



CREATE DRONES

**To inspire and prepare the youth of
today to become the engineers and
scientists of tomorrow.**

**Whirlwind
Game Manual
2019-2020**

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Section 1: Introduction

1.1 - Overview

This section provides background for the 2019-2020 CREATE Drones Challenge game called **Whirlwind**. This competition is for students primarily in the 9th through 12th grades. Younger students are allowed to participate as well, based upon their ability and readiness for this level of engineering challenge.

This document lays out the event as conceived at the beginning of the season. There will be two additions to the challenge. The first will be December 22nd, 2019, with changes going into effect on January 5th, 2020. All events after this time will include the additional task. The second will be March 1st, and applies only to the U.S. Open Robotics Championship - Drone Division Tournament. It is our intent and philosophy to continue to offer additional challenge during the season to increase the learning that comes with new challenges. Be sure to check the forum (<https://forum.create-found.org>) on these dates as the challenge additions will be announced there first.

1.2 - Introduction

Join the CREATE Foundation this year to out-design, out-build, and out-fly the competition. Like a whirlwind, be the first to complete the course and be crowned champion, all while learning about engineering, the engineering process, how to communicate, collaborate and lead. Whirlwind is a robust engineering challenge that will help students hone important life and technical skills while having a great time!

The Whirlwind challenge has multiple key components:

- ◆ **Design/Engineering:** Teams will work together to design, build, and test drone add-on equipment and team-built game mechanisms. The engineering process will be chronicled in a mandatory engineering notebook.
- ◆ **Competition/Collaboration:** Events ranging from a few hours to multiple days allow the teams to test their engineering, flying, collaboration, and communication skills.
- ◆ **Judging:** From registration to eliminations to the finals, the teams will have the opportunity to show the referees/judges and other tournament officials their skills across both technical and interpersonal areas. Judging will encompass each team's mandatory engineering notebook, on-field performance, technical knowledge, and social interactions throughout the event. Sportsmanship as well as engineering excellence will count heavily in the judged awards. See the appendix of this document for a full list of awards.

1.3 - Event Summary

Registration and Inspections: The day starts with registration and inspections. During inspections not only will the drones and team-built game mechanisms be inspected for safety and compliance to rules, the teams will also be quizzed on their technical knowledge and their engineering journey. The engineering notebook will be reviewed with the teams at this time. Submission of an engineering notebook is mandatory. Teams will not be able to register or pass inspection without submitting an engineering notebook and will therefore not be allowed to participate. NOTE: Engineering notebooks must be 7.5"x9.75" only, and the team number must be clearly written on the outside front cover of the notebook. Notebook is to be written in pen, not pencil. No erasing, simply strike through any discarded ideas or diagrams with a single line.

Pilot's Meeting and Open Ceremony: Once the scheduled time for registration and inspections is over there will be a pilot's meeting where the referees will go over important rules and answer any questions teams might have. The referees will also take this time to remind teams of sportsmanship and the tournament code of conduct to be followed by all teams, team members, and their fans. The pilot's meeting will be followed immediately by the opening ceremony.

Solo Flights: Each team will be given two opportunities to fly solo and complete this year's solo task of moving a 3"x3"x3" cube five feet into the neutral zone. These flights are optional, but keep in mind, that although this challenge is not part of qualification races, it does become part of the elimination races. A team's ability to do well in the solo flights may become a very important consideration during alliance selection. Solo flight awards are given for the top finisher(s). The exact number of awards depends upon each event. Solo flights are 60 seconds long. A team's score is the number of seconds remaining on the clock.

Qualification Races: Teams are randomly paired to compete against two other randomly paired teams: one blue alliance and one red alliance. Each win earns teams of that alliance two points, a tie earns each team one point, and for each loss teams of that alliance get zero points. The winning alliance's time remaining goes to all four competing teams' strength of schedule points, unless team(s) are disqualified. In that case the disqualified team(s) get zero points and zero strength of schedule points. At the end of qualification rounds all teams are ranked based upon the win/loss points they have received with strength of schedule points acting as a tie breaker for teams with identical win/loss point totals.

Alliance selection: After all qualification races are over the top teams invite other teams to join them in a permanent alliance of two teams to compete through an elimination tournament. A team may decline, and if they do they will be taken off the board and no other teams may select them. They may still act as an alliance captain and invite other teams to join them if they are ranked high enough. Teams should consider carefully before they decline because if they are not able to act as alliance captains they will be eliminated from further play.

Eliminations: Once all the permanent alliances have been determined the elimination portion of the tournament begins. Alliances are seeded based upon their alliance captain team's ranking at the end qualification races. The elimination races introduce one additional element not found in the qualification races: the solo task. Teams compete through a traditional single elimination tournament with the final winning alliance crowned as the on field tournament champion.

1-v-1 Fun Races: Just before the final race, teams no longer in the elimination tournament may opt-in to join the 1-v-1 Fun Races. Two teams, from those that opted-in, will be randomly picked to race against each other. Each race will consist of one lap around the arena, racing in both the red and blue sides of the arena while avoiding the neutral zone. The winner moves on. Should both drones be unable to finish the race (except for the final race) both teams will be eliminated and the team that was to face the winner will get a bye. In the finals, if neither drone finishes the race, the teams will race again until a champion is crowned. This portion of the tournament will take place during the final judges/referees award deliberations. It is meant to be a light-hearted and fun activity. There will be no trophies for this portion of the tournament, just an opportunity to race, have some fun, and entertain the spectators.

Awards and Closing Ceremony: The closing ceremony will end the competition and give event organizers an opportunity to thank sponsors and volunteers. Awards for both on-field and judged awards will be given out at this time. Remember, teams are being observed throughout the competition. From registration, inspections all the way to the final elimination race, team technical knowledge, communication skills, sportsmanship, collaboration, and social skills are all being taken into consideration in determining awards.

1.4 - Example Event Schedule

Time	Description
8:00-10:00	Registration/Inspections
9:00-10:45	Solo Flights
10:45-11:00	Pilot's Meeting
11:00-11:15	Opening Ceremony
11:15-12:30	Qualification Races
12:30-1:15	Lunch
1:20-1:50	Qualification Races
1:50-2:00	Alliance Selection
2:05-3:15	Elimination Races
3:15-3:45	1 v 1 Fun Races
3:45-4:00	Closing Ceremony / Awards

1.5 - Let's Fly!

On the following pages are the rules of this fast-paced challenge. Your team will have the opportunity to design, build, and test your own drone add-on equipment and team-built game mechanism to race past the competition.

