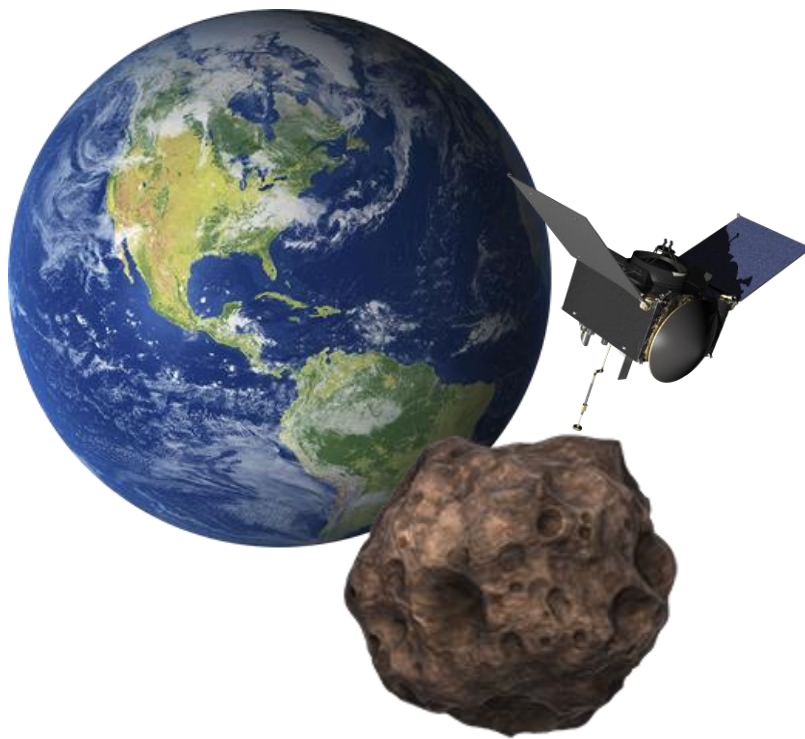




# SkillsUSA®

## 2020 UAV Drone Robotics Competition *ASTEROID EXPLORATION & MINING*



**Design                      Build                      Program                      Pilot                      Present**



Competition (V2020)

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## Asteroid Exploration & Mining

Asteroids often contain minerals that can be mined and used in space for construction materials and/or be brought to Earth for other production purposes. Often among these are gold, silver, platinum, cobalt, iridium, titanium, molybdenum, osmium, and palladium; just to name a few. It's the near future and some of these resources have become incredibly scarce on Earth. A Great Space Mission has been funded by all the World's Nations to identify Asteroids that are rich in these vital resources that can be brought to Earth to replenish reserves. Your mission is to navigate a treacherous Asteroid field using Star-Gates to traverse rapidly between spaces (like worm holes), scanning each Asteroid for the presence of minerals precious to Humanity. You will also acquire a physical sample of an Asteroid and land your spacecraft safely on the International Space Station.

## The Competition

This competition is designed to develop skills in problem solving, mechanical engineering, electronics engineering, programming and piloting. Participants and Instructors will find new levels of passion and enthusiasm for Unmanned Aerial Vehicles (UAVs), Robotics, Drones, and STEM based careers. Both the **UAV Robotics Contest** and the **Applied Learning Contest** will make up a portion of the total points earned by each team. Below is an overview of the competition as a whole:

## The UAV Robotics Contest – 600 of 1,000 Total Points

The objective of the Robotics Contest is to Design, Build and Program a UAV prior to the competition and show up ready to Pilot it and accumulate the most points within the two (2) allotted four (4) minute rounds. The contest challenges (listed below) can be attempted at any point during a four (4) minute round and in any order. The Space Station Landing, being the exception must be the last task performed. Each challenge may only be completed one (1) time per round. **Autonomous Bonus Points:** If at any point a team is able to successfully complete any one (1) of the challenges listed below autonomously (hands-free and without intervention), they will score an additional thirty (30) Autonomous Bonus Points. Teams are limited to scoring one only (1) thirty (30) point bonus per-round. **Scoring Example:** Here is a one (1) round scoring example: If a team was able to successfully tag every asteroid, pass through every gate, picking up the Asteroid sample, land on the space station's center most target, and complete one of the aforementioned challenges autonomously, then that team will have scored a total of 300 + 30 bonus points (330 total) for the round. In the event of a tie the team with the lowest combined time for both rounds will place highest.

