BEST

Boosting Engineering, Science & Technology™

Blade Runner
BEST 2014 Design Contest
Game Specific Rules
Version 1.17
August 23, 2014

1. Introduction/Game Premise

Wind energy is an important topic of the present and the future, providing the world with sustainable clean energy. The enormity of the present day wind turbines continues to grow. The weight of the components, the axle load (total weight resting on a given axle) must be distributed across many axles so that the maximum weight-per-axle limits are not exceeded. This makes the transport vehicles very long and heavy. Below are sample shipping lengths and weights for the entire transport vehicle loaded with the components of the turbines.

Blade: 45.2 m (148.4') ship length: 56.4 m (185')
Blade sweep diameter: 96.6 m (310.5')
Ship weight 40823.3 kg (90,000 lbs)

Nacelle: 3.5m x 3.8m x 11.4m (11.5'x12.5'x37.5' (WxHxL)) ship length: 61.6m (202')
Ship weight 338 658.3 kg (740,000 lbs)

Tower:
- Base: 16.1m (52.8') ship length: 53.9m (177')
- Mid-section: 24.3m (89.7') ship length: 60.7m (199')
- Top-section: 36.0m (118.2') ship length: 60.7m (199')

Ship weight: 181 436.9 kg (400,000 lbs)

Height to C/L of hub: 81.4m (267')
Height to top of blade: 128.6 (422')

These giant turbines pose an interesting engineering challenge – how to transport the components and assemble these massive structures.

The engineering challenge is to design a vehicle capable of transporting and maneuvering structures of extreme length and weight to the assembly site without negatively affecting America's transportation system. There are also logistic challenges to overcome prior to transportation and assembly of the wind turbines. Due to the potential roadway damage, transportation law requires an Over Size Over Weight (OSOW) permit be obtained prior to transport. The cost of obtaining the permit contributes to the maintenance of the roadway. Additionally, some environmentally sensitive areas exist which hamper the development of the infrastructure required to deliver the components to the assembly site. The transportation path travels through the habitat of an endangered species (Prairie Chicken Environments). Federal law requires relocation of endangered species to an acceptable alternative habitat.
Transport of the components to the assembly site can begin once the logistic challenges are resolved. Once the components are delivered to the assembly site, the vehicle will construct the wind turbines. Cranes on-site will aid in the final upright positioning of the fully completed turbines.

BEST Robotics is searching for the optimum solution to this engineering challenge. It is calling for innovative engineering corporations to develop and build a prototype vehicle to

participate in a competition to win a contract with an emerging national wind energy company. The BEST award will go to the corporation with the total package: transportation and assembly performance (game scoring), innovation and robustness of the vehicle, engineering approach and documentation (notebook), marketing and presentation of the project, environmental stewardship, and spirit and sportsmanship during the competition.

In addition, an agreement with your neighboring company can be made that allows the cooperating teams to work together with a mix of parts on the small and large turbines.

Please read and follow the rules outlined in this document to aid you in rising to this engineering challenge. Good luck!

2. Objectives

Use teamwork and innovative thinking to execute five sets of tasks to assemble and position a wind turbine into a completed state. This includes designing and building a prototype vehicle capable of transporting and maneuvering components of the wind turbines. Determine a strategy to complete these tasks as efficiently as possible.

2.1 Task Set 1: Logistics

There are two tasks associated to logistics: acquiring the OSOW permit (tie breaker) and relocating the Prairie Chicken Environments.

2.2 Task Set 2: Transportation of Components

Load and transport all turbine components in the stockpile area to the assembly site by traveling over the bridge or the damaged road. This includes three large turbine blades one small turbine nacelle, and one small turbine hub/blade assembly.

2.3 Task Set 3: Assembly of Turbines

Assemble small turbine and the large turbine using the correct components. The blades attach to the hub, the hub attaches to the nacelle and the nacelle attaches to the tower in the lowered position. The order in which these components are assembled is does not matter. The small turbine blades are permanently attached to the hub but begin play in the folded transport position and secured with an elastic shipping strap. The large turbine blades can be assembled to the hub in two scoring positions.

2.4 Task Set 4: Upright Positioning of Wind Turbines

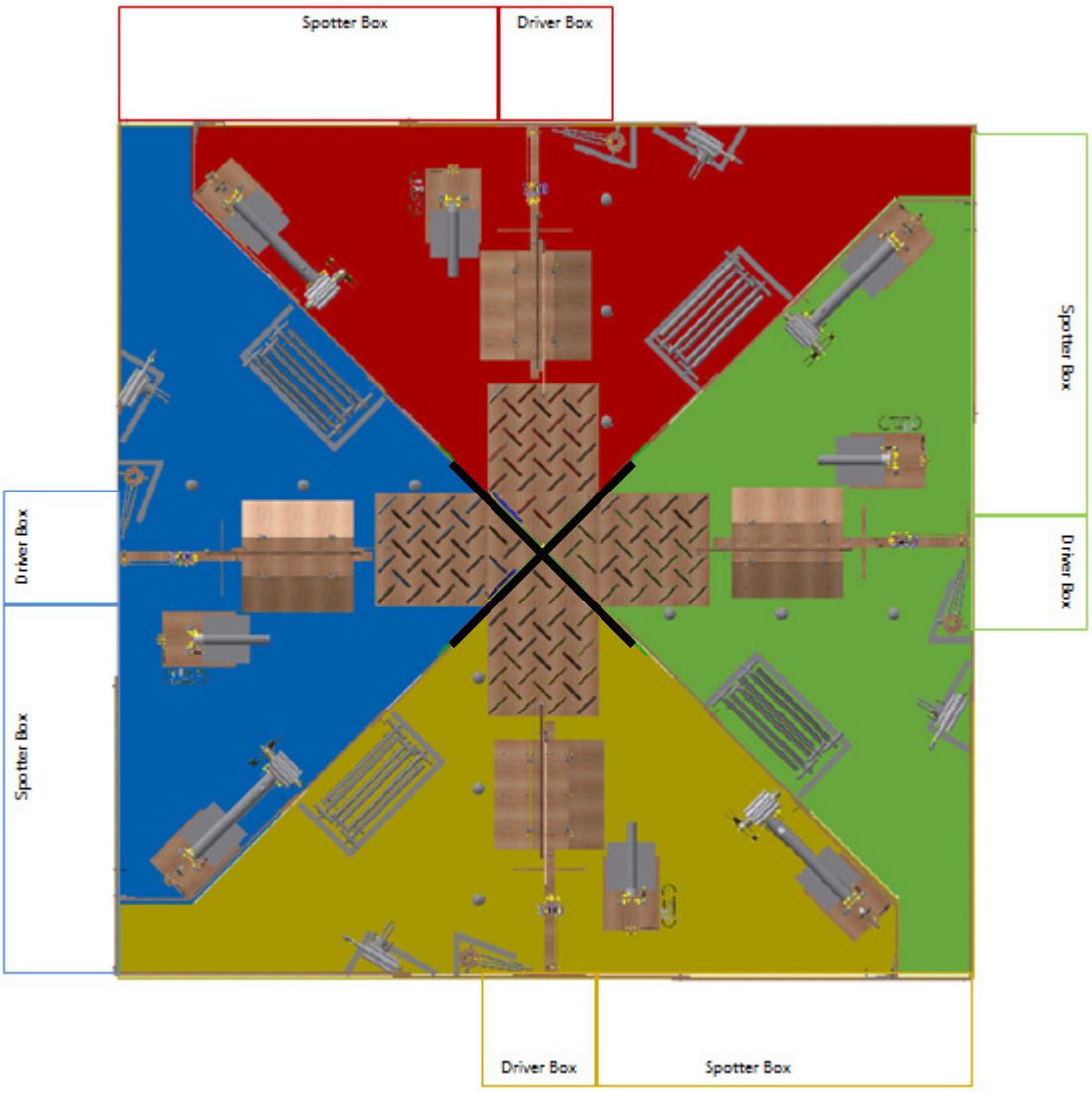
Once a turbine is fully assembled (small or large turbine) the turbine is raised to the upright position by the crane (rope and board) and crane operator (spotter).