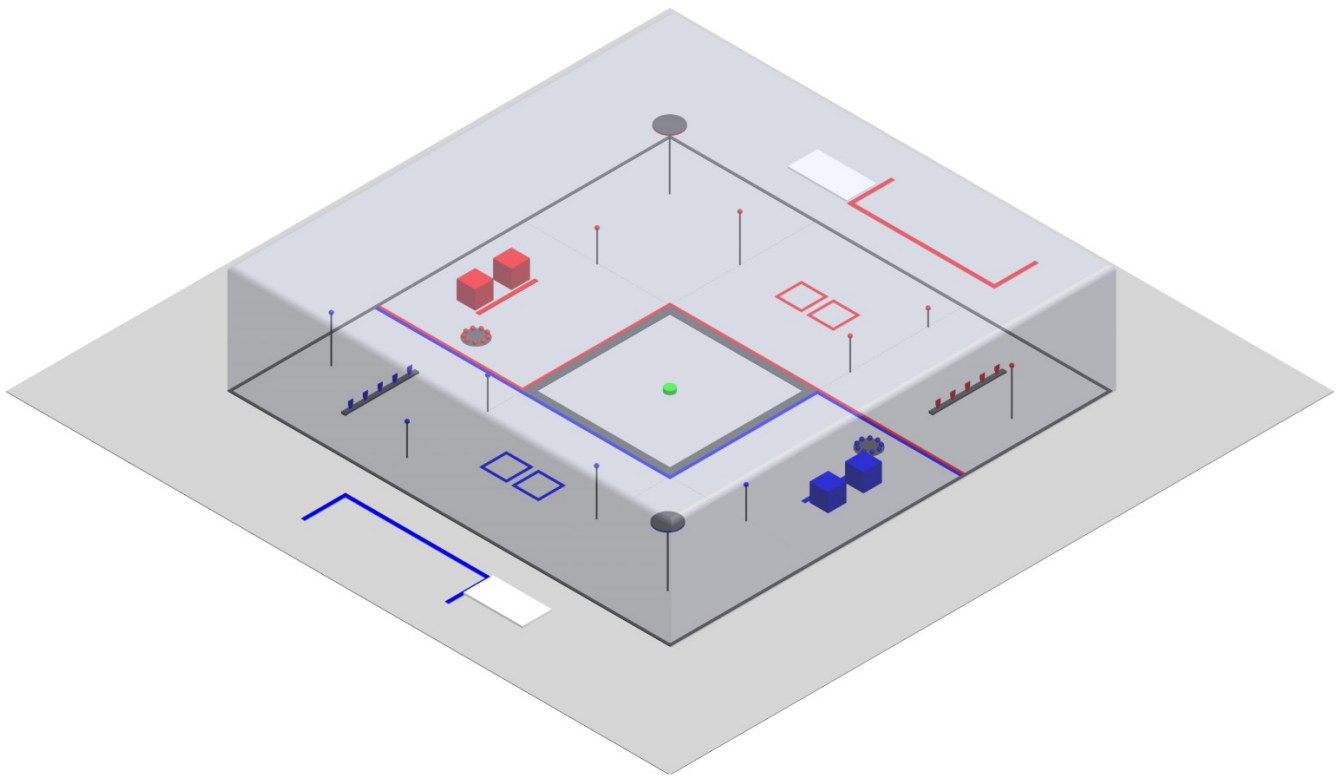
Section 2: The Game

2.1 - Overview

This section describes the CREATE Drones Challenge game called *Whirlwind*. It also lists the game definitions and game rules.

2.2 - Game Description / Field Drawings

Races are flown in an arena initially set-up similar to the figure below:



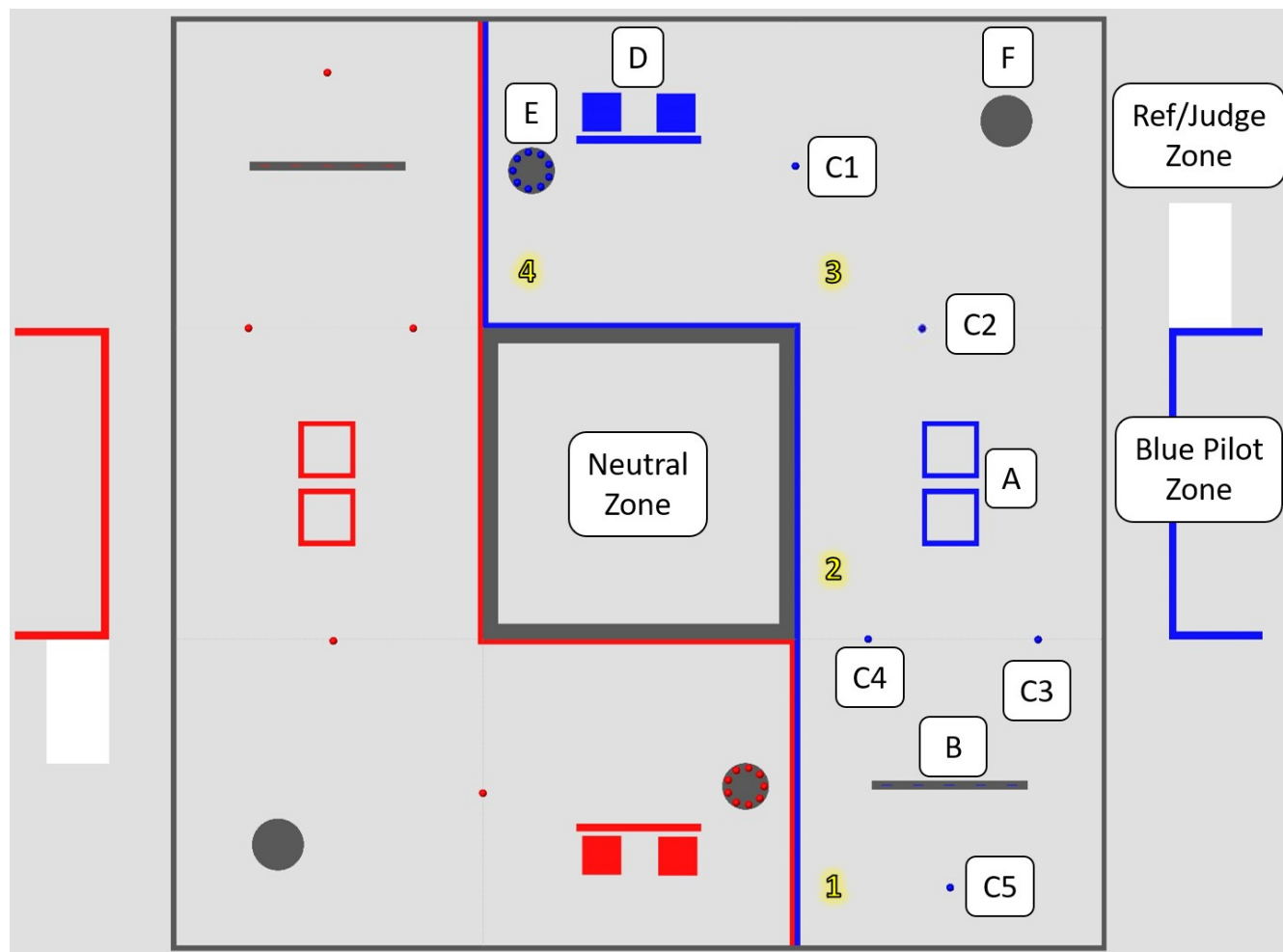
Four teams, two each on opposing alliance, compete to finish all the tasks on the course and race to land on the landing pad. The on-field competition is broken into three parts: Solo Flights, Qualification Races, and Elimination Races.

