz. Targets C and E have open tops. Targets A and D have lids with 1 3/4” and 2” openings respectively. Balls resting on the lids are not scored; they must be at least halfway inside the container to be scored.

Targets A, D, and E are mounted on wooden posts.

Targets B and F are thin-wall plastic tubes placed over wooden plugs at the bottom which support them. These tubes are the type used to protect T-12 fluorescent lamps and are 1 1/2” I.D.

The Ball Corrals have sides 1/2” high mounted on 1/4” plywood.

The balls shown in the Targets in Figure 4 are for illustration only; there is no significance to the number or positions shown of the balls.

10.4 The Cooperation Target

![Diagram of The Cooperation Target]

Figure 5 The Cooperation Target
The Cooperation Target is mounted on the same plywood base which holds the other Targets; refer to Figure 1.

The Cooperation Target consists of a 6” square piece of plywood and a lattice made of 13/16” dowels. The selected Cooperation Card, showing where balls of different color are to be placed, is set on the plywood square. The lattice is placed on top of the card and located with pins.

10.5 A Snapshot of the Playing Field

The following is a snapshot of the Playing Field. Minor changes may be made prior to the event; we will notify registered teams as this occurs.

Figure 6 The Playing Field
10.6 Scoresheet

The scoresheet to be used by the Judges to score each match will be approximately as shown below. The Scoring Judges will enter this information into a separate spreadsheet to calculate the actual scores.

<table>
<thead>
<tr>
<th>Team Name</th>
<th>School</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Match □</td>
<td>Second Match □</td>
</tr>
<tr>
<td>Third Match □</td>
<td>Fourth Match □</td>
</tr>
<tr>
<td>Playoff 1 □</td>
<td>Playoff 2 □</td>
</tr>
<tr>
<td>Operators for this Match</td>
<td>Operators for this Match</td>
</tr>
<tr>
<td>Target 1</td>
<td>Balls Scored 1</td>
</tr>
<tr>
<td>Target 2</td>
<td>Balls Scored 2</td>
</tr>
<tr>
<td>Target 3</td>
<td>Balls Scored 3</td>
</tr>
<tr>
<td>Target 4</td>
<td>Balls Scored 4</td>
</tr>
<tr>
<td>Target 5</td>
<td>Balls Scored 5</td>
</tr>
<tr>
<td>Target 6</td>
<td>Balls Scored 6</td>
</tr>
<tr>
<td>Cooperation</td>
<td>☐ Yes</td>
</tr>
<tr>
<td></td>
<td>☐ No</td>
</tr>
<tr>
<td>Penalties if any</td>
<td>Interference</td>
</tr>
<tr>
<td>Damage □</td>
<td>Delay of Game penalty □</td>
</tr>
<tr>
<td>Any other penalty</td>
<td></td>
</tr>
</tbody>
</table>
10.7 Engineering Presentation Rubric

Note that two awards, the Engineering Design Presentation Award, and the Modeling, Testing, and Documentation Award will be based on this presentation.

<table>
<thead>
<tr>
<th>Scoring Category</th>
<th>Description of criteria for scoring</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentation Content &amp; Structure</td>
<td>Does the presentation contain all required elements and how well organized/effective is its structure? (Refer to Section 8.1 for requirements.)</td>
<td>0  4  8  12  16  20</td>
</tr>
<tr>
<td></td>
<td>The presentation has no real structure or content.</td>
<td>The presentation contains most elements of the necessary content but may not be effectively organized to effectively communicate it.</td>
</tr>
<tr>
<td></td>
<td>The presentation contains some of the necessary content but is missing other key elements.</td>
<td>The presentation contains all of the necessary content in minimal form and is reasonably well organized.</td>
</tr>
<tr>
<td></td>
<td>The presentation contains most of the necessary content but is not effectively organized.</td>
<td>The presentation contains all of the necessary content, is rich in some areas and is very well organized.</td>
</tr>
<tr>
<td></td>
<td>The presentation contains all of the necessary content in minimal form and is reasonably well organized.</td>
<td>The presentation contains all of the necessary content, is rich in all areas and is exceptionally well organized.</td>
</tr>
<tr>
<td>Presentation Quality</td>
<td>How well is the presentation given? Criteria include: clarity of voice, eye contact, effectiveness of expression, body language, charisma, flow, effectiveness of poster as a visual aide, etc.</td>
<td>0  4  8  12  16  20</td>
</tr>
<tr>
<td></td>
<td>The delivery of the presentation clearly lacks rehearsal and the way in which it is presented significantly detracts from the content.</td>
<td>The delivery of the presentation does not significantly detract from the content but is not effective.</td>
</tr>
<tr>
<td></td>
<td>The delivery of the presentation is effective, but stiff, lacks charisma, and/or does not flow well.</td>
<td>The delivery of the presentation is solid with minimal detractors</td>
</tr>
<tr>
<td></td>
<td>The delivery of the presentation is engaging.</td>
<td>The delivery of the presentation is exceptionally charismatic and engaging.</td>
</tr>
<tr>
<td>Solves Problem</td>
<td>Measure of how well the team's Crane and control system solves/addresses the basic elements of the problem:</td>
<td>0  4  8  12  16  20</td>
</tr>
<tr>
<td></td>
<td>1. Ability to collect Balls.  2. Ability to score different Targets.  3. Ability to adjust to the Cooperation Card.</td>
<td>The Crane and its control system do not solve any of the basic elements of the problem.</td>
</tr>
<tr>
<td></td>
<td>The Crane and its control system adequately solve 1 basic element of the problem.</td>
<td>The Crane and its control system adequately solve 3 basic elements of the problem and is exceptional in some respects.</td>
</tr>
<tr>
<td></td>
<td>The Crane and its control system adequately solve 2 basic elements of the problem.</td>
<td>The Crane and its control system completely solve 3 basic elements of the problem and is exceptional in all aspects.</td>
</tr>
<tr>
<td>Engineering Tests</td>
<td>Measure of the quality of engineering modeling/testing prior to the competition:</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1) Modeling/testing data were provided for different design or strategy alternatives.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2) Modeling/testing addresses how to maximize scoring.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3) Modeling/testing were used to develop competition strategy (type of Crane, mode of energizing, control system).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4) Modeling/testing were used to modify and/or validate design.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5) Modeling/testing demonstrate good understanding of physics and mechanics.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No modeling/test data provided.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Modeling/test data marginally addresses 1-5.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Modeling/test data address most aspects of 1-5.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Modeling/test data address all aspects of 1-5 and is exceptional or distinctive in some aspects of 1-5.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Modeling/test data addresses all aspects of 1-5 and is exceptional or distinctive in all aspects of 1-5.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Team Participation</th>
<th>How well the team works together as a group to contribute to the presentation.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No participation by the team.</td>
</tr>
<tr>
<td></td>
<td>Presentation dominated by select individuals.</td>
</tr>
<tr>
<td></td>
<td>Most team members participate in presentation.</td>
</tr>
<tr>
<td></td>
<td>Most members contribute significantly to the presentation.</td>
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<tr>
<td></td>
<td>All members contribute to the presentation.</td>
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<tr>
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<td>All members contribute significantly (~equal contributions across entire team).</td>
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