2.5 Task Set 5: Expanding/Installing the Turbine Blades in Expanded Position

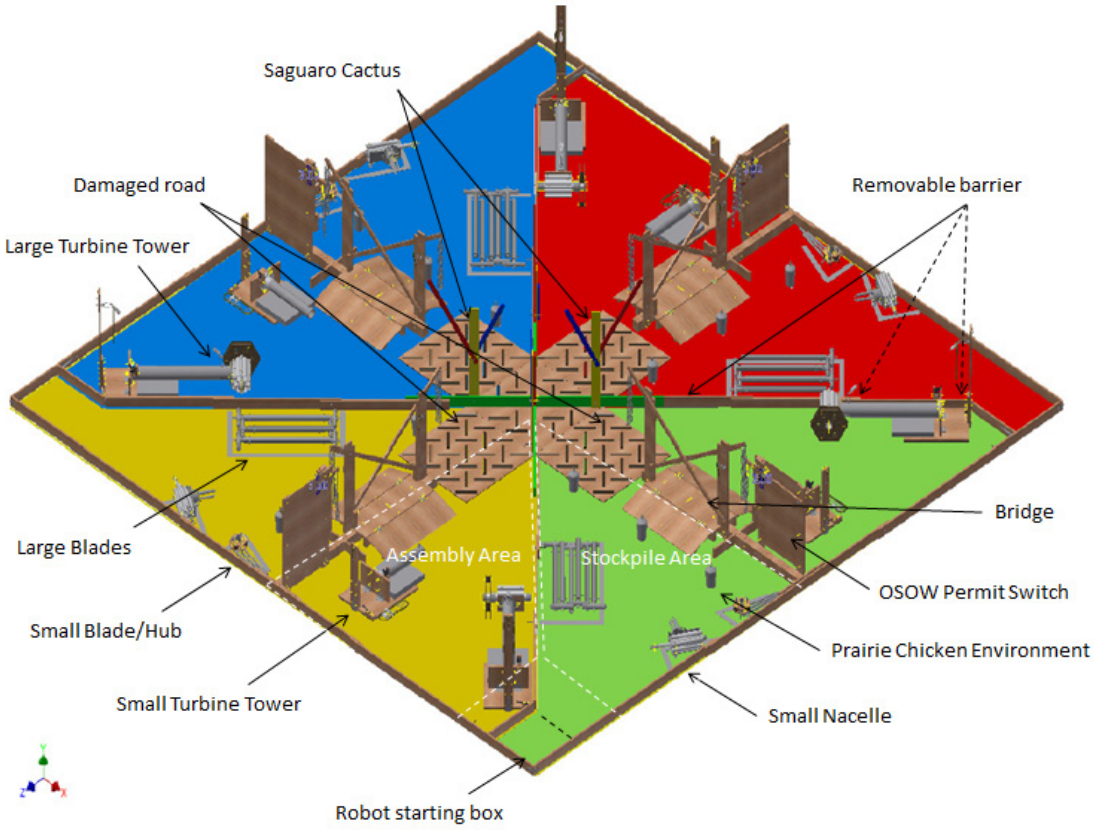
While installing and assembling the turbines, the blades can be positioned into an expanded position. The small turbine blades are expanded by removing the shipping strap while the tower is being raised or once in raised position. The large turbine blades can be installed in expanded position by the robot while the turbine tower is in lowered position or can be repositioned by the spotter once the tower is raised and in locked position.

3. Game Field Description

The Blade Runner Game Field is a 24’ x 24’ square, defined by 1”x4” s.
Contained within the square are four triangles (red, green, yellow and blue in clockwise order). Each color defines the playing field for each team. Each triangle is approximately 24’ (base) x 12’ (height).
The base on each triangle is defined by the perimeter of the square.
The sides of the triangle are defined by a 1”x4” removable barrier that extends from the robot box to a fixed barrier in the shape of an “X” (black “X” in image below), located in the middle of the playing field that separates each team’s roadway.



A section of restricted overhang is created by Saguaro cacti in the central area of the field. At the apex of the X and at each of the four ends are 1”x4” constructs representing these environmentally sensitive plants. Extending from the X barrier to the robot start box are 1”x4”s. An 8’ section can be collapsed during cooperative play allowing free transport between the cooperating team areas. The removable barrier is folded out of the way for passage of vehicles from each team’s playing field (the barrier collapses to extend between the dashed lines in the drawing below).



Each game field triangle consists of two main areas:

1. Stockpile area
2. Assembly area

These areas are separated by the damaged road, the bridge, and the OSOW permit station/switch. The assembly area is defined as the area to the right of the roadway, bridge, and permit station. Dimensions of the assembly areas are shown in the detailed field drawing below.

3.1 Stockpile area

This is the starting location for the game pieces (the location for each piece will be marked with tape). These game pieces with be transported to the assembly area to assemble the turbines. (Detailed construction of the game pieces is given in section 4.

This area contains the following game pieces:

- Vehicle starting location (2’x2’square)
- Small turbine nacelle
- Small turbine blade/hub assembly

- Six separate large turbine blades (30” long) – three for standard play and three for cooperative play
- Three Prairie Chicken Environments

3.2 Assembly Area

The assembly area is the area of the field where assembly of the turbine is completed.

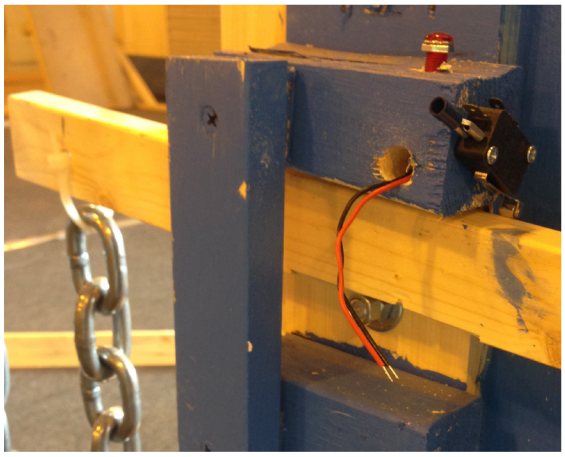
This area contains the following game pieces:

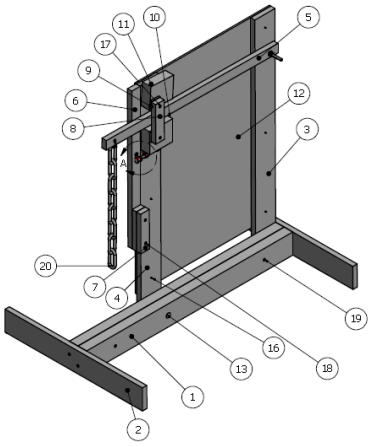
- Large turbine tower with attached nacelle
- Small turbine tower

3.3 OSOW Permit Station

The oversize over-weight permit is located next to the bridge and faces the stockpile area.

- This is a mechanical and electrical switch and is the tie breaker for game play. The time at which the electrical switch is triggered is recorded by the scoring computer.
- The button is a hinged plywood piece that releases a lever, which then opens a switch that is normally closed.
- Opening of the switch sends a signal to the scoring computer which records the time at which the switch was closed. The switch also turns on an LED light which is mounted to the arm of the permit switch.





OSOW switch that has not been activated

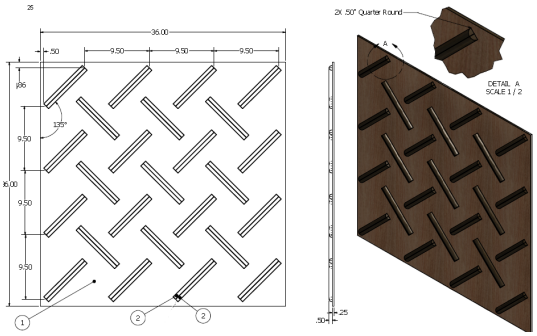
3.4 Prairie Chicken Evironment Relocation Safe Zone

The relocation safe zone is the 2’ x 2’ robot start box defined by 2” tape on the floor. (indicated by the area on the detailed field drawing)

3.5 Damaged Roadway

The damaged roadway can be crossed to transport game pieces from stockpile to assembly areas. The Over-size Over-weight permit switch must be activated to obtain points for transport or assembly of parts in your assembly area.
Details:

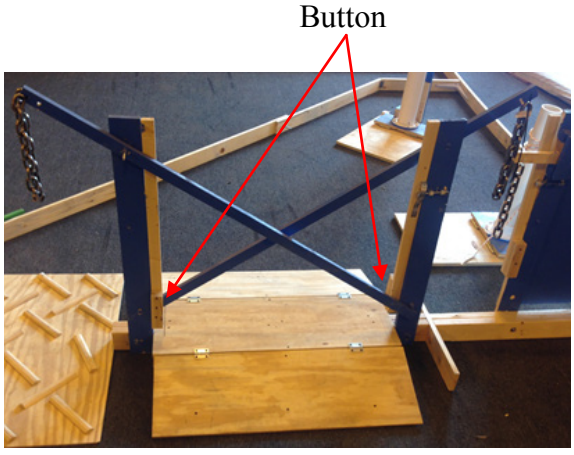
- The damaged roadway is constructed of a 3'x3' x ¼" plywood square with ½" ¼-round (two pieces glued together) molding attached in a cross hatch pattern, see image below.
- The fixed X barrier is mounted to an additional 3'x3' damaged roadway, thus the damaged roadway extends to the center of the field.