- ◆ **Solo Flights:** In the solo race, a single team uses their drone to activate their team-built game mechanism to move/launch/transport the Whirlwind cube into the neutral zone. (See Section 4 of this manual for all the details.) Once the game mechanism successfully completes its task the team then races to the landing pad.

- ◆ **Qualification Races:** Four teams, two randomly paired teams on opposing alliances, compete to finish all the tasks on the course and race to land on the landing pad.
 - Five balls on posts must be removed from their starting positions, five fans must be knocked down, and one round ball holder with nine balls must be cleared before landing on the landing pad.
 - All tasks can be completed in any order.
 - Once all tasks have been completed the first drone that “lands” (true landing is not required, only tripping the landing pad sensor) on the landing pad is the winner.
 - If a drone lands on the landing pad prior to all tasks being completed, the race time will be scored zero for that alliance and the best that can be hoped for is a tie.
- ◆ **Elimination Races:** Once the permanent alliances have been selected, these alliances compete in races identical to the qualification races with one addition: the team-built game mechanisms are added.
 - The team-built game mechanism task must also be completed prior to “landing” on the landing pad. Other than this addition, these races are the same as qualification races.
 - Both teams may deploy their team-built game mechanism. Only one of them needs to successfully get the Whirlwind cube into the neutral zone for the task to be complete.

The competition field is an arena encased in 30' x 30' x 7.5' of netting, divided into 10'x10' zones as shown by the dotted lines in the diagram on the following page. Four zones make up the blue alliance section and four zones make up the red alliance section, surrounding a neutral zone. The two Pilot Stations are outside of the competition field arena.

The following detailed diagram and table can be used to setup the game elements:



Legend:

Game Element	Key	Zone	Position
Starting pads	A	1	Centered
Flag fence	B	1	Centered
Elevated balls	C1, C3 = 24" tall C2, C5 = 36" tall C2 = 12" tall	1,2,3,4	C1, C2 - centered on boundary C3, C4 - 24" from edge of boundary C5 - centered and 24" from boundary
Team-built game mechanism launch line	D	4	5' away from and centered on neutral zone boundary
Round ball holder	E	3	Centered between game mechanism launch line and boundary
Landing platform	F	4	36" from each boundary

2.3 - Game Definitions

Add-on Equipment - Any mechanism, either functional or decorative, built by a team which is added onto a drone without altering the standard drone in anyway. Examples of add-on equipment would be a larger landing footprint (to cover more surface area on the landing pad) or protective propeller guards.

Alliance - Two randomly paired teams that work together during a race.

Coach - A student or adult designated as the team adviser during the tournament.

Course completion - All tasks must be successfully accomplished before landing on the landing pad. The task list changes according to the type of race:

- **Solo flights:** Drone activates the team-built game mechanism to move/launch/transport the Whirlwind cube into the neutral zone before landing on the landing pad.
- **Qualification races:** Five balls on posts must be removed from their starting positions, five fans must be knocked down, and one round ball holder with 9 balls must be cleared before landing on the landing pad.
- **Elimination races:** The tasks from the qualification races AND the task from the solo flight must be completed before landing on the landing pad.

Drone - A quad-copter supplied by CREATE. The drone may not be altered in anyway. Adding mechanisms, both functional and decorative, are allowed per the rules detailed in Section 4 of this game manual. Changing any of the parts, motors, electronics, batteries, propellers, ANYTHING that comes with the standard drone, is prohibited.

Drone Extraction Break (DEB) - A three minute time period between races, specified by the referees, in which teams may go into the arena and remove their drones that have been caught in the netting. This is the **ONLY** time drones may be removed from netting. Should a drone get caught in the netting, either during solo flights or qualification races, teams are **NOT** allowed to try to remove their drones or any add-on equipment until a referee calls for a DEB. At that time, all teams with drones caught in the netting have three minutes to extract their drones. *If your team gets drone(s) caught in the net, one teammate should stay near the arena to be ready for when the DEB is called.* Only two members per team are allowed in the arena during the DEB; one of these members may be a coach. Be sure to bring a screw driver because the only acceptable way to extract your drone is to remove the blades caught in the netting. Care must be take to ensure the netting is not damaged. If in three minutes teams are not able to extract their drones they must leave their drone and try again at the next DEB. During elimination races teams are to remove any drones caught in netting immediately after the elimination race. **Since both your drone and add-on equipment may be trapped in the arena for an extended period of time, it is very important that you have a second working drone and a complete duplicate set of add-on equipment.**

Landing Pad - The area a drone “lands” on when the course is completed to end the race. True landing is not required as long as the drone trips the landing pad sensor.

False Start - Any drone leaving their launch pad early is considered a false start. Penalties are assessed upon each drone. Therefore it is possible for an alliance to be penalized twice if both drones leave their launch pad early. False starts are determined by the referee. The alliance of the team that has false started will be assessed a 5 second penalty (allotted race time will be reduced by 5 seconds) for each drone/team guilty of this infraction. Egregious or repeated infractions may result in the disqualification of the offending team or alliance.

Launch Pad - The taped area on the floor from which a drone starts the race. The drone may be placed in any orientation, so long as it fits inside the taped off square.

Neutral Zone - The 10' x 10' portion of the arena in the center. This is the one area in the arena where it is legal for drones from both alliances to fly in.

Pilot - A team member responsible for operating and controlling the drone. Only two pilots from a team are allowed to be in the Pilot's Station during a race.

Pilot Change - Changing from the first to the second pilot in the middle of the race; the timing of the change is left up to each team. For solo flights the pilots must change at some point during the flight. In qualification or elimination races, the change must occur between :50 and :70 seconds; should the alliance finish the course in less than 70 seconds then no pilot change will be required.

Pilot's Station - The designated region where the pilots stand during any race.

Pre-placement - Placement of the team-built game mechanisms created by teams. Each season there will be a specific set of rules governing the pre-placement of these student-designed and built game mechanisms.