### **Challenge: Analyzing Asteroids for Precious Minerals (aka. Asteroid Laser Tag) (20-40 Points based on difficulty)**

Successfully navigate and tag the deepest crater (target zone) on each of the asteroids to obtain a "hit". A hit is registered when the laser has been on the target zone long enough to cause the light on top of the asteroid to flash. The time required to hold the laser steady on the target zone may vary from asteroid to asteroid, ranging from a fraction of a second to a maximum of two (2) seconds. Difficulty is based on a combination of the asteroids position, the position of target zone, and the tag time duration needed for the laser to register a successful hit. The UAV Contest Technical Committee will set the Star Gates and Asteroids placement and tag times at their discretion; however, once a round of competition begins no further adjustment can be made during that round. Prior to the start of the second round, adjustments can be made at the discretion of the UAV Contest Technical Committee. There is one (1) twenty (20) point asteroid; two (2) thirty (30) point asteroids; and one (1) forty (40) point asteroid.

### **Challenge: Navigating Star Gates (aka. Flying through PVC Racks) (15-35 Points based on difficulty)**

Teams will carefully navigate through various sized star gates, successfully passing the entire UAV through one side of the gate and completely out the other side. Gate difficulty is based on the size and positioning of the gate. There are two (2) fifteen (15) point gates; one (1) twenty five (25) point gate; and one (1) thirty five (35) point gate.

### **Challenge: Capturing Asteroid Sample (Capturing Sample is worth 50 Points)**

Teams will acquire a sample of the Asteroid, which is a 2.5" length by 2" width by 1.75" height box covered with Velcro hooks. Capture points are awarded after the UAV successfully acquires and returns the sample to the space station landing zone.

### **Challenge: Successfully Landing on the Space Station (Landing Pad Zones) (0-40 points based on difficulty)**

Before the time has elapsed, each team may attempt to land the UAV on the space station landing pad. The landing pad will be made up of concentric rings, and as the rings decrease in size they increase in difficulty and points. There are ten (10) points for the largest outer most ring, twenty (20) points for the second largest ring, thirty (30) points for the third largest ring, and forty (40) points for landing within the smallest ring in the center of the landing pad. Upon final touchdown, if the landing gear resting points occupy more than one ring the lower point value ring score will be awarded. Lastly, if any part of the landing gear is "touching" a line then the points default to that larger lower value ring zone.

## The Applied Learning Contest – 400 of 1,000 Total Points

Each team will create an engineering notebook that demonstrates their depth of understanding in each of the four (4) challenge categories listed below. Any medium is acceptable for the notebook itself, along with media that may give the notebook an extra edge (e.g. text, illustrations, pictures, graphic models, flow charts, etc.). If the notebook is not present the Applied Learning Contest and all of its associated points shall be forfeit. Teams will have roughly a 2' x 2' area of a table space as their designated display area. The scoring will be based on a 0-100-point system, 0=Not Addressed; 40=Minimally Addressed; 80=Well Addressed; 100=Above & Beyond.

- Challenge:** *Describe the Core (2min-4max) Technologies that Enable UAV Stability and Flight.*
- Challenge:** *What Current and Future Careers are emerging as a result of Global UAV Usage?*
- Challenge:** *Communicate the Journey your Team has taken in preparing for the UAV Robotics Contest.*
- Challenge:** *Engineering Notebook and Competition Drone Wow Factor.*

Each Applied Learning Contest Judge will independently evaluate and score each teams engineering notebook and competition drones through the lens of the four (4) challenge questions listed above. After all the teams have completed their presentations the judges will get together and come to a consensus (e.g. using average score, etc.) on the points to be awarded to each team in each of the four (4) challenge categories.