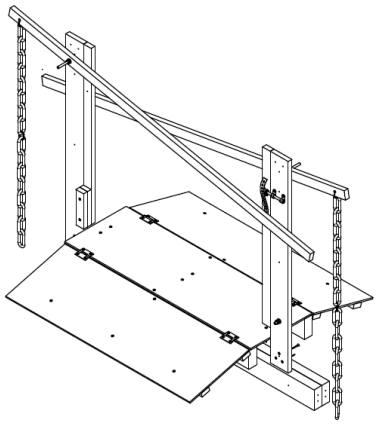


3.6 Bridge with Gates

The bridge can be crossed to transport game pieces from stockpile to assembly areas.
Details:

- The bridge is a platform 4" from the ground with a ramp at 17°, 11" long on each side. It is 2.5' wide by 3' long, constructed of ¼" plywood.
- The gates are 6' long 1" trim molding with 1' chain counter weights. Buttons at each side of the bridge on the uprights control opening of the gates. Once the buttons are pushed, it releases the gate.



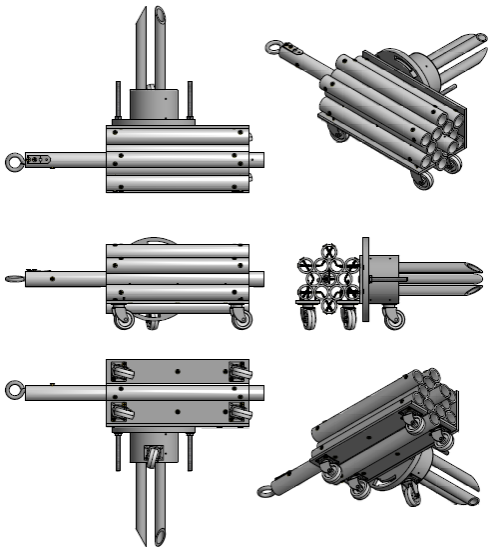


4. Game Piece Descriptions

Each triangle of the playing field will have the same parts although the color for each part will change depending on the area of the playing (red, green, yellow or blue) and will be marked according to the field drawings with tape patterns.

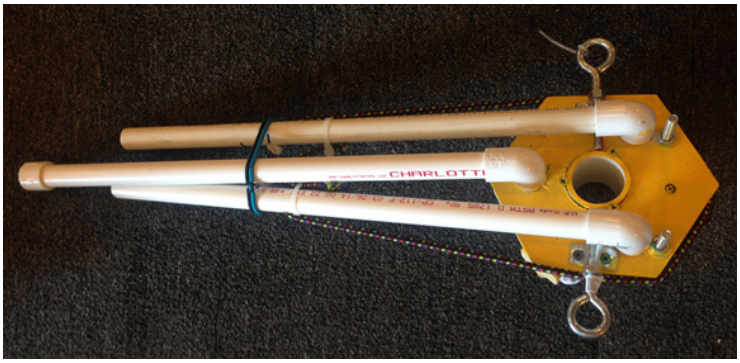
4.1 Small Nacelle:

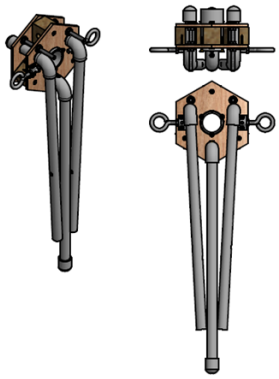
- This piece is located in the stockpile area. During game play the small nacelle is to be transported to the assembly site. During assembly of the small turbine, the small blade/hub assembly will be slid onto the axle protruding from the small nacelle and the base of the nacelle will be attached to the small tower.
- The nacelle is constructed of 12 1" PVC pipes 12" long glued together lengthwise with a 1" x 24" PVC pipe glued in the center as an axle that extends 10" from the front. The small hub/blade assembly slides onto this axle. The axle has a 1" eyebolt on the end of the axle.
- A "latch" is installed on the axle to prevent the Small blade/hub assembly for sliding off the axle when the arms are extended. The latch is a 2" bracket raised at 15° from the axle.
- One side of the nacelle is attached to ¼" plywood with four 1.5" caster wheels to assist with transport. The 5th wheel is mounted on a pvc flange.
- The small nacelle base is a 3" PVC flange with three 1" PVC pipes 8" long that extending out of the base to stabilize the connection to the tower.



4.2 Small Hub/Blade Assembly:

- This piece is located in the stockpile area. During game play the small hub/blade assembly is to be transported to the assembly site. The small blade/hub assembly will be positioned to be attached to the axle extending from the small nacelle.
- Blades are 1/2” PCV pipes, 18” in length with a 90° joint and 3” length of 1/2” PVC pipe. A 1/2” end cap on the short length of PVC pipe holds the blade in the hub.
- The small hub assembly consists of two parallel 8” hexagonal wood pieces with three holes for the blades to attach and a center piece of 2” PVC pipe for the axle of the nacelle to slide through.

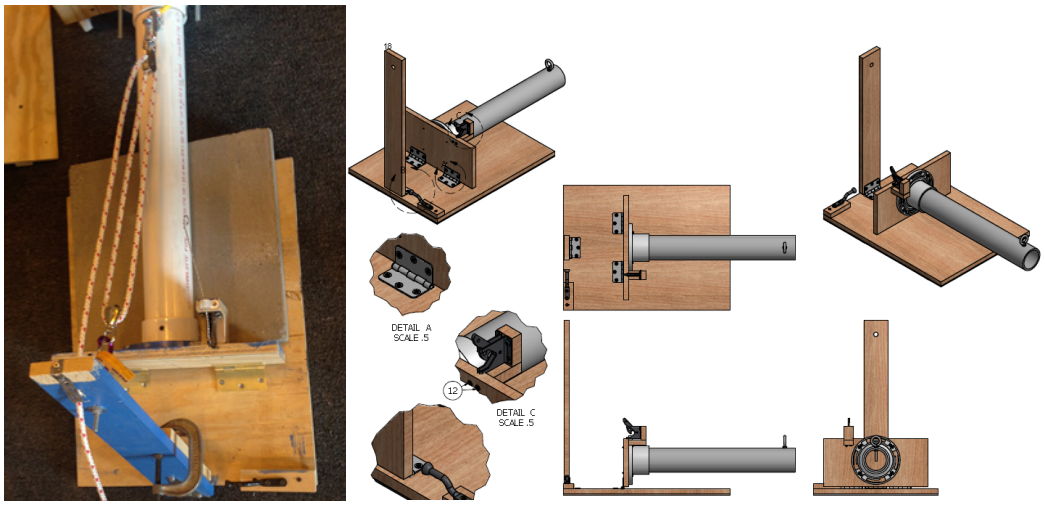




- The middle blade is fixed and does not turn with respect to the hub.
- The three blades are held together with an elastic band covered with cloth (hair band) 10” from the bottom of the middle blade, with the location marked with colored tape.
- The outer blades swivel on the hub. A bungee cord is attached on the outer side of each blade. The cord is then attached to the top of the hub, such that the blades will rotate into an extended position once the elastic band is removed. A screw is positioned on the hub to stop the blade, and tension from the cord will hold the blade in place.
- There is a 5/16” eyebolt on each side of the hexagon wood piece for lifting purposes to facilitate proper installation positioning with the small nacelle.