Race - A timed period where drones attempt to finish the course and land on the landing pad to win the race. These include 1-v-1 fun races, solo flights, qualification races, and elimination races.

Solo Flight - a sixty second flight where a single team uses their drone to activate the team-built mechanism to complete the required task and then land on the landing pad.

Team-Built Game Mechanism - Any mechanism built by teams for the purpose of completing the team-built game mechanism task. See Section 4 of this game manual for more details.

Team Member - Any of the student participants that make up the team. Only two pilots (per team) are allowed in the Pilot's Station for each race.

2.4 - Game Rules

2.4.1 - Scoring

- ♦ ***Qualification and Elimination Races*** - All race scores are determined by time. All qualification and elimination races are up to two minutes in duration. The first alliance to successfully complete the course and land on the landing pad will be the winner of the race and will be awarded two points for the win. The time left on the timer will be used as strength of schedule points and will be used in the ranking of teams as a tie breaker.
- ♦ ***Solo Flights*** - All solo flight scores are determined by time. All solo flights are sixty seconds in duration. Time remaining on the clock will be the score for that team.

2.4.3 - Safety Rules

1. If at any time the drone's operation is deemed unsafe or has damaged the race arena, surface, barriers or wall, by the determination of the referees, the offending team may be disqualified. The drone, add-on equipment and/or the team-built game mechanisms will require re-inspection before the team may race again.
2. If a drone becomes disabled in a race the pilot should shut down the drone immediately. Under no circumstances may a team member enter the arena while a race is in progress. The disabled drone can be retrieved after the race is over and the all-clear is given by a referee. If the disabled drone is stuck in the netting, it can be retrieved during the next DEB.
3. Drones may not be flown at ANY TIME outside of the netted arena while at the tournament. Any infraction of this rule may result in disqualification from a race(s) or disqualification for the entire event at the sole discretion of the head referee.
4. Team-built game mechanisms and their operation must be deemed safe by referees. Any such device deemed unsafe will require modification and re-inspection before being allowed to be used in the competition. Repeated or egregious infractions of this rule may result in disqualification at the discretion of the head referee.

2.4.3 - General Game Rules

1. At the beginning of a race, each drone may not exceed a volume of 18 inches wide, by 18 inches long, by 18 inches tall. An offending drone will be removed from the race at the head referee's discretion.

2. For each race, teams shall include two pilots. The pilots may change from race to race as long as no pilot flies for more than one team.
3. During a race, the pilots are the only people allowed in the pilot's station.
4. Only pilots are allowed in pre-placement of the drone or team-built game mechanism.
5. Pilots are prohibited from making intentional contact with any game or field object. The first instance of intentional contact will result in a warning, with any following instances resulting in disqualification.
6. During a race, drones may only be remotely operated by the pilots.
7. Drones must be designed to permit easy removal of game objects from any grasping mechanism without requiring the drone have power after the race.
8. Field tolerances may vary by as much as $\pm 12"$. Teams must design their drones accordingly.
9. Netting WILL sag and this will vary from arena to arena. In many places within the arena it may well sag well below 7.5'. This is simply to be viewed as part of the challenge.
10. The Neutral Zone is a "wild wild west" zone. There are no rules. Enter at your own risk.

2.4.4 - Whirlwind Specific Game Rules

1. At the beginning of each race, the four drones, two red and two blue, are placed on their respective launch pads. When the race begins the drones may start flying. If a pilot starts too soon it will be considered a false start and a false start penalty will be assessed. Repeated and/or egregious false starts may result in disqualification at the discretion of the referee.
2. The Pilot Change must occur sometime between :50 and :70 seconds into the race. Pilot One may hand the remote to Pilot Two anytime between 70 and 50 seconds remaining on the clock. If a team exchanges the remote too early or too late in a race the team may be disqualified for that race at the discretion of the referee. If the remote is exchanged significantly outside of the designated time, the referee may disqualify the alliance, which will receive a zero score for that race. If this happens during an elimination race the alliance will receive a score of zero and the best that can be hoped for is a tie. For solo flights the pilots must exchange control sometime during the flight. The exact timing will be up to each team. However, if the remote is not exchanged, it will result in a time/score of zero.
3. Whirlwind's team-built game mechanism will be a device that moves an event-provided game cube at least five feet into the neutral zone. The device may be powered by compression, gravity or pneumatics only. The entire mechanism may not exceed 18"x18"x18" when set in position. After the mechanism has been activated it can expand in an unlimited fashion, and may be in multiple pieces, keeping in mind safety rule 4.

Section 3: The Tournament

3.1 - Overview

The **CREATE Drones Challenge** is played in a tournament format. Students as old as 12th grade are allowed to participate as well as younger students who are ready for this level of engineering challenge. Each tournament will include **solo flights**, **qualification races** and **elimination races**. **Practice races** might be available at the tournament organizers discretion. The top ranked teams after qualification races are over will invite other teams to join them in a permanent alliance in the elimination portion of the tournament. The number of teams that advance to the elimination races will be determined by the event organizers. In addition to the competition portion of the event there are judged awards as well. These awards will range from technical knowledge, design, build quality, sportsmanship, and understanding of the engineering process.

3.2 - Tournament Definitions

Team Captain - A person chosen to represent their team.

Solo Flight - Flight done by a single team. The flight will consist of take off from the launching pad, activation and successful task completion of the team-built game mechanism, and landing on the landing pad. This is a time-based flight. Teams will be ranked based upon time. Flights are sixty seconds in length. If a team is unable to finish in sixty seconds or if their team-built game mechanisms fails to complete the assigned task, then their score will be zero.

Practice Race - An unscored race used to provide time for teams to get acclimated to the official playing arena.

Qualification Race - A race used to determine the rankings for each team.

Elimination Race - Races used to determine the tournament champions. This race is a combination of elements of the qualification races and the solo flight.

3.3 - Registration and Inspection

The first thing a team must do is to register for the event at the registration table. Event specific information will be shared at this time. Teams must register prior to getting inspected. Once registered, teams should proceed to their pit table and get settled, then proceed to inspections. Inspections have multiple parts:

- ◆ **Engineering Notebook:** Each team will submit a 7.5" x 9.75" engineering notebook when they register. Each notebook will have the team number clearly written on the outside front cover. All entries are to be done in pen. No erasing. Simply strike through, with a single line, any discarded ideas or diagrams. This notebook will be taken and reviewed, then returned to teams at the end of the interview. This engineering notebook may be used during optional/ad hoc, in-pit interviews with teams, at the discretion of tournament judges/referees. Not all teams are guaranteed these additional interviews, only those with superior notebooks or teams exhibiting superior technical ability/knowledge. Be sure to have your notebook available should a Rudge stop by your pit table.
- ◆ **Drone Inspection:** Each team is to have two, and only two drones. Both will be inspected to ensure compliance to all rules. Serial numbers of both drones will be written down on the inspection serial number log and only those drones will be legal to fly during the event. All add-on parts/equipment that might be used in the competition must also be inspected and approved prior to teams being allowed to compete. If your team would like a chair in the Pilot's Station during a race, the chair must be inspected at this time as well.
- ◆ **Team-Built Mechanism Inspection:** Each team will have at least one team-built mechanism designed to complete the team game task. They may have up to two TBMs if they so desire. It/they must be inspected to ensure compliance with all rules prior to a team competing.