## UAV Drone Design & Fabrication

**UAV Airframe:** The UAV airframe must be constructed out of MINDS-i pieces, however there are no limitations regarding the design of the airframe itself; as small, medium, large, as well as different shapes and configurations are all welcome and encouraged. Furthermore, there are no limitations to the number of rotors (3, 4, 6, 8) that may be employed on the UAV airframe itself. Team designed and fabricated center plate(s), are allowed and encouraged, however no Uni-Frames are allowed.

### UAV Design & Safety:

- Safety Ducts:** Each rotor, no matter how many have been employed, must be protected and enshrouded by a MINDS-i Safety Duct.
- Propellers:** The MINDS-i five (5) inch UAV Competition Propellers are designed with a specific blunt edge and are therefore the only propellers that are allowed in the competition. Keep fingers, face, hair and clothing and other bodily objects away from the propellers at all times.
- Motors:** Any motor is welcome to be used so long as it is no greater than 2800kv and has a can size of no greater than 2300.
- Lasers:** Any laser used on the UAV chassis must have a 2mw or less rating. Any use of a 5mw or higher laser will be considered a violation of safety.
- Batteries:** Any battery is welcome to be used, and any number of batteries may be employed, so long as they are all three (3) cells (11.1 volts) or lower.
- Radio Transmitters:** Any FCC part 15 compliant radio transmitter is welcome to be used that is 2.4GHz spread spectrum (e.g. Futaba FASST, Spektrum DSMX or DSM2, Hitec RCD AFHSS or similar technology).
- First Person View (FPV) Cameras:** Any FPV Camera(s) and transmitter is welcome to be used that operates on a 5.8GHz frequency. When another team is making their run, all other team FPV transmitters must be off.
- First Person View (FPV) Screens &/or Goggles:** Any FPV screen or goggles are welcome to be used by the pilot and any number of the team members during the round if so desired.
- Safety Glasses, Sharp Objects, Etc.:** Safety glasses must always be word inside the cage and/or field of play. No sharp objects or robotic appendages that could potentially cause harm or damage to a person or the playing field are allowed.

**Team Designed & Fabricated Components:** With respect to the guidelines outlined in the UAV Airframe section at the top of the page, teams are welcome to integrate self-designed and fabricated components, elements and programs onto their UAV airframe as they so desire. There are no limitations on the processes or materials that can be used for design and fabrication; as technologies ranging from 3D printing, machining, and forming (just to name a few) are all allowed. Furthermore, any amount of artistic team designed and fabricated cosmetic or visual components (e.g. body, paint, covers, accessories, mechanical and visual effects, etc.) may be employed for WOW Factor.

**Off-the-Shelf Components:** Also, with respect to the guidelines outlined in the UAV Airframe section at the top of the page, teams may incorporate off-the-shelf components onto their UAV airframe as they so desire. Any number of off-the-shelf components can be integrated; but no *one* (1) off-the-shelf solution can be employed in its entirety. An example of something that would be allowed is an off-the-shelf servo and/or actuator employed to power a self-designed articulating turret; whereas an off-the-shelf articulating turret would not be allowed. Another example of something that is allowed are off-the-shelf sensors of most any sort; whereas an off-the shelf sensor-array (multiple sensors combined) would not be allowed. Furthermore, any amount of artistic off-the-shelf cosmetic related components (e.g. lights, actuators, visual effects, etc.) may be employed for WOW Factor.

**Questions & Clarifications:** The UAV Contest Judges will inspect each robot prior to round-one (1) starting. If teams have questions and/or would like to have their UAV inspected in advance of the competition date, please contact Levi Wilson by phone at 509-252-5767; or by e-mail at [leviw@myminds.com](mailto:leviw@myminds.com)

# UAV Robotics Competition Details & Logistics:

**Team Start Times:** Each team will need to start at their assigned time. They will be given three calls before their time: First call is “In the Hole”; Second call is “On-Deck”; and Third call is “Start the Challenge”. Once “Start the Challenge” has been called for a specific Team, the clock will start. If a team’s UAV is unable to participate on-time, at the discretion of the UAV Contest Technical Committee, said team could be moved to the end of that round. If the team is still unable to participate by end of the round, then the round shall be forfeit along with the associated points. Teams are welcome to do a quick walk through the course just prior to their round starting, and Asteroid tag times shall be visible.