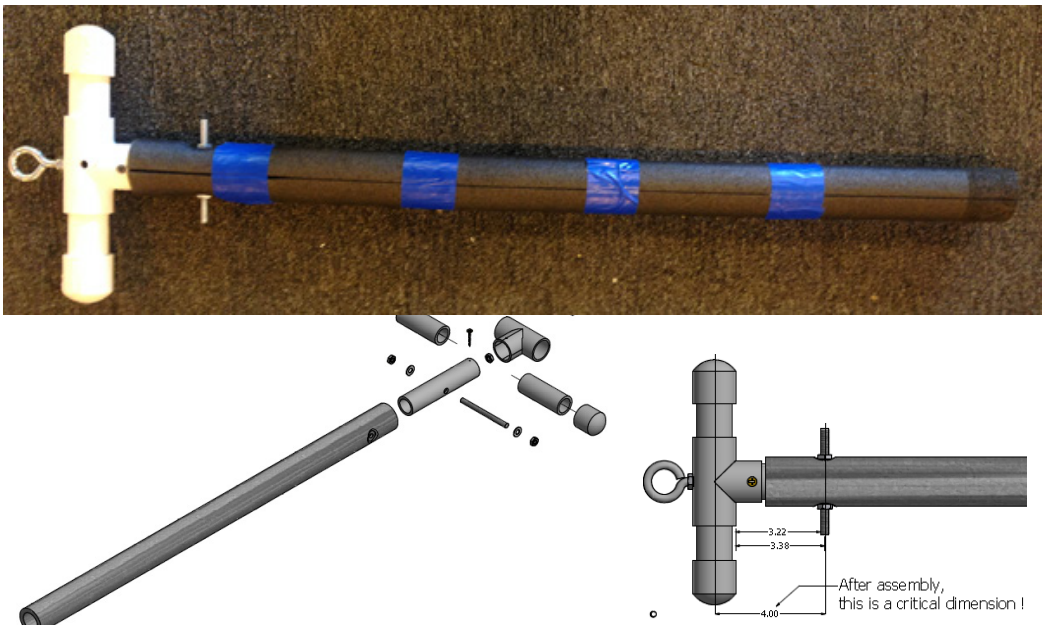
4.3 Small turbine tower

- This game piece is located in the assembly area at the base of the field triangle, 16” from the perimeter and 16” away from the bridge.
- The small tower consists of the tower itself attached to a base which is hinged to a footprint for stability. The top of the tower is attached to a rope to be pulled by the spotter. A hinged 1”x4”x3’ board lowers and raises with the tower to improve the pull angle.
- Once the tower is fully upright a latch on the base will engage. This prevents the tower from falling or being lowered again and indicates the full upright scoring position.
- The tower is constructed of 3” PVC pipe 2’ long (26” measured from base plate to top of the pipe) with no nacelle or hub attached at the top. The PVC pipe is open on the top to allow the nacelle to be installed in this location. See image below.



4.4 Large Blades:

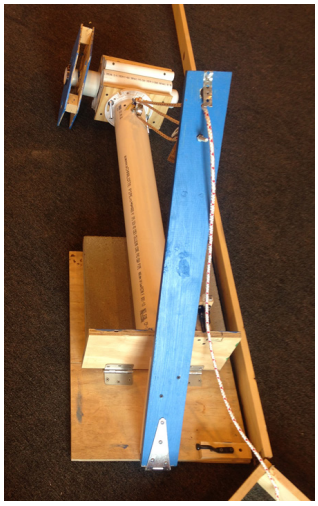
- This piece is located in the stockpile area. During game play, the large blades are to be transported to the assembly site. Each will be installed into one of the fittings on the large hub assembly attached to the large nacelle/tower.
- The blades are a 1” PVC “T” joint with 3” long PVC pipe extending from both sides with 1” end caps and a 6” PVC pipe extending from the end. At the intersection of the “T” joint, there is a 1” eyebolt. A 30” long section of 1” foam pipe insulation is attached at the end of the “T” and covers the 6” long section of PVC.



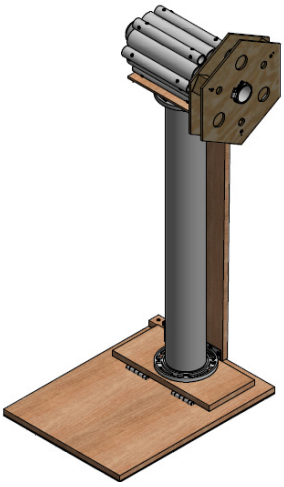
- A section of all-thread is attached on the blade that will insert into a corresponding hole in the turbine hub for positioning the blades in the expanded position.

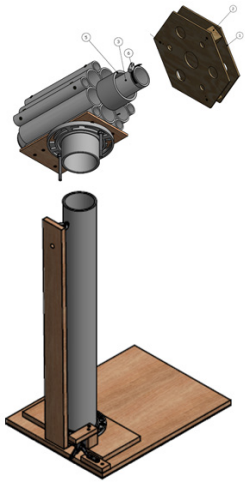
4.5 Large turbine tower with nacelle and hub attached

- The large tower assembly includes the tower, nacelle, and hub. The large blades are the game pieces to be installed on the large tower assembly.
- The large tower is constructed of 4” PVC schedule 40 pipe, 3’ long (40” measured from base plate to top of 4” PVC flange). See image below.
- The tower is attached to the base and the base hinged to a 3/4” plywood platform for stability. The top of the tower is attached to a rope to be pulled by the spotter. A hinged 1”x4”x3’ board lowers and raises with the tower to improve the pull angle. See image below.
- Once the tower is fully upright, a latch on the base will engage. This prevents the tower from falling or being lowered again and indicates the full upright scoring position.



Assembled Tower



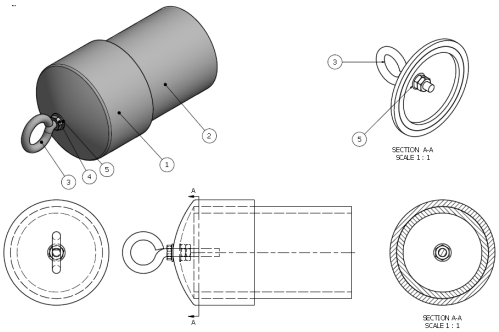


Tower, Nacelle, and Hub Separate

- The nacelle is a composite of six 2” PVC pipes and six 1” PVC pipes – all 10” long; and a 2” PVC x 24” axle with 2” PVC end cap.
- The hub consists of two 14” hexagonal shaped ¼” plywood pieces with 2” spacing between them, three 2” holes on each piece.
- A small hole is positioned in the hub for a bolt on the blade to slide into in order to position the blades in the expanded position. Above is a drawing of the small and large holes in the hub.
- A corresponding bolt is found on the blade that will insert into the hole.

4.6 Prairie Chicken Environments:

- These pieces are located in the stockpile area. During Game Play, these pieces are to be relocated to the Safe Zone (initial robot starting box) to score points. A point deduction will be recorded for Prairie Chicken Environments that are no longer upright.
- Prairie Chicken Environments are constructed of 3” PVCpipe that is 6” long with a 3” PVC cap on the top. A 1” eyebolt is attached on top for movement of the piece. The overall dimension of the Prairie Chicken Environment is 7” to the top of the cap and 8-1/2” to the top of the eyebolt. (Prairie Chicken image is not required)

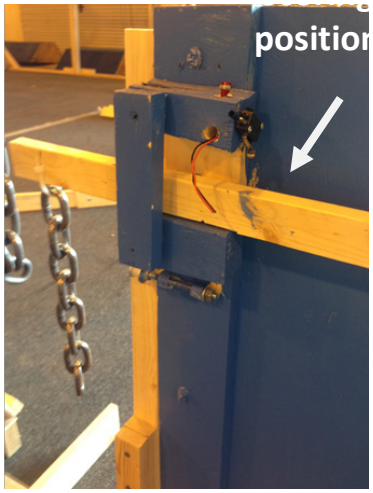


5. Game Play

The objective of the game is to acquire a OSOW permit, transport game pieces from stockpile to assembly areas, and assemble one small and one large wind turbine with an option to cooperate with your neighboring team for added points.