Any team that fails either the Drone Inspection or the Team-built Mechanism Inspection will be required to fix any issues and be re-inspected prior to being allowed to compete.
- ◆ **Interviews:** Once both Drone and Team-Built Mechanism inspections have been passed, the process will move to the interview phase. Teams will use this opportunity to tell the story of their engineering journey to the inspector/judges. This presentation can focus on the drone, the team-built mechanism, their engineering notebook, or their engineering journey. Teams that are able to incorporate all of these elements into a 3 minute presentation will score higher than teams that focus on a subset of these areas.
- ◆ **Judging:** Information about teams will be collected throughout the inspection process as well as throughout the competition. All this information will be used in determining the winners of judged awards across

a number of areas. See the Appendix of this game manual for a full list of awards.

3.4 - Practice Races

At the event, practice races may be played during the team registration time until the Pilots' Meeting begins. Practice races are optional for teams. They will be run in qualification race format. If practice races are offered at an event a practice race schedule will be provided.

3.5 - Solo Flights

Solo Flights will be offered to teams on a first come, first served basis, after they have successfully passed inspection and prior to Qualification Races. The exact schedule will vary from event to event, so be sure to check the event schedule. Solo Flights are sixty seconds in length. They are run one or two drones at a time. If two drones are allowed to compete at once they will each be on their own side of the arena. Care must be taken so that neither drone impedes the progress of the other drone. In the case that a referee deems a drone has interfered with another drone, the offending drone will be given a Solo Flight score of zero and the team that was interfered with will be given the option to rerun their flight, or take the score they achieved.

Solo Flights will consist of taking off from the starting pad, successfully activating their team-built game mechanism, ***successful completion of the team game task by the team-built game mechanism***, and racing to and landing on the landing pad. (For all the details and rules regarding the team-built game mechanism, refer to Section 4 of this game manual.) The clock will be set to sixty seconds and will count down from the start of the race to the time the drone lands on the landing pad. The remaining time will be recorded as their score. ***Each event will allow each team only two Solo Flight attempts.***

Please note that it is the ***responsibility of each team*** to come prepared and ready for Solo Flights. A certain amount of time, adequate for all teams to get two attempts will be planned for in the event schedule, however if teams are not ready to participate and dead time occurs during that allotted time, some teams may find out that Solo Flight time has expired before they can get both of the attempts in. In this case it is NOT the responsibility of the event organizer to provide more time for Solo Flights. Get to registration early. Be ready to pass inspections. Get to Solo Flights as soon as they open. Ultimately it is up to each team to ensure they get their Solo Flights done.

3.6 - Pilots' Meeting / Opening Ceremony

Just prior to the opening ceremony a mandatory pilots' meeting will be held. ***All pilots are to attend.*** All coaches and team members are encouraged to attend. At this meeting the Whirlwind Challenge rules will be reviewed. There will be a time for Q&A from team members during this meeting. Event specific instructions will be reviewed at this time as well. Immediately following the pilots' meeting, the opening ceremony will be held. At this time all members of all teams, fans, spectators and officials are to be in attendance. Although the opening ceremony will be unique to each event, and event partner, CREATE encourages every opening ceremony to recognize any/all sponsors, identify and thank key volunteers, thank all volunteers, and remind teams that "Honor by Design" is an ideal worthy of all teams. Please build sportsmanship into each and everything you do. The opening ceremony will mark the beginning of the arena competition.

3.7 - Qualification Races

A schedule of qualification races should be handed out at least 10 minutes prior to the first qualification race. Randomly paired teams, joined in an alliance, will face off against another randomly paired set of teams in a head-to-head race. Each team in a winning alliance will be awarded 2 ranking points. Losing teams will receive 0 ranking points. If the race ends in a tie, each team will receive 1 ranking point. All teams, except those disqualified, will receive strength of schedule points, equal to the winning alliances score/time. Teams will be ranked via their ranking score and then strength of schedule score.

Qualification Races are a maximum of two minutes in length. The clock will be set to 120 seconds and will count down from the beginning of the race. Alliances that land prior to all task on the course being completed will receive a score of zero. If neither alliance is able to complete the course in this allotted time, the race will end and be scored a tie. After a drone from one alliance lands on the landing pad, and the referee sees no infractions the referee will finalize the race and it is over at that time. If the referee deems that the course was not properly cleared the race continues and the other alliance should continue the course and complete it as quickly as possible. Once a race is over the ref will turn to the losing alliance and ask if they want to challenge the decision. If there is no challenge the race is final. If the opposing alliance challenges the decision, they must clearly specify the nature of their objection. The referee will take into account their petition, confer with the other ref if appropriate, and render a final decision. If the petition is upheld the winning alliance will be given a score of zero and the petitioning alliance will be given a chance to race alone, at a later time. In this rare case the race will be pending until it is rerun. ***Please note that the ONLY members that may petition the referees are the pilots of the alliances that competed in that race.*** Referees will be happy to answer questions, when time allows, from other team members or coaches, but under no circumstances will race results be overturned once teams have left the pilots' station.

The Qualification Races will NOT include team-built game mechanisms as one of the tasks. Teams that do not have a functioning drone should attend races even though they

do not have a drone to race. This is not only a courtesy to your alliance partner, but teams that attend races will be awarded ranking points and strength of schedule points. Teams that do not attend races will be disqualified from that race and will receive zero ranking points and zero strength of schedule points.

3.8 - Alliance Selection

Once qualification races are over, all teams will be ranked based upon ranking points and strength of schedule points. Top teams will be brought to the arena floor and will ask one other team to join them in a permanent alliance to compete in the Elimination Races. The number of alliance captains will be up to each event partner, but the following is recommended by CREATE:

16 team events – 8 alliance captains – All teams moving onto the Eliminations

24 team events – 8-12 alliance captains

36 team events – 8-12 alliance captains

A more detailed description of alliance selection can be found in section 1 of this manual. Once alliance selection has been completed there will be a brief 5-10 minute pause before Elimination Races are started. Depending upon the schedule this pause may be longer.

3.9 - Elimination Races

Elimination Races are similar in format to Qualification Races with one addition: the **team-built game mechanism** will be added as one of the tasks to be completed. When teams are considering who to ask to join them in their permanent alliance, not only should they consider a team's performance/ranking in the Qualification Races, but also the Solo Flight rankings. Each team should bring their team-built game mechanism to all elimination races. Both alliance's mechanisms will be required to be placed in the arena prior to the start of the race. However, only one successful mechanism task will be required. All elimination races will be single elimination. Teams will progress through the bracket until a champion alliance is determined.

Ties during Elimination Races will be determined by a sixty second **Speed Race tie breaker**. At no time may drones be exchanged, or batteries exchanged. All Speed Race tie breakers must be performed with ONLY the drones and batteries that were brought to the field for the Elimination Race. Each alliance will select one drone to race against one drone from the other alliance. The arena will be set up the same as a normal Elimination Race. The tie breaker race will consist of 1) Lifting off from the launch pad,, 2) Removing all balls from the round ball platform, and 3) Landing on the landing pad. Should the tie breaker race end in a tie, another tie breaker race will be run. If a second tie breaker race is required, the team/drone not used in the first tie breaker race must be used. If yet additional tie breaker races be required the alliance may select either drone for all subsequent tie breaker races. If drones are unable to complete a tie breaker race due to damage or drained batteries, the higher seeded alliance will be deemed the winner and will move on. Prior to the final Elimination race there will be about a 30 minute pause to allow the final four teams to prepare and for final judges' deliberation.

3.10 - Awards / Closing Ceremony

Immediately after the finals race the Closing Ceremony will begin. All head-to-head competition awards, solo flight awards, and judged awards will be presented at this time. This will conclude the event, which we hope is a springboard for further education. See the appendix of this document for a full list of awards.

3.11 - Tournament Rules

1. Referees have ultimate authority during the competition. *Their rulings are final.*
 - A. The referees will not review any recorded replays.
 - B. Any petitions for the referees must be brought forward by a pilot prior to leaving the pilots station.
2. The only people permitted by the arena are the two pilots.
3. Pilots must be wearing protective eye wear at all times while in the arena or Pilot's Station.
4. Each team will be allotted ONE time-out of no more than three minutes. The time-out can only be called directly preceding a team's race and **cannot** be taken during a race. Time-outs can only be taken during the finals of a tournament. The races must progress according to schedule.
5. The *qualification race* schedule will be available no later than immediately after the pilot's meeting.
6. The qualification race schedule is NOT GOING TO BE STRICTLY ADHERED TO. It should be viewed as a rough guide and no more. The schedule will be based upon a full two minute race time. However, it is very likely that many races may end sooner than 2 minutes and the next race will start very shortly after a race ends. It is the intent to get teams as many qualification races a possible in the allotted time. Moving ahead, sometimes well ahead, of the printed schedule will assist with this. THEREFORE IS IS SOLEY UP TO EACH TEAM TO KEEP TRACK OF RACES AND TO GET TO THEIR RACES ON TIME.
7. All teams will be **scored** on the same number of *qualification races*.
8. When a team comes to the arena for a Solo Flight, Qualification Race or an Elimination Race they are allowed to bring one drone, one drone remote, one set of drone add-on equipment, protective eye wear for each pilot, previously inspected chair(s) and one team-built game mechanism (if applicable). No additional batteries for either the drone or remote are allowed and swapping batteries at the arena is strictly prohibited. Come prepared. Be sure your batteries are charged and your drone is ready for competition.

Section 4: The Drone and Team-Built Game Mechanism

4.1 - Overview

This section provides rules and requirements for the design and construction of any add-on components to your drone and to the team-built game mechanism. Refer to Section 3.3 of this game manual for more information regarding inspection guidelines. The “CREATE Drone Inspection Checklist” can be found on the CREATE Drone Challenge game page of the CREATE website: www.CREATE-Programs.org.

4.2 - Drone Rules

1. Only unmodified Hoshi HS107 drones are legal. They may not be modified in any way. To ensure compliance only drones purchased directly from CREATE or HOI (Higher Order Innovation) are legal and must contain a serial number sticker.
2. Add-on equipment (including decorative elements) may not cover the serial number sticker of the drone. Teams will be unable to pass inspection if the serial number is unable to be read. **If the serial number sticker becomes unreadable it is the responsibility of the team to contact Higher Order Innovation to discuss a replacement sticker with sufficient time before the tournament.**
3. Each team should have two working drones, both of which have to pass inspection. Only two drones are allowed per team per tournament.
4. Any significant change to add-on equipment during the course of the tournament will require re-inspection.
5. Any other additional parts may be made for the drone as long as they are deemed safe by inspectors and the drone with all combinations of add-ons fits within an 18” x 18” x 18” box without exerting any pressure on the sides or top of the sizing box or sizing tool. Add-on equipment attached to the drone cannot be electronic, battery operated, or remotely controlled.
6. Drones may expand beyond their starting size constraints after the start of a race/flight.
7. Any restraints used to maintain starting size (i.e. zip ties, rubber bands, string, etc.) **MUST** remain attached to the drone for the duration of the race/flight.

4.3 - Team-Built Game Mechanism

The 2019-2020 game mechanism task will be to build a mechanism that is activated by a drone and moves a 3"x3"x3" cube into the neutral zone.

Game Mechanism Positioning:

- ◆ A taped line 4' wide and 5' from the neutral zone marks the line behind which the team-built mechanism must be placed. For the details on this taped line see the diagrams in Section 2 of this manual
- ◆ The team-built game mechanism must be positioned on the floor such that it is NOT touching the taped line. It may be as close to the line as teams want to place it, without touching it.

Team-Built Game Mechanism:

- ◆ The game mechanism may be a maximum of 18"x18"x18"
- ◆ It may not have any battery power.
- ◆ It may not have any electronics or motors.
- ◆ All power must be either compression (springs, rubber bands, etc), pneumatics (air only) or gravity.
- ◆ Mechanism must be activated by drone only.
- ◆ Once activated the mechanism can expand beyond the initial 18"x18"x18" starting size.
- ◆ All safety rules apply to this mechanism.

Task:

- ◆ A 3"x3"x3" plastic cube, supplied by the referees/judges, will be placed by a team member on the team-built game mechanism so that no part of the cube touches the ground or taped line.
- ◆ The game mechanism will be placed on floor such that it does not touch the taped line, and is placed behind the side of the taped line furthest from the neutral zone.
- ◆ The cube must be moved into the neutral zone, and come to rest in the neutral zone. If any part of the cube is in the neutral zone and no part of the cube is touching the arena floor of either alliance zone, then the task is considered successfully completed.
- ◆ Once the mechanism has completed its function, but the cube has not been successfully moved inside the neutral zone, it is legal for the drone to attempt to finish the task. However, the game mechanism must be the first to attempt to move the cube.

- ◆ This task must be successfully completed for the course to be considered completed (solo flights and elimination races only).

Awards:

- ◆ The design and consistent successful functioning of this mechanism will be heavily considered in many of the judged awards. Clever design, consistent successful performance, and quality of build will all be factors that referees/judges will be looking for.
- ◆ See the Appendix of this document for a full list of awards.

4.4 - Additional Rules

1. Teams may be requested to submit to random inspections of their drones, add-on equipment and/or team-built game mechanisms at any time during the event at the discretion of the referees. Failure to comply will result in disqualification.
2. Referees or inspectors may decide that a drone, add-on equipment, or team-built game mechanism is in violation of the rules. In this event, the team in violation will be disqualified and will be barred from the arena until the equipment passes re-inspection. For more information on the inspection process please refer to section 3.3 of this game manual. The “CREATE Drone Inspection Checklist” can be found on the CREATE Drone Challenge game page of the CREATE website: www.CREATE-Found.org.
3. The following types of mechanisms and components are NOT allowed:
 - A. Those that could potentially damage playing field components.
 - B. Those that pose an unnecessary risk of entanglement.
4. Drones must display their team number (numerals/alpha only, i.e. “148” or “148-A”).
 - A. The judges, referees, and announcers must be able to easily identify drones by team number.
 - B. Team number must be visible from each side. The placement of the team number must be on the opposite sides of the drone along the longest sides of the drone.
 - C. The numerals must each be at least two inches high, at least in 3/4-inch stroke width and in a contrasting color from their background.

5. All drone add-on equipment and game mechanisms are to be built by the students. Adults, coaches, parents, mentors are to be facilitators, offer suggestions, teach and guide. We understand that each student is unique and their learning facilitated by different styles which may benefit from varying levels of assistance. For instance, if a child cannot remove a stripped bolt it is perfectly acceptable for an adult to do that for the student. If a student has never seen a particular mechanism it is a great learning experience for the student to build it with an adult. However any mechanism that is in ANY significant way built by an adult should be dis-assembled and re-assembled by the student(s). It is very important that the students understand their equipment and are able to fix it during the tournament as adults are not to assist in any capacity, except to help remove stripped bolts or where safety is involved. Teams with adults acting in discord with this rule will be removed from consideration for judged awards. Repeated and/or egregious infractions may result in a team being disqualified from the tournament.

Section 5: Arena Procedures

5.1 - Overview

This section provides the procedures for teams and referees regarding the entry, set-up, and exiting the *arena*.

5.2 - Queuing

All queuing tables are on the opposite side of the arena from the audience. Teams with up-coming races/flights will stay in this area with both remotes and drones OFF, until called to the Pilots' Station by tournament officials. Only the two pilots, one drone, one drone remote, one set of drone add-on equipment, protective eye wear, and one team-built game mechanism (if applicable) is allowed at the queuing tables.

5.3 - Entering the Arena

When called to the arena the pilots will make their way to the Pilot Station as directed by the ref/judge and wait until given the okay to enter. The only team members allowed in the Pilots' Station are the two team pilots. The only equipment allowed per team in the Pilot's Station are one drone, one drone remote, one set of drone add-on equipment, protective eye wear for each pilot, previously inspected chair(s) and one team-built game mechanism (if applicable). No additional batteries or other equipment is allowed. Once teams enter the Pilots' Station they are not allowed to leave for any reason and no other team member may enter this area. So be SURE you come prepared. If you enter the Pilots' Station with a missing battery or dead battery you will NOT be allowed to exchange or swap it out. As engineers, it is important to be prepared and to plan ahead. **Both the remote and drone should be off at all times prior to entering the arena.**

5.4 - Arena Set-Up

When directed to enter the arena all teams should enter and place their drones (still off) and remotes (still off) and team-built mechanisms (if applicable) into the neutral zone nearest their alliance area.

The pilots may then be asked to set up the game elements of the opposing alliance. Once both sides of the arena has been setup the referee will inspect and certify the arena as ready, or direct corrective changes be made. If any pilot has a concern about the setup of the arena they should voice their concerns at this time.

Once the arena setup has been certified all pilots are to get their drones, remotes, and team built mechanisms (if applicable). If team-built mechanisms are to be used, teams are to place them in their desired starting position and pre-load the game cube. Teams should then position their drones on the launch pads.

5.5 - Activating Drones

The activation of the drones will start with the activation coin flip. A referee will go to the center of the arena and flip a large “coin” that is red on one side and blue on the other. Whichever color lands up will determine which alliance goes first in activating their drone.

A referee will ask the first alliance to pick a team to go first. That team will then turn on their drone, then remote, and then link. They will then activate the blades of the drone to verify they have been linked. The team may optionally turn their blades off, or leave them running at their discretion. The final step of activation will be for the teams to sync the video camera with their cell phone for first person view (FPV). The activation of the FPV can be done at the team's own pace and will not be considered as part of the required/formal activation process.

Once the first drone is activated, a team from the opposing alliance will activate a drone. Then the second drone of the first alliance will activate and finally the second drone of the second alliance will activate.

Each team will have a maximum of 20 seconds to activate their drone. If their drone cannot be activated with the allotted time both drone and remote will be turned off and will remain off throughout the duration of the race/flight. If the drone is activated but the video has not been linked it will be up to each team to try to get their video linked. However, teams will not be allowed back into the arena to access their drones. If the video link cannot be established at that time then FPV will not be available to that team for that race.

The referees will ask if the teams have placed their drones on the launch pads as they would like. Teams may quickly make final adjustments to the placement of their drones on the launch pads at this time. Once teams are satisfied with the placement of the drones they are to exit the arena, return to their respective pilot's station and await the start of the race.

5.6 - Start of Race / Flight

Once all drones are ready, all the pilots and referees will proceed to their respective stations. The referee will ask each team/alliance if they are ready. When all teams have given the thumbs up, the referee will launch the race. An electronic countdown will take place and the race/flight begins.

5.7 - Finalizing Results

Once the race is deemed finished by the referee, the results are considered final unless one of the pilots of the opposing alliance challenges the ruling with a specific issue. ***Please note that the ONLY members that may petition the referees are the pilots of the alliances that competed in that race.*** If, after careful consideration, the petition is denied, the race stands as final. If the petition is upheld, and it is found that the alliance that landed first has violated a rule, then the score of that race will be pending until the alliance with the successful challenge has a chance to race again, alone, in the arena. If that alliance successfully completes the course in the allotted time they will be deemed the winner and the race scored accordingly. If they do not finish in the allotted time, the race will be deemed a tie and scored accordingly.