**Round Time Accumulation:** The maximum time for each round is (4) minutes, for a total of eight minutes total contest time over two (2) rounds. When a team starts the clock will continue until the course has been completed, and/or the maximum time has expired. If at any time during the round a team’s UAV is tangled, snagged and/or caught in the net/cage, then that round’s time shall stop and may not be re-started. However, any points the team scored prior to getting hung up shall be counted in whole.

**Re-Setting the Robot:** Once the round has started, a team may reset, fix or repair their UAV during the round; perhaps in the event of a crash or malfunction. There are NO time-outs however, and the clock will continue to tick down while the adjustments are being made. Teams must re-set their UAV by placing it in a take-off friendly position within close proximity to the last position of the UAV. Teams will incur a ten (10) point deductions for every reset.

**Team Sizes:** The total team sizes shall be a minimum of two (2) team members to a maximum of three (3) team members. If for some reasons a teammate cannot attend and a single player (team of 1) must therefore compete alone, then a 30 point penalty shall be assessed to each round the additional teammate is not present.

**Team Members Inside the Field:** The number of team members allowed inside the cage at the same time during a round shall be no greater than two (2). The two (2) teammates should optimally work together as a team inside the cage; i.e. one team member closely monitors the UAV’s position relative to the targets and obstacles, relaying information to the pilot in real-time. The two (2) team members in the cage are welcome to change pilots back and forth as they see fit, but time shall not stop during any hand-off.

**Team Members Around the Fields Perimeter:** Additional team members may gather in strategic positions around the outside perimeter, to assist in and/or operate the drones’ auxiliary functions; i.e. aiming lasers, controlling turret or effectors, monitoring sensors, etc.

**Safety Precaution’s & Rule Violations:** UAVs will only be allowed to operate inside the practice ring, the contest field or soundly secured to a PID Rack. Only PID Racks that meet competition standards will be allowed (see detailed drawings below) and there is no unsecured testing allowed outside of these three (3) options. Safety Glasses must always be worn while on the practice field, the contest field cage, and while testing on the PID Rack. Batteries must always be stored inside a LiPo Battery safe flame-retardant bag when not in use. The UAV Contest Judges will assign violations as specified if an infraction occurs, and may also assign additional violations per their discretion that have not been listed that are related to sportsmanship, integrity, respect and safety etc. A first (1<sup>st</sup>) violation is a written warning, a 2<sup>nd</sup> violation is a 50-point team deduction, and a 3<sup>rd</sup> violation is team disqualification. However, please be aware that the UAV Contest Judges also have the authority and discretion to disqualify a team for any single major violation (stealing, sabotage, etc.). **NEVER OPERATE UAV OUTSIDE OF THE EVENT CENTER OR COMPETITION COURSE AS DOING SO WILL RESULT IN IMMEDIATE DISQUALIFICATION.** See complete list of safety regulations at the end of this document.

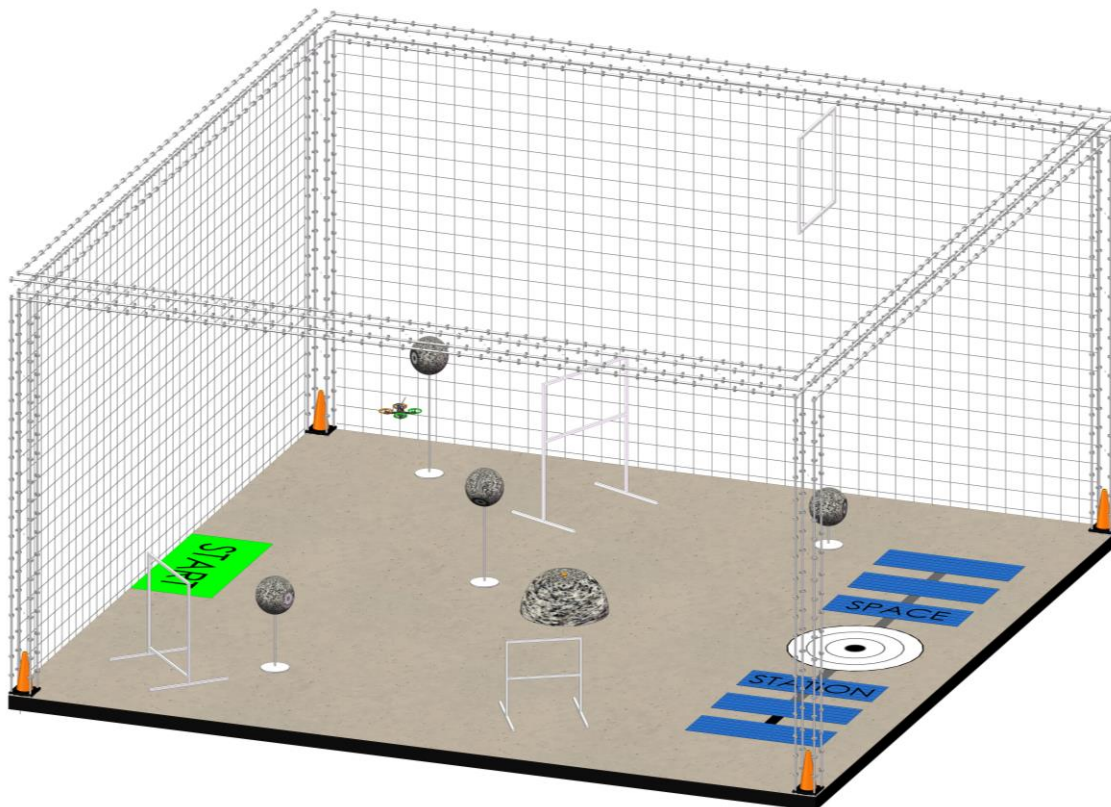
**Questions & Clarifications:** Contact MINDS-i’s General Manager, Levi Wilson; Work (509) 252-5767; E-mail [leviw@my Mindsi.com](mailto:leviw@my Mindsi.com)



## The UAV Contest Area:

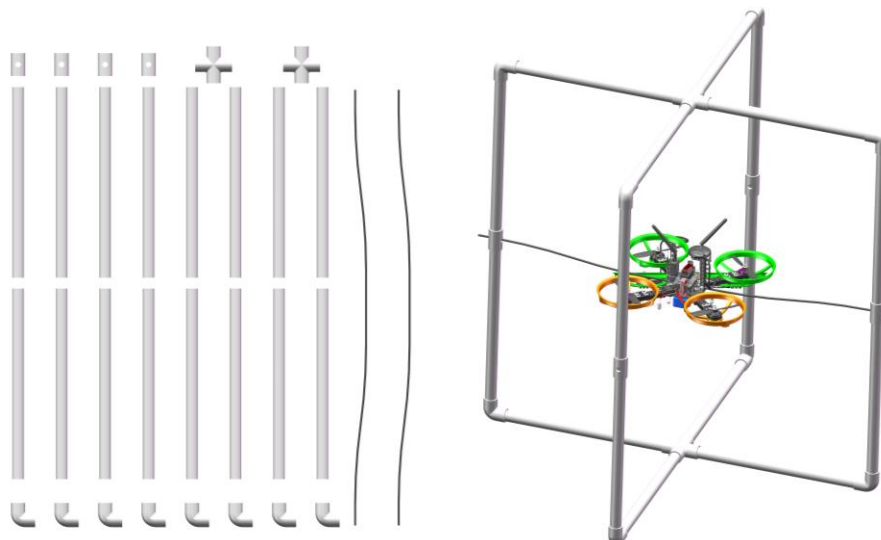
The field contains several obstacles and targets including Star-Gates and Asteroids. The UAV Contest Technical Committee will determine and set the obstacles and target placements at their discretion prior to the start of round one (1) of the contest. Once a round of competition begins no further adjustment can be made during that round. However, after the first round of competition has ended and prior to the second round of competition beginning, the UAV Contest Technical Committee can again adjust the placement of obstacles at their discretion. The field will be constructed of a rigid truss system with a safety net on all faces and top to prevent any fly away drones. The field (shown in diagram below) will be roughly 30' long x 30' wide x 15' tall (may vary depending on available space).

**UAV Field: Image not to scale**



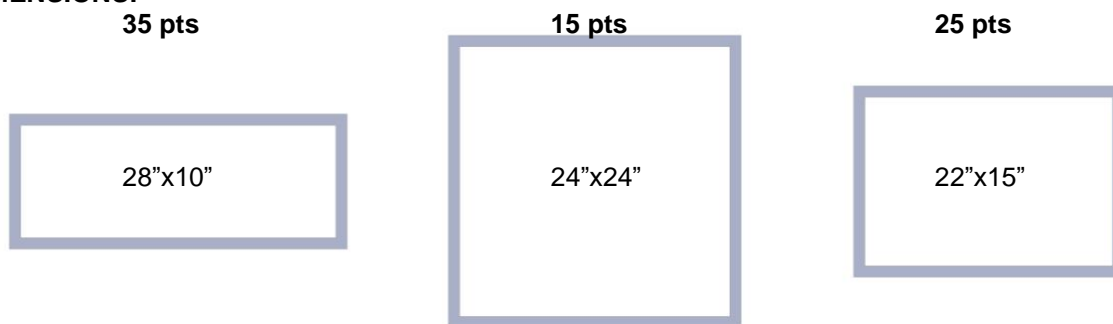
**PID Tuning Racks:** In the event that practice time on the course is not possible all UAV testing must be conducted in a MINDS-i approved tuning rack. **NEVER OPERATE UAV OUTSIDE OF THE EVENT CENTER OR COMPETITION COURSE AS DOING SO WILL RESULT IN IMMEDIATE DISQUALIFICATION.** The rack must be made from 3/4-inch schedule 40 PVC pipe or stronger material. All testing rack's need to weigh at least five (5) lbs. Safety glasses must be worn at all times while participating in the UAV Competition.

**UAV Test Racks:**

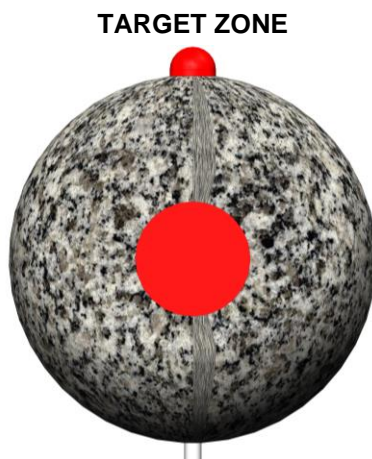


**Star-Gates:** Will come in three (3) sizes based on points/difficulty (15, 25, and 35). Gates will be made from 3/4-inch schedule 40 PVC available in many local and national hardware stores. Labeled dimensions are from interior surfaces.

**GATE DIMENSIONS:**

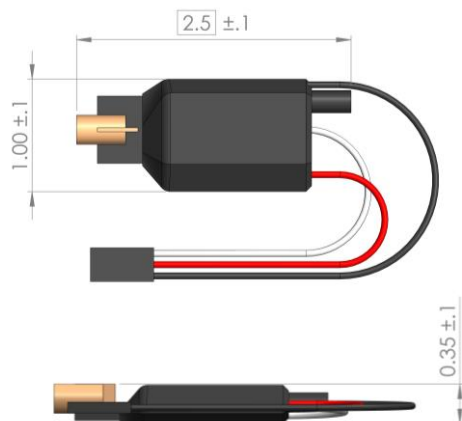


**Asteroids:** The outside diameter of the Asteroid's target zone is five (5) inches, and the height of the Asteroid from the ground will vary from Asteroid to Asteroid. The time required to hold the laser steady on the target zone to register a hit may vary from Asteroid to Asteroid ranging from a fraction of a second to a maximum of two (2) seconds. Teams can do a quick walk through of the course just prior to their round starting allowing them to check things like the laser set time for each asteroid. There are three levels of difficulty with higher points for higher difficulty (20, 30 and 40 points). Point difficulty is based on a combination of the laser tag time length, Asteroid height, and target zone position.



Target Diameter (red area) 5" Diameter

**Laser Module:** The laser module required to compete will be provided the day of the competition by the contest organizer. The laser module will be roughly 2.5 x 1 x .35 inches with a three-wire cable that comes out of the opposite end from the laser. The module will come with the hook side of Velcro on it and can be attached with Velcro, wire ties or any non-permanent method. If you would like a copy of the wiring schematic for the Laser Module you can contact us at [info@mymindsi.com](mailto:info@mymindsi.com) and reference the SkillsUSA UAV Competition. If you are constructing a gimbal or similar device for the laser you will want to make sure your design accounts for how to mount the laser.



Mounting suggestions



**Recommend Things to Bring:** Wi-Fi enabled laptop, power strip, extension cord, replacement batteries for drone and controller, battery charger, Li-Poly battery safe bag, Maintenance Repair and Replacement components, PID Testing Racks etc.

## **Safety Regulations:**

Use care and good sense at all times when operating. Failure to use your system in a safe and sensible manner can result in injury or damage to property. You and you alone must ensure that the instructions are carefully followed and all safety precautions are obeyed.

### **NEVER OPERATE UAV OUTSIDE OF THE EVENT CENTER OR COMPETITION COURSE AS DOING SO WILL RESULT IN IMMEDIATE DISQUALIFICATION.**

- Always turn on the transmitter before turning on the receiver.
- CHOKING HAZARD: Do not allow children under age 3 or any individuals who have a tendency to place objects in their mouths to play with any part of the MINDS-i system, including, but not limited to: connectors, pieces, electronics, radio transmitters, wheels, tires. The system contains small parts which could accidentally be swallowed and cause suffocation.
- The transmitter's antenna could also cause injury if played with violently or pointed towards someone's face.
- Do not pick up your UAV Drone when it is in motion.
- WARNING! Electrocution Hazard. Do not use the materials provided for other than its intended purpose.
- Always use recommended batteries. If improper batteries are used, they may become hot, leak and may rupture.
- Do not attempt to recharge non-rechargeable batteries.
- Only batteries of the same equivalent type as recommended are to be used. Do not mix old and new batteries.
- Do not lick batteries. If battery appears to be leaking or has a crystalline deposit on the outside, dispose of it immediately (wear gloves when handling, preferably nitrile or other non-reactive material).
- Do not run a wire between battery terminals, as wire will get very hot, can be irreparably damaged or explode.
- Make sure the batteries are installed with the correct polarity as shown. Do not disassemble your batteries. Never allow them to become hot or to burn. To avoid short-circuits, avoid getting them wet. Do not short circuit batteries.
- If liquid from inside the batteries contacts your skin or clothes, wash them with water. If leaked battery fluid gets into your eyes then flush them immediately with cool water and seek medical attention. Do not rub eyes.
- Always wear safety glasses to protect your eyes. Note that normal glasses, while usually made of impact-resistant plastic, will not afford sufficient protection from shrapnel or flying debris.
- Always wear close-toed shoes to protect your feet from heavy or sharp objects which might be dropped.
- If you have long hair keep it tied back or under a hat to avoid it becoming caught in moving parts.
- The system contains plastic and metal parts. Cutting or bending can cause parts to break; resulting in sharp edges which can cut skin.
- Battery disposal. Do not throw batteries into the trash, especially rechargeable batteries. Contact your local waste disposal office for information on battery disposal.
- Robotics Education Equipment, it is NOT a toy, and harm may occur if not properly assembled and operated.
- Never remove, modify or operate without the safety shrouds.
- MultiRotor Drones have powerful motors and high-speed propellers. Never place your hands near propellers while it is armed as in when the safety light displays solid red.
- Always disarm the MultiRotor before handling.
- Only fly inside designated completion field, never outside the field, and never outside the facility.
- Always follow the preflight and post-flight steps in the order described in its manual and remain attentive while flying.
- When the battery reaches 25% of its remaining charge, it will land and display a blinking yellow LED.
- UAVs can do significant harm if a fast spinning blade contacts an object.
- Only touch the electronics when the battery has been unplugged. Although the batteries used are low voltage they are discharging at a very high current and as such, if you touch both the red and black lead while in use you may receive a significant (40 amps or higher) shock.
- It is best to assume that if the battery is plugged in that the motors can start rotating at any time.
- MINDS-i maintains no responsibility for inadvertent errors in this manual. Visit [www.mindsieducation.com](http://www.mindsieducation.com) for the latest updates and information.