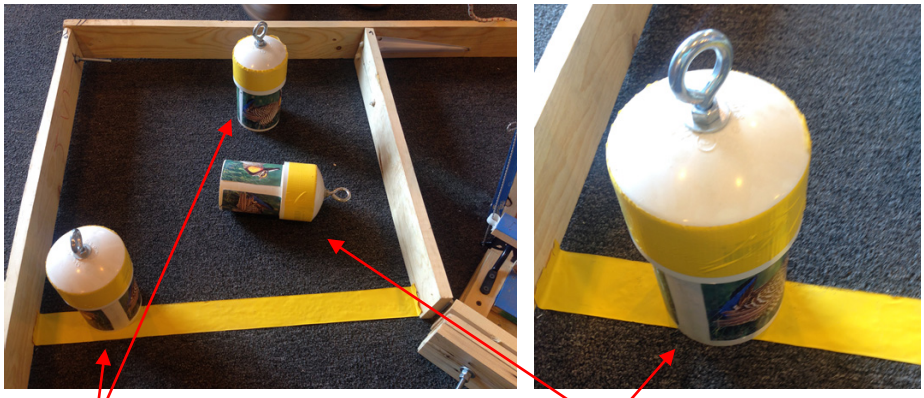
5.1 Logistic Tasks

- Acquire the OSOW Permit
  - The OSOW permit switch in the permit station should be activated for two reasons:
    - Tie breaker - The time the switch is activated is recorded by the computer and in the event of a tie determines the winner of the match.
    - This permit must be obtained in order to score points for any game pieces in your team's assembly area; this includes transport or assembly.
    - The OSOW permit is not needed to score points for assembly using your parts in your neighbor's assembly area (adjacent to your stockpile area). Cooperative play must be established prior to the match.
  - The permit is obtained by pushing the button approximately ½" so that it falls and opens the switch for the tie breaker



- Relocating Prairie Chicken Environments – Three Prairie Chicken Environments are located in stockpile area.
  - They may need to be moved to the designated relocation Safe Zone for easier movement on the field for transport of turbine components over the bridge or across the damaged road.
  - Points will be awarded for Prairie Chicken Environments in the upright position and a higher point value will be recorded for relocation to the safe zone still in the upright position.
  - No portion of the game piece can be outside of the taped area to score points.
  - Regardless of location on the playing field, a deduction in points will occur if the Prairie Chicken Environment are no longer in the upright position.

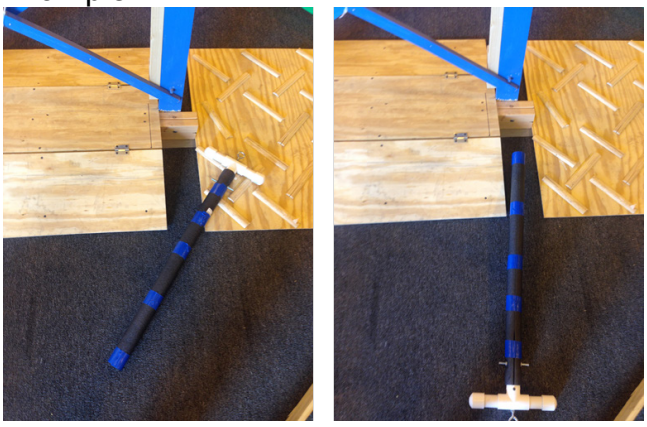
- The relocation of the Prairie Chicken Environments can occur at any time during the match.
- If OSOW permit is not obtained, points will still be recorded for upright position or relocation of Prairie Chicken Environments.



5.2 Transporting Turbine Components (Game Pieces) to the Assembly Area.

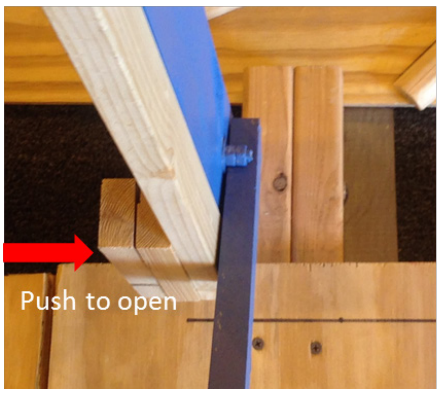
- The following components (game pieces) should be transported from the stockpile area to the assembly site by traveling over the bridge or on the damaged road.
  - Small nacelle
  - Small hub/blade assembly
  - Large blades (3)
- To score points for each of these game pieces, the entire component should be in the assembly site and not touching any of the following items: damaged road, bridge, safe zone, or permit station. No points for transportation will be scored for components touching these portions of the playing field or the robot.

Example:



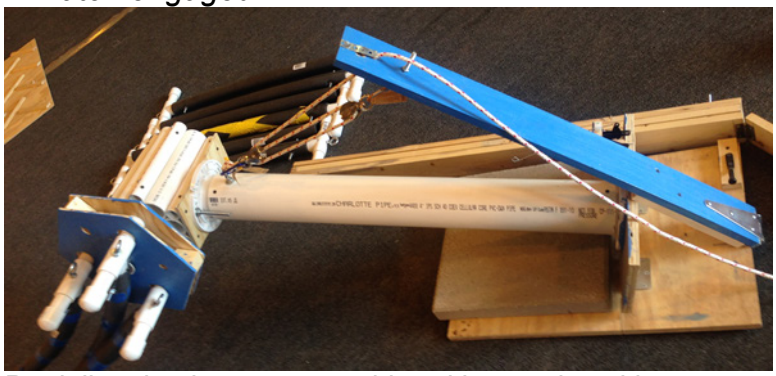
Not Scoring Scoring

- Points will be obtained for each bridge gate that is opened. The gate button on each gate can be pushed to release the gate.



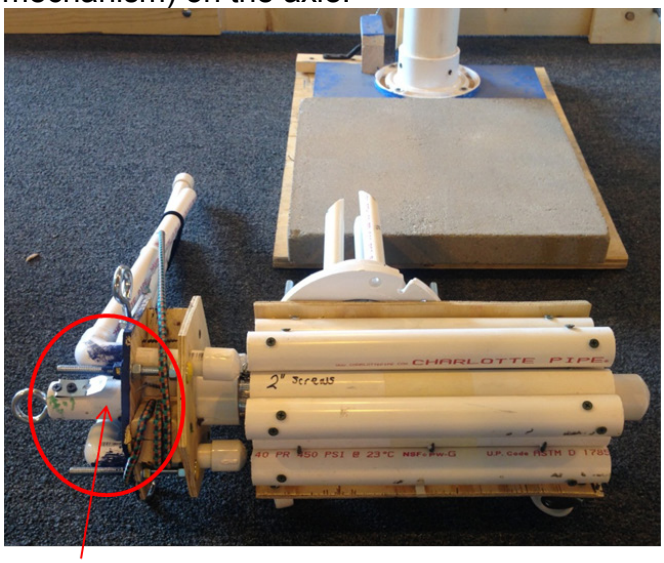
5.3 Assembling Turbines

- Both towers begin match play in the lowered position.
- Towers can be partially raised by the crane operator (spotter) to aid in the installation of the blades or nacelle. A one-way latch on the rope prevents the towers from being lowered until the end of the match.
- Once the tower is raised to the full upright position, the tower will lock into place.
    - *A lowered tower position is considered to be any position that is **not** the fully upright position.*
    - *An upright position is the tower raised to the upright position with the latch engaged.*

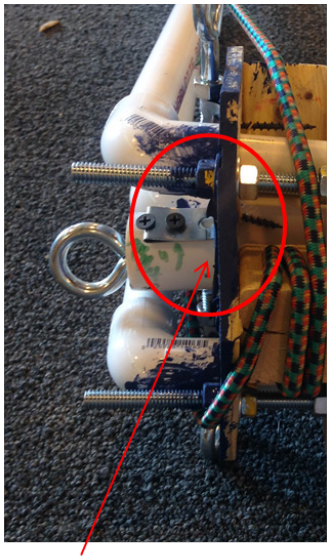


Partially raised tower – considered lowered position

- Small hub/blade assembly can be installed onto the small nacelle with the tower in the raised upright position.
- Small turbine assembly – points are awarded for each of the following items individually:
    - Small hub/blade assembly properly attached to the small nacelle's axle Scoring position: hub/blade assembly is installed past the latch (locking mechanism) on the axle.