Please keep in mind that only in areas of clear error of the written rules will a referee's decision be overturned. In areas of judgment, the referee's judgments are final. If however a rule has been missed or misinterpreted by the referee we want the teams to speak up and ensure that all calls are correct. All disputes should be handled in a respectful way. Teams exhibiting argumentative behavior or are unwilling to accept the final decision of the referees run the risk of being removed from consideration of all judged awards and/or removed from alliance selection and/or disqualified from the event.

All teams are to keep their remotes ON. **Remotes should not be turned off until after the drones are turned off.** It is important that the connection between remote and drone not be severed. If it is, the drone will sense the remote is no longer communicating and will start searching for another remote to connect to. This leaves the drone open to accidentally being linked to, and controlled, by a different remote. This creates a safety issue.

5.8 - End of Race / Flight

Once any challenges have been resolved and results are finalized, the final results will be displayed on the timer screen.

5.9 - Re-entering and Exiting the Arena

When directed by the referees all teams will re-enter the arena to retrieve their drones, drone add-on equipment, and team built-game mechanisms (if applicable). ***The drones should be retrieved first and immediately shut off. Then the remotes should be shut off.*** Then all other equipment should be gathered. Once all equipment has been retrieved teams will quickly exit the field and the pilot station area. Care should be taken by teams not to touch anything in the arena other than their equipment. If drones have become entangled in the netting the drones are to be shut off and both the drone and any/all add-on equipment are to be left until the ref calls for a DEB (Drone Extraction Break)

5.10 - Disabling Drones

Should at any time during the race, in the very rare instance it escapes the protective netting, it is to be ***IMMEDIATELY*** shut down by the pilot. It will then remain off for the duration of the race. If this event is deemed even partially the fault of the pilot that team will be disqualified from that race.

If a drone gets into a difficult position during the race/flight, even if it risks being damaged, pilots may NOT enter the arena during a race. They may not enter the arena under any circumstance until give the okay by a referee. Safety is our primary concern. It is a lot easier to repair a drone than a person.

Appendix: Awards

A.1 - Overview

This section describes the awards for the CREATE Drone Challenge. It also describes the format of judging and offers helpful hints for teams to be used in preparation.

A.2 - Types of Awards

There are three types of awards given to teams competing in the CREATE Drone Challenge:

On-Field Awards - Based solely on the scores obtained on the field.

Judged Award - Based solely upon the scores received in the judged portion of the competition.

Hybrid Award - Based on the combination of on-field performance, the judged portion of the competition, and social interaction throughout the tournament. Teams must do well in both the On- Field and Judged Award categories.

A.3 - Judging

Judging is done throughout the day. It is done informally by referees/judges and event officials as they watch your team's interaction with event officials, referees, judges, other teams and fans, and how you relate to members within your team.

Team judging is offered to every team attending a CREATE Drone tournament. It has a formal structure as follows:

- ♦ ***Team Presentation*** - During the first three minutes time your team will have an opportunity to present to the judges. Your focus can be your team-built mechanisms, how they work, and/or your engineering journey. You will be judged on presentation skills and technical knowledge.
- ♦ ***Questions*** - During the next 3 minutes scripted questions as well as specific inspector/referee questions will be asked.

A.4 - Helpful Hints

Awards are based upon each team's performance throughout the entire day. Please keep in mind that everything you do says something about you and your team. Judges and event officials will be with you in the pit area, playing field and all the common areas. The following are characteristics of winning teams:

- ◆ Respectful - Respectful of each other, other teams, officials and everyone at the tournament.
- ◆ Enthusiastic - Enthusiasm is contagious. Great teams have plenty of it and spread it around!
- ◆ Focused - Everyone on your team should have a role to play and should take their role seriously.
- ◆ Knowledgeable - Each member of your team should have a good understanding of your drone, drone add-on equipment and team built game mechanism. They should know how team built components were constructed and what decisions were made in the final design of these mechanisms.
- ◆ Each team member contributes to the presentation and to answering questions. It is perfectly acceptable to have one team member (student) lead the presentation. However the best teams are careful to make sure that every member of their team has a part in the presentation.
- ◆ Engineering notebooks are VERY helpful for the judges in team judging. Teams are strongly encouraged to spend the time to write a first-class engineering notebook. A well-written engineering notebook, which details not only your designs, both rejected and accepted, but also your journey as a team, will be looked on very favorably by the judges. A log of practice flight time will be viewed positively by the Judges. (These logs usually include start/stop time of the practice session, the skill being practiced, and the initials of the pilot. Often these logs are kept in the back of the engineering notebook.) The notebook is also an excellent way to prepare for your 8 minute interview as it helps you remember things that happened throughout the year and organizes your thoughts. Please keep in mind that all elements of the notebook are to be done by the students.
- ◆ Well run teams have coaches and mentors that understand that their role is to be a facilitator. During the interview all questions should be answered by the students only, unless specifically directed to a coach/mentor.

A.5 - Awards List / Description

Champion - *“To defeat all opponents in a competition or series of competitions, so as to hold first place.”* This award is given to each team of the winning alliance.

Engineer - *“To design or create using the techniques or methods of engineering.”* This award is given to the team that has the best overall design and construction. Creative design as well as excellence in construction will be taken into account. Teams winning this award will have drone add-on components and team-built game mechanisms that are well constructed, have no sharp edges that could cause injury to people or the field, and all mechanisms are solid with no loose parts. Also, the journey the team took to arrive at their final design and steps to construct their drone will be an important consideration in determining the winner of this award.

Finalist - *“To defeat all opponents in a series of competitions except for the Champion, so as to hold second place.”* This award is given to each team of the second place alliance. The Finalist award will be awarded at large format tournaments.

Ace - *“A person that excels at a particular sport or activity”.* This award is given to the team ranked first in the Solo Flight Challenge.

Honor - *“Honesty, fairness and integrity in one's beliefs and actions.” “A source of credit or distinction.” “High respect, as for worth, merit or rank.”* This is CREATE's highest award. They honor themselves and their team by working together, working hard, and building a mechanisms worthy of their potential. For a team to be considered for this award they must perform well in all aspects of the tournament. This award is given to the team that exemplifies all aspects of CREATE's honor code.

A.6 - “Honor by Design”

Honest - Follow the spirit of the rules of the competition. Do “what’s right” when no one is looking.

Competitive - Always give your best. Be humble in victory and gracious in defeat. Be respectful of your teammates, coaches and mentors, competitors, judges and spectators.

Collaborative - Act in the best interest of the team’s goals and be supportive of your fellow teammates. Share knowledge, tools, and parts with other teams.

Leader - Encourage, praise, involve and constructively challenge your teammates.

Professional - Works hard and is determined. Overcomes obstacles. Is well trained and acts in a professional manner.