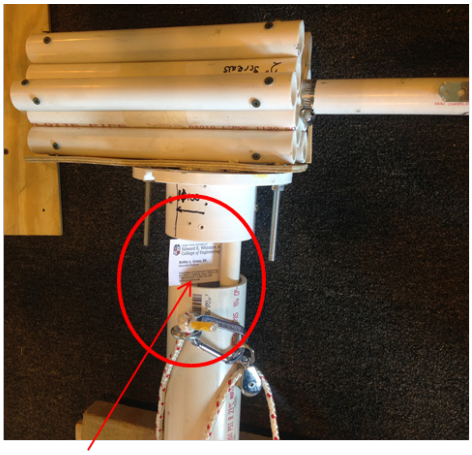


Past latch - scoring



Not Past latch – not scoring

    - Small nacelle attached to small tower - The stabilization pipes sliding inside the pipe with the base of the nacelle (flange) pushed 2" or closer to the top of the tower (the height of a standard business card is a good measure for scoring).

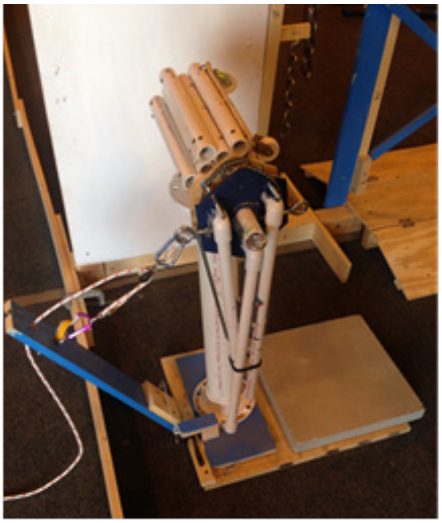


Height of card or less - scoring

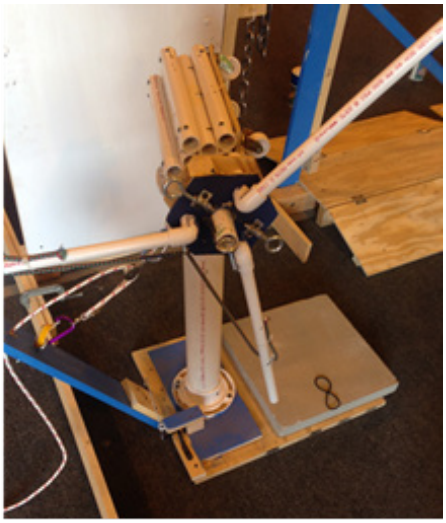
More than height – not scoring

    - Fully assembled small turbine in lowered position includes hub/blade assembly and small nacelle must be in the qualified scoring positions indicated above.

- Fully assembled small tower, nacelle and hub/blade assembly raised to the upright position with tower base latched in place once buzzer is sounded.
- Bonus: Once the fully assembled small tower is raised or is being raised the elastic band on the blades can be removed by the robot to release the blades into the expanded position.

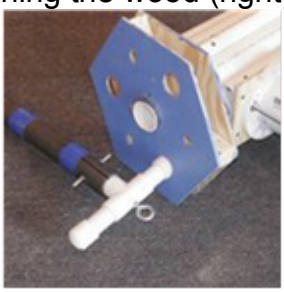


Full assembled upright position



Blades in expanded position for bonus

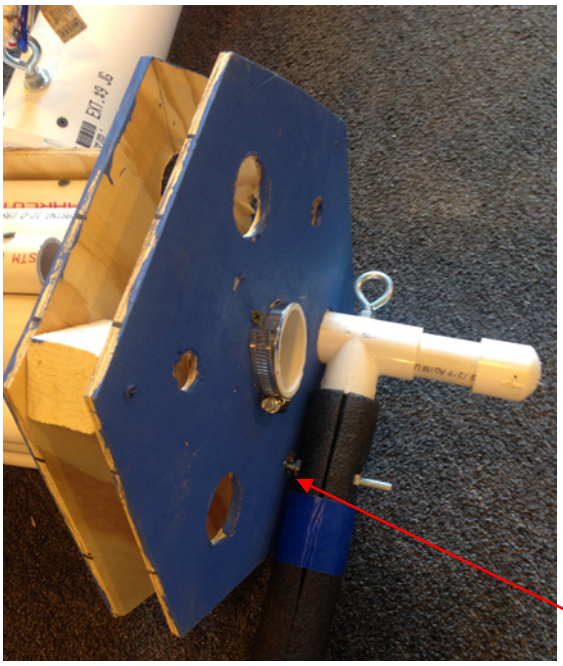
- Large turbine assembly – points are awarded for each of the following items individually
  - Installation of each of the large blades in the lowered position – the blade must be installed in the correct scoring position.
  - There are two possible correct scoring positions:
    - Correct Scoring Position #1: when the cap of the tee is installed past the wooden face plate of the hub and the 1” PVC pipe or tee is touching the plywood opening of the hub. In the figure below illustrating scoring position 1, the scoring blade shows the 1” PVC pipe touching the wood of the hub (left and middle). The blade not in scoring position shows the end cap touching the wood (right).



Scoring Position #1 Scoring close view Not scoring

    - Correct Scoring position #2: expanded position - when the head of the bolt is flush or past the wood hub.
    - If more than one blade is in scoring position #2, the blades must all be in either the clockwise or counter-clockwise position. Only

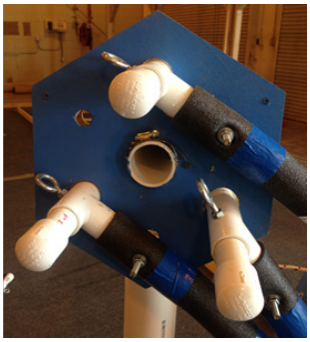
one blade will be scored in position #2 other blades will be scored as position #1.



Scoring position #2

Counter Clock-wise

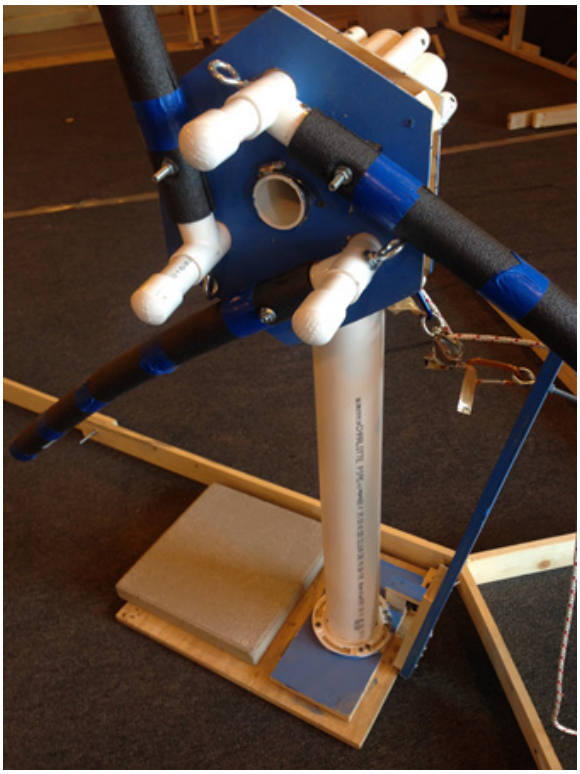
Clock-wise



Mixed (not allowed)

- Positioning the blades in scoring position #2 (expanded position), can be completed in two ways: (1) by the robot with the tower in the lowered or raised position and/or (2) by the spotter once the tower is locked in the upright position.

- Bonus: Large turbine tower assembly is raised to the upright position with the latch engaged. All three blades must be still attached to hub in Scoring Position #2. If any of the blades fall out during the raising of the large turbine tower assembly, no Bonus points will be recorded and only the blades in the proper scoring positions will count even if all three blades were in the proper scoring positions before the large turbine tower was raised.



5.4 Cooperative Game Play Option

This option includes and requires teamwork and communication with one or more adjacent teams. Two adjacent teams may cooperate if they both agree on the cooperation and indicate their cooperation to the referees before the match begins.

Your team may request permission to assemble your game pieces (or theirs, or a combination of both) on the towers belonging to the team to your LEFT. Additionally, your team may agree to let the team to your RIGHT assemble their game pieces (or yours) on your towers. Strategy and cooperation between teams can be a great advantage with this game play option.

5.4.1 Movement on the field during Co-op play

- At **NO** time during co-op play may your robot cross the damaged roadway or bridge of another team.

5.4.2 Identifying Cooperative Play Alliances (Co-op Team Identification)

- During staging for your next match in the pit or staging area, your team will discuss with adjacent teams to identify strategy for the match.
- A co-op card from each team must be given to the referee as the teams enter the field to place on the cactus corresponding to the barrier to be lowered, signifying both teams agree to cooperate.
- The defined co-op teams cannot be changed after co-op cards are provided to the referees.
- The scorecard for this match will be marked with the identified co-op teams.
- Possible questions co-op teams might want to discuss:
    - Role of each robot in the assembly area?
    - Will the small/nacelle and small blade/hub assembly from the stock pile area be used in co-op play? (only one of each of these parts are available for each team)
    - Quantity and color of blades or nacelle and blade/hubs to be assembled on tower?
- According to the proper layout of the field, possible co-op alliances are:
    - Red (towers) and Blue (game pieces)
    - Blue (towers) and Yellow (game pieces)
    - Yellow (towers) and Green (game pieces)
    - Green (towers) and Red (game pieces)

  Note: Game pieces of a different color than listed above will not be valid for scoring. For example, no points would be awarded for green game pieces on a red tower.

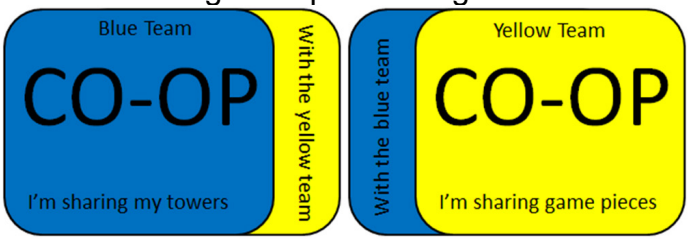
5.4.3 Field Modification According to Co-op Definitions

- Once both co-op cards are provided to referees and placed on the game field, the referee or field set-up personnel will fold the barrier to open the field between the stockpile and assembly areas of the two cooperating teams.

Example Co-op field setting:

Blue and yellow Cooperation - Field section has been folded away

These co-op cards must be provided by both teams and clipped to the cactus tower indicating a cooperation agreement was reached.



5.4.4 OSOW Permit

- The OSOW Permit switch may activated by an adjacent co-op team as long as rule 5.4.1 is not violated.

5.4.5 Transport

- Only one set of game pieces (one small nacelle assembly, one small turbine assembly, and three large tower blades) will score points for transport to your assembly area and/or for assembly on your towers. Game pieces of another team transported to or in your assembly area are not counted as transport points for your team.

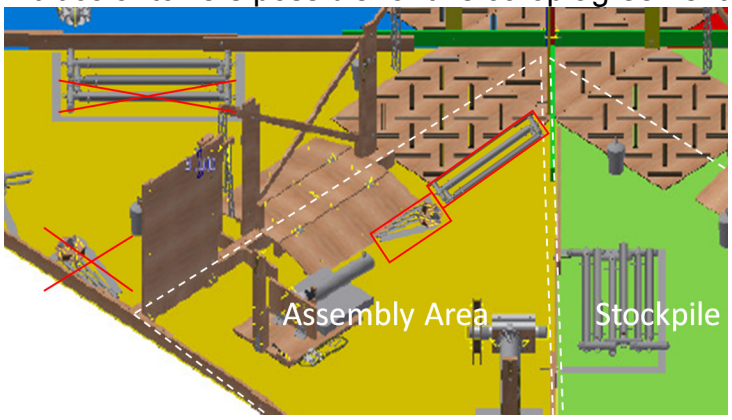
- No points are awarded for transporting your game pieces to the (LEFT) adjacent assembly area.

5.4.6 Assembly with Co-op Teams

- Only your game pieces and the LEFT adjacent co-op game pieces score on the (LEFT) adjacent (co-op) team's towers.
- Only your game pieces and the RIGHT adjacent co-op game pieces score on your team's towers

5.4.7 Match play with fewer than four teams

- If a round has fewer than four teams on the playing field, the vacant field is automatically available for coop play to the two adjoining teams. The teams adjacent to the vacant playing field can choose to co-op play with this field by providing the co-op card for the vacant field color and notating on the scorecard.
- If the field is vacant because the team does not show up for the round, they forfeit any points from co-op play provided by the other team.
- Field modification for fewer than four teams: If the vacant field is providing the towers in the co-op agreement, three large blades and the small hub/blade assembly of the vacant field are to be placed in the assembly area next to the damaged road and bridge respectively (see image below). This makes multicolor towers possible for this co-op agreement.



5.5 Rules for the Driver

- Driver must remain in the driver's box during the match.
- Driver cannot touch any part of the field or game pieces.
- Penalties are issued by the referee for infractions. See section 6.3.

5.6 Rules for the Spotter

- The spotter must remain in the spotter box during the match.
- The spotter may touch the rope to raise towers by pulling. Note: The towers can be manipulated (raised) to aid in placement of components onto the turbine towers. However, once the towers are latched into the fully upright position, the tower cannot be lowered again during that match.
- The spotter may position the large blades in scoring position #2 once the tower is raised and latched in the upright position, provided the blade was in scoring position #1 when the tower was latched into the upright position. If the match

ends and the spotter is still in the process of installing (still touching) the blade when the match ends, the blade is scored as being in position #1,

- If the robot is installing the blade while the tower is in the latched position: the spotter may not touch the blade until the robot has installed the blade into a scoring position and has released the game piece and is no longer touching the game piece. The referee must monitor this interaction and will assess penalties if a violation occurs.
- The spotter may not use the rope or their person (foot, hand, etc) to manipulate any portion of the field or game piece until the tower is in the upright latched position. (Spotter may not catch and reposition the blades while the tower is being raised)
- The spotter must remove hands from all game pieces once the buzzer sounds.

- Cooperative play: the spotter must provide the scorecard and co-op card to the referee indicating cooperative play is agreed to before leaving the staging area.

6. Scoring

6.1 Scoring Summary and Point Values

For a game piece to score it must be in the qualifying scoring location as described in the game play section. Scoring is based on the resting position of all game pieces at the end of the match.
Note: No points are recorded for any game piece connected to or still touching the robot when the match ends.

6.1.1 No match will result in negative point totals. The score for a round is 0, if no other points are awarded AND one or more Prairie Chicken Environments are no longer upright.

6.1.2 OSOW Permit:

- 5 points are recorded for acquiring the OSOW permit. The OSOW permit

  Must be obtained to score for the following:
  a. Points for transport of your game pieces to your assembly area
  b. Points for assembly of your game pieces on your towers

  Is **not needed** to score for the following:
  c. Prairie Chicken Environment relocation
  d. Opening gates
  e. Transport of your blades to your neighbors assembly area
  f. Assembly of your blades on your neighbor's tower (adjacent to your stockpile area)

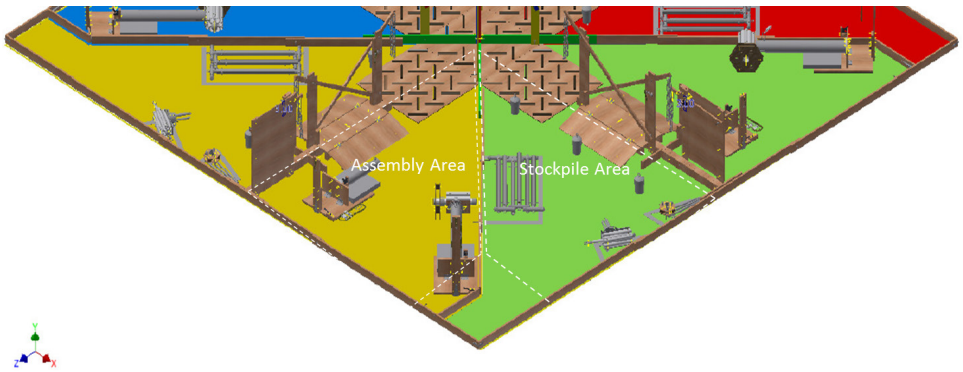
The temporal order in which the teams' OSOW permits are acquired (tripped) will serve as the tie breaker in the event of a tie.

6.1.3 Prairie Chicken Environments:

- When your team is not cooperating with the team to your LEFT 10 points are recorded for each Prairie Chicken Environment (total of three) that is moved to your team's Safe Zone and is in the upright position
- When your team is not cooperating with the team to your LEFT 10 points are deducted for each Prairie Chicken Environment that is no longer in the upright position (regardless of position on the field)
- When your team is not cooperating with the team to your LEFT 4 points are recorded for each Prairie Chicken Environment (total of three) not located in the safe zone, but still in upright position.
- Note: Prairie Chicken Environments can be returned to the upright position by the robot at any time during the match.
- In case of cooperative play: The two teams sharing the assembly area will split (50%) the point total (penalty or positive points) for the Prairie Chicken Environments located in the stockpile area adjacent to the assembly area. (This rule is to discourage co-op teams from disturbing the adjacent teams Prairie Chicken Environments.) Note that this affects only the three prairie chicken environments of the team supplying the turbine parts (blades, hub,

nacelle) since the environments belonging to the team supplying the towers are not accessible by both robots.

For example, if yellow and green have a co-op agreement, the green team's robot cannot access the yellow teams Prairie Chicken Environments. Conversely, the yellow team can access the green teams. The scoring for the green teams Prairie Chicken Environments will be shared between the yellow and green teams.



6.1.4 Gates:

- 5 points are recorded for each of your gates that are opened on the bridge.

6.1.5 Transport:

- 30 points are recorded for transporting your small nacelle into your assembly site
- 30 points are recorded for transporting your small hub/blade assembly into your assembly site
- 10 points are recorded for transporting each of your three large blades into your assembly site

6.1.6 Assembly/Installation:

- Small Tower:
  a. 30 points are recorded for installing your small nacelle onto your lowered small tower.
  b. 30 points are recorded for installing your small turbine hub/blade assembly into your small nacelle.
  c. Additional 10 points are recorded for having **both** your small nacelle and small hub/blade assembly installed on your lowered small tower.
  d. 20 points are recorded for a fully upright and latched small tower with **both** nacelle and hub/blade assembly properly installed. If the nacelle or the hub/blade assembly falls off once the tower is latched into the upright position, no assembly points will be awarded for the component that is not installed and no Bonus points will be awarded.
  e. 20 bonus points are recorded for removing the transport band and allowing the blades to extend. Removing the elastic band while the turbine is still on the ground will not allow the blades to expand and is

not considered a bonus scoring position and no bonus points will be awarded unless all three blades are no longer touching the ground and the tower is latched in the upright position.

f. Note: The tower can be raised while installing or reinstalling game pieces anytime during the match.

- Large turbine blades
  a. Scoring Position #1:
     1. Blade 1: 20 points are recorded for your 1st of 3 blades installed into your large turbine tower assembly
     2. Blade 2: 20 points are recorded for your 2nd of 3 blades installed into your large turbine tower assembly. **Plus** a 20 point bonus is recorded for successfully installing Blade 2 in scoring position #1 with the tower in the upright and latched position.
     3. Blade 3: 20 points are recorded for your 3rd of 3 blades installed into your large turbine tower assembly. **Plus** a 40 point bonus is recorded for successfully installing Blade 3 in scoring position #1 with the tower in the upright and latched position.
  b. Scoring Position #2:
     1. Blade 1: 40 points are recorded for your 1st of 3 blades installed into your large turbine tower assembly
     2. Blade 2: 40 points are recorded for your 2nd of 3 blades installed into your large turbine tower assembly. **Plus** a 20 point bonus is recorded for successfully installing Blade 2 in scoring position #2 with the tower in the upright and latched position.
     3. Blade 3: 40 points are recorded for your 3rd of 3 blades installed into your large turbine tower assembly. **Plus** a 40 point bonus is recorded for successfully installing Blade 3 in scoring position #2 with the tower in the upright and latched position.
  c. Reminder: A lowered tower is a tower that is not latched in the upright position. A partially raised tower is not considers raised and upright until the tower gate is latched.

6.1.7 Cooperative Play Assembly Points:

- 50% of points are recorded for each team for assembly of your game pieces on the adjacent team's tower. 100% of the points are recorded if your game piece is on your tower (with OSOW permit since you traveled over the road or bridge for this). See the scoring table below for example of large blade scoring in scoring position #1. The same concept is used for scoring position #2, but point values are increased for this position.
- A 50-point bonus is recorded for an upright latched large tower with two blades installed in scoring position – one of the two blades must be the same color as the tower.
  - OSOW permit must be obtained by the team providing the tower.
- A 100-point bonus is recorded for an upright latched large tower with all three blades installed in scoring position – one of the three blades must be the same color as the tower.
  - OSOW permit must be obtained by the team providing the tower.

Cooperative Play Scoring Table

Example Co-op Teams:
Team X owns the turbine towers
Team Y owns game pieces to be shared (blades, etc.)

Large Tower Assembly

Blades installed on X tower	Team X Points			Team Y Points		
	Scoring Position 1	Scoring Position 2	Bonus*	Scoring Position 1	Scoring Position 2	Bonus*
X	20	40	-	-	-	-
XX	20 + 20 = 40	40 + 40 = 80	20	-	-	-
XXX	20 + 20 + 20 = 60	40 + 40 + 40 = 120	40	-	-	-
Y	10	20	-	10	20	-
YY	10 + 10 = 20	20 + 20 = 30	10	10 + 10 = 20	20 + 20 = 30	10
YYY	10 + 10 +10 = 30	20 + 20 + 20 = 60	20	10 + 10 +10 = 30	20 + 20 + 20 = 60	20
XY	20 + 10 = 30	40 + 20 = 60	50	10	20	50
XXY	20 + 20 + 10 = 50	40 + 40 + 20 = 100	100	10	20	100
XYY	20 + 10 + 10 = 50	40 + 20 + 20 = 80	100	10 + 10 = 20	20 + 20 = 40	100

* Note - Tower must be in the upright latched position to qualify for the bous points

Small Tower Assembly

Piece installed in correct scoring position	Team X Points	Team Y Points
Small Nacelle (SN) onto Tower	30	-
Blade/Hub Assem. onto Small Nacelle	30	-
Small Nacelle (SN) onto Tower	15	15
Blade/Hub Assem. onto Small Nacelle	15	15
Blade/Hub Assem. onto Small Nacelle	-	30
SN and Blade/Hub onto Tower in Lowered Position	10	-
SN and Blade/Hub onto Tower in Lowered Position	5	5
SN and Blade/Hub onto Tower in Lowered Position	5	5
SN and Blade/Hub onto Tower in Upright Position	20	-
SN and Blade/Hub onto Tower in Upright Position	10	10
SN and Blade/Hub onto Tower in Upright Position	10	10
Bonus for Blade Extension*	20	20

* Note - Both teams are awarded bonus if either the SN or Blade/Hub is red and installed on green tower in upright latched position with blades extended.

6.2 Match Scoring/Calculations

- The end of the match is defined by the moment the buzzer goes off.
- The driver and spotter must stop all actions at this moment. Scoring position of the game pieces is defined once everything comes to a rest after the buzzer.

6.3 Penalties and Infractions

- No points are given for transport or assembly of your parts on your tower in a match if the OSOW permit is not obtained prior to the buzzer.
- 10 points are deducted for each Prairie Chicken Environment not in the upright position at the end of the match.
- In the event of cooperative play, the 10-point deduction for overturned environments for the three Prairie Chicken Environments accessible by both robots will be shared by the cooperating teams, a 5-point deduction for each environment per team.
- A 20-second penalty is incurred if the Spotter touches or manipulates a large blade prior to the large blade being placed in scoring position by the robot.

The Referee must determine the large blade is in scoring position #1 before the Spotter touches the large blade. The robot can longer be touching or manipulating the large blade when the spotter begins to move the part into scoring position #2.

- A 20-second penalty is assessed if the driver steps out of the driver box during the match.
- A 20-second penalty is assessed if the driver touches any part of the field or a game piece.
- 10 points are deduction if the spotter disturbs the Prairie Chicken Environments in the safe zone of an adjacent team.

6.4 Tie-Breakers

OSOW permit is obtained by pushing a micro switch, which activates a light, and the scoring computer records the times. The team that gets the OSOW permit first as recorded by field electronics wins the tie-breaker.

Appendices

Printable CO-OP cards: