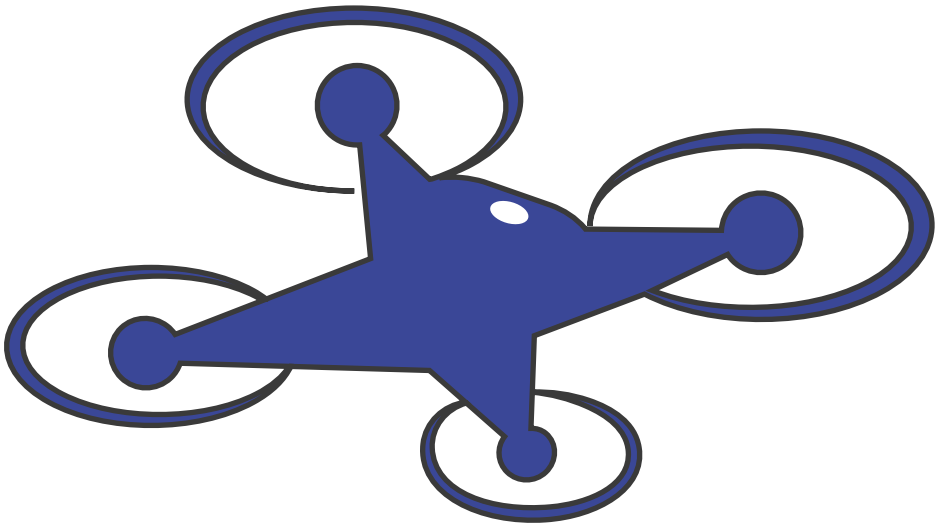

DRONES IN SCHOOL

CONTEST MANUAL

2018-2019 Season

www.dronesinschool.com

Last Update: October 20, 2018

What's It All About?

To participate in Drones in School you and your team will design, construct and race a first-person view (FPV) drone.

The Team

Form a team of 3 – 6 students, think of a name, decide job roles; Team Manager, Manufacturing Engineer, Design Engineer, Graphic Designer and Project Manager. Register your team with Drones in School. (dronesinschool.com).

The Process

1. Develop a Team Identity, Create a Plan and Find Sponsors

Prepare a plan, work-up a budget, and raise the needed capital through team sponsorship. Teams are encouraged to partner with business and industry for sponsorship funding.

2. Design Your Drone

Using 3D Computer Aided Design (CAD) software, design your FPV drone to the specifications in the Contest Manual for the current racing season.

3. Build

Using traditional manufacturing processes, Computer Aided Manufacturing (CAM) software and/or 3D printing technology, the team will develop the best way to manufacture and assemble their drone.

4. Test and Improve

Put your drone through its paces and test all aspects. As you work through the engineering process you will need to make changes to the design. Make sure these are documented for your portfolio.

The Competition

1. Display Booth

Each team will produce an informative display showing their work through all stages of the project. Think about your team identity, the design process and the role each member has played on your team.

2. Technical Evaluation

Each drone is submitted for judges to evaluate compliance with the Contest Manual specifications.

3. Engineering Judging

Judges interview teams to learn how their drones have been manufactured and why particular design features were chosen.

4. Verbal Presentation

Each team will prepare a presentation that will be delivered to a panel of judges. This presentation will need to cover all aspects of the challenge. This will be completed within a set time limit.

5. Portfolio Judging

Each team will create a portfolio documenting their project from beginning to end. The portfolio will be displayed in the Display Booth.

6. Let's Race!

Teams compete with each other to see if they have a winning racing drone. The race will consist of a head-to-head and capture the flag event.

Rules and Regulations

1. The Challenge

1.1. Your team is tasked with designing, building and racing the first person view (FPV) drone of the future.

1.2. In order to enter the championship, you must assign job roles to the members of your group. Ideally, one role should be allocated to each person. However, if you have fewer than six team members you will have to double up or share some roles and responsibilities. The following job roles should be covered by the members of your team:

- Team Manager (maximum 1 person)
    - This person is responsible for managing the team, The Team Manager works closely with all members of the team, offering assistance where necessary. The Team Manager serves as the main point of contact for the team advisor, Drones in School and organizations that are partnering with or sponsoring your team.
- Project Manager
    - This person oversees the project management of all key deliverables and ensures that all equipment is ready for the competition. This includes organizing time, materials and equipment for completing all aspects of the project. The Project Manager will need to work with all members to ensure tasks are progressing on time and offer assistance as needed.
- Manufacturing Engineer
    - This person is responsible for advising team members on the manufacture of the drone and the constraints of the machining/manufacturing process. Manufacturing engineers will need to work with the design engineers to report and solve any problems with the construction of the drone and serve as the primary repair technician. The Manufacturing Engineer may also oversee the construction of the display booth.

- Electrical Engineer
    - This role is responsible for ensuring all electrical components of the drone are installed and working properly. Electrical engineers must also ensure that all team members are following the correct operating procedures and protocols for setting, modifying and operating the camera and/or radio frequencies during an event.
- Design Engineer
    - This role is responsible for the styling and the aerodynamic performance of the drone and design of the display booth. Design engineers will need to work with the manufacturing and electrical engineers to ensure their ideas can be realized, repaired and maintained.
- Graphic Designer
    - This person is responsible for producing the drone color scheme, team logo/identity, any special sponsorship logos, final graphic renderings, and any additional team marketing materials. The graphic designer will need to work with all team members to coordinate the design and production of the display booth, portfolio and team uniform.

2. Levels

2.1. Teams are invited to participate in the following divisions, based on the current academic level of the most senior team member.

2.1.1. Middle School - Students enrolled in a public, private or home-school offering instruction between and including grades six, seven and/or eight.

2.1.2. High School - Students enrolled in a public, private or home-school offering instruction between and including grades nine, ten, eleven and/or twelve.

3. Mandatory project elements for all Regional Qualifiers, Regional, National and World Finals

3.1. Drones

3.1.1. Each team must produce two (2) identical racing drones for all events.

3.2. Portfolio

3.2.1. Each team must produce one (1) 'hard copy' portfolio (20 page maximum, excluding front and/or back covers) presented in an A3 (or similar) sized format for exhibit in the team display booth. This portfolio should detail the efforts of the team and include the design, engineering, marketing, manufacturing, and project management processes completed to date.

3.2.2. Portfolio and Display Booth should address the following items:

3.2.2.1. Project management processes

3.2.2.2. Team roles, the division of work, and team member collaborations

3.2.2.3. Team identity

3.2.2.4. Marketing efforts

3.2.2.5. Design and Manufacturing process

3.2.2.6. Development, Testing, and Evaluation

3.2.3. Refer to the judging scorecard for portfolio specifications and content requirements.

3.3. Display Booth

3.3.1. Each team will be provided with a 120cm wide x 80cm deep x 150cm tall, dedicated exhibition style space for setting up their display booth.

3.3.2. Each Display Booth space will have access to a single 110V outlet. Teams should provide their own surge protector if needing additional outlets.

3.3.3. Each Display Booth must contain the following:

3.3.3.1.1 At least one assembled Racing Drone. This drone can be removed from the Display Booth during the Capture the Flag portion of the competition or if needed as a backup during the head-to-head race. The drone should be on exhibit at the Display Booth at all other times.

3.3.3.2. Team logo and an explanation of the process utilized to create the team name and logo.

3.3.3.3. Evidence of utilizing an engineering design process to develop the project.

3.3.3.4. Renderings of drone design.

3.3.3.5. Full plans for the drone frame design with orthographic and isometric views.

3.3.3.6. Team members and the role they fulfilled in the project.

3.3.3.7. A printed copy of the Portfolio.

3.3.4. Refer to judging scorecard for display booth scoring specifications.

3.3.5. All teams will be able to set up their Display Booth upon arrival and prior to judging.

3.3.6. No part of the completed Display Booth is allowed to protrude beyond the physical dimensions of the allocated exhibition space. This includes anything that might protrude above the highest point. e.g.,Flags.

3.3.7. **ONLY** student team members are permitted to set-up their Display Booth. There must be no supervising teacher/adult or other outside assistance unless deemed to be a health and safety issue.

3.4. Verbal Presentation

3.4.1. Teams will be required to deliver a verbal presentation to the judges relating to their project.

3.4.2. The presentation must not last longer than 5 minutes (10 minutes at the National and World Finals).

3.4.3. A display or projector will be provided at the competition.

3.4.4. Teams must bring their own laptop with any slideshow or other multimedia files that need to be shown as part of their verbal presentation.

3.4.5. Each team will have 5 minutes prior to the timed presentation to set up their equipment and any visual aids.

4. The Registration Process

4.1. Registration is completed online at www.dronesinschool.com. Each school wanting to compete in the 2018/19 season must register before the last qualifying race in their region. Registration fees are per team.

Registration includes:

- Access to support from Drones in School and access to register for qualifying races during the season
- 4 - Drones in School Payload samples
- Access to special pricing on parts and accessories from authorized Drones in School partners

Each team will also need:

- 2 - Drones in School authorized motor sets
- 2 - Drones in School authorized flight controllers
- 2 - Radio Transmitters (one for each drone flight controller)
- 2 - FPV Transmitter Cameras
- 2 - FPV Goggles
- Batteries
- Battery Charger
- additional supplies deemed necessary by the team

4.2. We strongly suggest trying to raise your registration fee through either sponsorship or fundraising.

4.3. Registration fees are non-refundable after 21 Days. All fees must be received before the date of your regional final.

5. Judging

5.1. Judging categories

5.1.1. There are six (6) main judging categories, each with specific judging activities.

- Specification Judging
- Design and Engineering Judging
- Portfolio and Display Booth
- Verbal Presentation Judging
- Racing (Capture the Flag and Head to Head)

6. Drone Design Regulations

6.1. Each Drone may have a maximum of 4 motors. Motors must be official Drones in Schools authorized motors. (see www.dronesinschool.com for the complete list)

6.2. The Transmitter and Receiver for all flight controllers must operate on the 2.4GHz frequency

6.3. All flight controllers must be authorized Drones in School flight controllers. (see www.dronesinschool.com for the complete list)

6.4. Each Drone must be fitted with an FPV transmitter camera operating on the 5.8GHz frequency

- 6.4.1. The FPV transmitter camera should be capable of 40 channels with a frequency range of approximately 5.658GHz to 5.917GHz (known as Race Band)
- 6.4.2. The FPV transmitter camera should not have a power output of greater than 25mW

6.5. Each drone must be powered by a maximum of two 1s Lipo batteries maximum 3.8V each

- 6.5.1. Only one battery may be used to power the flight controller and motors
- 6.5.2. Only one battery may be used to power the FPV transmitter camera
- 6.5.3. Drones can be designed to use a single battery to power the flight controller, motors, and FPV transmitter camera

6.6. The maximum dimensions shown below are to the furthest extremes in each direction and include propellers, antennas and any other part of the drone required for it to operate:

- 6.6.1. Length: 120mm
- 6.6.2. Width: 120mm
- 6.6.3. Height: 120mm
- 6.6.4. Propellers: 40mm Maximum (Must be completely surrounded by covers or ducts)
- 6.6.5. Motors: must be Drones in School authorized motors
- 6.6.6. Weight: 50g Maximum

6.7. Payload

- 6.7.1. Each drone must carry the official Drones in School Payload during the Head-to-Head and Capture the Flag portions of the event.
- 6.7.2. The Payload may not be glued or permanently fastened to the drone. It must be removed and presented to the Drones in School official at the end of each flight.
- 6.7.3. On the signal of the Drones in School official, each team will have 30 seconds to provide their payload to the official by placing it in the official's hand or a spot designated by the official.
- 6.7.4. Loss of the Payload during a Head-to-Head or Capture the Flag match will result in the team losing that match.
- 6.7.5. 2018-19 Payload description
  - 6.7.5.1. Each drone must carry a plastic disk that is 31mm in diameter and 4mm thick. (see image to the right)

6.8. Only one drone design may be used by a team at any given event and must be used for any and all event activities.

6.8.1. It is expected that damage will be sustained throughout the course of an event, so any parts including frames, propellers, motors, flight controllers, FPV transmitter camera, etc. may be changed or replaced. However, these must be identical to those with which the drone passed inspection during the Technical Evaluation.

6.8.2. Adding or removing of any subsystems or attachments for different types of activities is not permitted.

6.9. The flight controller, motor, and payload must be the ones authorized from Drones in School. The flight controller, propellers, battery and FPV transmitter camera may be purchased from any vendor/source. All other components of the drone must be designed and manufactured by the students on the respective team.

6.10. All Drones must be able to be disarmed via a single switch on the transmitter. This switch must be clearly identified with red heat-shrink tubing or red PVC tape tightly wrapped to the switch actuator.

6.11. Drones must be fitted with a failsafe that cuts power to all motors in the event of loss of signal between the transmitter and the drone.

7. General Rules

7.1. Each team must have two people present in the Pilots Box during their match or race.

7.1.1. One team member will be the Pilot and must sit in the Pilot's Seat while the match or race is in progress.

7.1.2. The other team member will be the spotter and must stay in the spotter's Station by the Pilot for whom they are spotting.

7.2. The Pilot may only control their Drone from FPV using appropriate FPV Goggles.

7.2.1. Pilots are not permitted to control their Drone from a line of sight (LOS) perspective.

7.2.2. Pilots must not remove their FPV Goggles during a match or race. Removal of FPV Goggles will result in a Warning or Disqualification.

7.3. After the race or match begins, the transmitter may only be touched by the Pilot.

7.4. Prior to the match starting, each drone must be placed on their designated starting pad by either team member (Pilot or Spotter).

7.4.1. Drones must be disarmed when they are being placed and must remain disarmed until an event official states that it is safe to arm.

7.4.2. Any drones that are armed prior to an event official stating that it is safe to arm may be disqualified from the match.

7.5. Drones in Schools officials can request that any or all drones are disarmed at any point during the match of race.

7.5.1. Drones in Schools event organizers and officials reserve the right to intervene and disarm any drones at any time and for any reason.

7.6. No additional team members are permitted to enter the live area at any point during a match.

7.7. While it is expected that there may be contact between drones during a match or race, intentionally crashing into opponents will result in a warning or disqualification.

8. Competing Teams

8.1. Each team must consist of a minimum of 3 students to a maximum of 6.

8.2. Only members of the official competing team (maximum 6) are permitted to wear the team's uniform

8.3. During the competition, only the official team members (maximum of 6) can represent the team at registration, Display Booth set up, Technical Evaluation, Verbal Presentation, Design & Engineering judging, racing, and any direct communication with Drones in Schools event organizers and officials.

9. Team Responsibilities

9.1. Teams must read the Drones in Schools Contest Manual (this document) carefully to ensure their drones and all project elements satisfy these regulations and that they understand the requirements and procedures for all aspects of the competition and judging.

9.2. During the competition, it is the team's responsibility to ensure that team members are present at the correct time and location for all scheduled activities.

9.3. Security of the Display Booth and its elements is the team's responsibility during competition.

10. Role and Responsibility of Supervising Teacher / Team Advisor

10.1. All supervising teachers/team advisors should carefully read and understand the conditions for entry to a Drones in School event and must have explained all relevant information to their students.

10.2. It is the primary responsibility of any supervising teacher/team advisor to ensure duty of care/well-being for all their student team members. Any concerns arising during the event in relation to this should be brought to the attention of Drones in Schools event organizers and/or officials immediately.

10.3. The supervising teacher/team advisor is permitted to be present during any judging activity with their team but, must not interact in any way with the student team, judges or judging process. Any incident considered inappropriate will be brought to the attention of Drones in Schools event organizers and/or officials, and penalty points may be applied.

11. Regulations Documents

11.1. Drones in School issues the regulations, their revisions and any amendments made through the Drones in School contest manual.

11.2.Drones in Schools Contest Manual (this document).

11.2.1.Text clarification - any frequently asked questions that are deemed by Drones in School to be related to text needing clarification will be answered. The question and the clarification will be published to all teams at the same time through the Drones in Schools website (www.dronesinschool.com)

11.2.2.Other supplementary competition regulations or documents may be issued by Drones in School that provide groups with further logistic and additional important event information. Any supplementary regulations will be issued to each supervising teacher/team advisor and the Team Manager, where the Team Manager has supplied Drones in School with a contact email address.

12. Safety Rules

12.1.If at any time a drone or the actions of the team responsible for that drone are deemed to be unsafe or behaving in an unsafe manner, the offending team's drone may be disarmed by the event officials and the team may be disqualified from the match or race. Serious breaches of safety may result in disqualification from the event,

12.2.Any team member entering the live area at any time must wear suitable eye protection

12.3.Lithium Polymer batteries may only be charged when all the following criteria are satisfied:

12.3.1.Charging takes place in the designated Charging Zone(s) which will be defined by the Drones in Schools event organizers at check-in.

12.3.2.Batteries are contained in a suitable fireproof LiPo safe bag while being charged.

12.3.3.Failure to comply with this rule may result in disqualification from the event.

12.4.Drones may only be connected to a battery when in a designated Live Area.

12.5.The FPV transmitter camera may only be powered up when your team is about to participate in a match or race – powering an FPV transmitter camera at any other time may result in interference for another team currently competing in a match or race and may result in disqualification from the event.

13. Capture the Flag Rules

13.1.Capture the Flag is played by two teams that consist of two drones. One team will be designated as the Red Team, and the other will be the Blue Team. Drones must work together to capture more flags than the opposition.

13.2.The game is played on a field of approximately 12 meters by 6 meters. The field is divided into two halves, one Red and one Blue. Each half contains five flags which start the match set to the same color as the half they are in.

13.3.Teams must "capture" the flags that are owned by the opposing team by changing their color. When a drone taps a flag, it will change color, alternating between red and blue. Teams can receive bonus points by being landed on one of their starting pads before the match ends.

13.4.The winner is the team with the most points at the end of the match.

13.5.The Capture the Flag competition is a single elimination tournament.

13.6.At the beginning of the match, each drone must be placed so that it is only contacting a starting pad and so that no part of the drone is touching the surrounding floor.

13.6.1.Only one drone may occupy each starting pad.

13.6.2.Drones can begin and end on any starting pad.

13.7.Each Drone FPV transmitter camera should be set to the frequency/channel that corresponds to the frequency/channel displayed on the starting pad selected and corresponding Pilot's Seat.

13.8.Pilots must not take off until directed to do so by the Drones in School official. False starts may result in disqualification from the match.

13.9.Scores are calculated as soon as the timer signals the end of the match. Any flags captured or landings completed after the end of the match will not be scored.

13.10.Pilots are not permitted to land on the opposing team's starting pad. Minor violations will result in a warning, but match affecting violations may result in disqualification from the match.

13.11. Any flags that are damaged during a match so that they do not display a color will not be counted towards the score of either team.

13.12.A drone is considered landed if:

13.12.1.It is contacting a Landing Pad of the same color as it's team

13.12.2.No part of the Drone is touching the surrounding floor

13.12.3.Rules 12.12.1 and 12.12.2 remain satisfied when the drone is disarmed

13.13.Each team will compete in three Capture the Flag matches and their final score will be the average of the total points scored from each of those three matches.

14. Capture the Flag Scoring

14.1. Each flag is worth 5 points

14.2.A landed drone is worth 25 points

15. Head to Head Rules

15.1.Head to Head is a double elimination race around a race course which is marked out by a series of gates. Two pilots, one from each team, will race together on a single course. The winner is the pilot who completes the required number of laps first.

15.2.Race courses will vary in size and layout depending on the venue and the amount of space available.

15.3. Gates used will vary based on the venue but will have a minimum opening of 900 cm^2.

15.4. At the beginning of each match, each drone must be placed so that it is only contacting a starting pad and so that no part of the drone is touching the surrounding floor

15.5. Each drone FPV transmitter camera should be set to the frequency/channel that corresponds to the frequency/channel displayed on the launch pad and corresponding Pilot's Seat.

15.6. Pilots must not take off until directed to do so by the Drones in School official. False starts may result in disqualification from the race.

15.7. Pilots must navigate through the gates in the correct order and in the correct direction. If an Event Official is not satisfied that the course has been successfully completed, the lap may be voided.

16. Head to Head Scoring

16.1. Eliminated before Quarter Final = 10 points

16.2. Eliminated in Quarter Final = 15 points

16.3. Eliminated in Semi Final = 20 points

16.4. Eliminated in Final = 30 points

16.5. Head-to-Head Winner = 40 points

17. Awards

17.1. Each Drones in School event will include the following awards

17.1.1. Overall Event Champion

17.1.2. Design and Engineering Champion

17.1.3. Portfolio and Display Booth Champion

17.1.4. Verbal Presentation Champion

17.1.5. Capture the Flag Champion

17.1.6. Head to Head Champion

17.2. Optional Award

17.2.1. Fastest Head to Head Lap

17.2.2. Judges Choice

18. Contest Manual Updates

18.1. Although great care and effort has gone into the preparation of this document, Drones in School reserves the right to update the document as needed throughout the competition season.

18.2. Any update will be posted to the Drones in School website.

18.3. A "last updated" date will be included on the cover for each version of the document.

Appendix: Judges Sheets

Team Number: _____ Team Name: _____

School: _____

Portfolio & Display

PORTFOLIO

Project Management	Little evidence of project management presented. 1 2 3	Simple management and planning used to guide progress. A range of resources considered. 4 5 6 7 8	Comprehensive project management. A wide range of factors considered; e.g.. scope, time, resources and project risks. 9 10 11 12 13 14 15	
Team Work	Limited team work evident. 1 2 3	Evidence of effective team work and roles defined 4 5 6 7 8	Highly structured team with clear roles. All team members had effective and critical contributions. Role collaboration recognized 9 10 11 12 13 14 15	
Portfolio Clarity & Quality	Difficult to follow with basic presentation. 1 2 3	Clear structure, well organized. Good use of graphics, charts and tables to enhance presentation and impact. 4 5 6 7 8	High impact and professional throughout. Consistent and clear. Excellent use of graphics, charts and tables to enhance portfolio 9 10 11 12 13 14 15	
			Portfolio Total	/45

PIT DISPLAY & MARKETING

Team Identity	Inconsistent, limited or obscure identity 1 2 3	Effective team identity consistent through various project components. 4 5 6 7 8	Excellent and highly effective team identity. Consistently applied through all project elements. 9 10 11 12 13 14 15	
Marketing	Limited or irrelevant 1 2 3	Some marketing activity / sponsorship explained 4 5 6 7 8	Creative and effective activities linked to sponsorship & ROI 9 10 11 12 13 14 15	
Display Booth	Repetition of portfolio elements 1 2 3	Clear and effective presentation and messaging. Some project development displayed. 4 5 6 7 8	Clean, well organized and has high impact. Highly professional with attention to detail. Well presented project development. 9 10 11 12 13 14 15	
			Pit Display & Marketing Total	/45

DESIGN PROCESS

Ideas	Single or basic concepts 1 2 3	Multiple concepts with links to research. 4 5 6 7 8	Several technically inspired ideas. Form linked to function. 9 10 11 12 13 14 15	
Development and Testing	Limited development shown 1 2 3	Logical design developments based on testing 4 5 6 7 8	Clear and justified developments linked to tests and research 9 10 11 12 13 14 15	
Manufacture	Little manufacturing detail 1 2 3	Manufacturing processes and issues presented 4 5 6 7 8	Detailed assessment of manufacture, stages, materials & issues 9 10 11 12 13 14 15	
			Design Process Total	/45

DRONES IN SCHOOL

Portfolio Total + Pit Display & Marketing Total + Design Process = Portfolio and Display Total = 135

Team Number: _____ Team Name: _____

School: _____

Verbal Presentation

TECHNIQUE				
Visual Aids	Little use of aids. 1 2 3	Some aids used effectively 4 5 6 7 8	Highly professional aids effectively improve communication 9 10 11 12 13 14 15	
Team Contribution	Minimal team participation 1 2 3	Good contributions from most team members 4 5 6 7 8	Excellent team work with all members participating effectively 9 10 11 12 13 14 15	
Dynamic	Artificial and/or low energy 1 2 3	Generally enthusiastic and lively delivery 4 5 6 7 8	Passionate with consistent and appropriate levels of animation 9 10 11 12 13 14 15	
Engagement	Minimal engagement 1 2 3	Some audience connection at times 4 5 6 7 8	Audience fully engaged and excited throughout presentation 9 10 11 12 13 14 15	
			Portfolio Total	/60
COMPOSITION				
Concept Clarification	Several concepts lacked clarification 1 2 3	Clear and appropriate explanations 4 5 6 7 8	Concise and creative clarification of ideas requiring explanation 9 10 11 12 13 14 15	
Use of Time	Too fast or ran out of time 1 2 3	Good timing. Balanced topic depth and pace 4 5 6 7 8	Ran on time or under. Excellent balance of depth for each topic 9 10 11 12 13 14 15	
Presentation Agenda	No agenda presented 1 2 3	A basic agenda presented and could be followed by audience 4 5 6 7 8	Clear presentation outline. Excellent connections between topics and easy for audience to follow 9 10 11 12 13 14 15	
			Pit Display & Marketing Total	/45
SUBJECT MATTER				
Innovation	Little innovation presented 1 2 3	Innovations described and justified 4 5 6 7 8	Originality. Clever innovations with high positive project affect 9 10 11 12 13 14 15	
Collaboration	Little collaboration 1 2 3	Links with industry or higher education described 4 5 6 7 8	Collaborations justified with learning and project outcomes 9 10 11 12 13 14 15	
Learning Experiences	No real reflections discussed 1 2 3	Good explanation of some learning outcomes 4 5 6 7 8	A range of personal, life long learning and career skills acquired identified as project outcomes for a range of team members 9 10 11 12 13 14 15	
			Design Process Total	/45

DRONES IN SCHOOL

Technique Total + Composition Total +Subject Matter Total = Verbal Presentation Total = /150

Team Number: _____ Team Name: _____

School: _____

Design and Engineering

COMPUTER AIDED DESIGN AND ANALYSIS

Application of CAD-CAM	Basic application. Final design in CAD only 1 2 3	Appropriate use of CAD in product development stages. Good understanding of CAM evident 4 5 6 7 8	Advanced use of CAD and CAM technologies throughout. Final CAD identical to the physical model car produced 9 10 11 12 13 14 15	
Analysis	Minimal analysis shown 1 2 3	Good analysis. Results applied to development 4 5 6 7 8	Variety of advanced and relevant analysis techniques conducted 9 10 11 12 13 14 15	
Organization	Generally unorganised 1 2 3	Satisfactory organisation of data and models 4 5 6 7 8	Data & parts highly ordered & linked. Full CAD product assembly 9 10 11 12 13 14 15	
Orthographic & Rendering	Basic drawing & rendering 1 2 3	Good technical drawing and realistic rendering 4 5 6 7 8	High detail & includes spec dimensions. Photorealistic render 9 10 11 12 13 14 15	

CAD & Analysis Total /60

MANUFACTURING

Quality	Reasonable quality with inconsistencies 1 2 3 4	Good overall quality with attention to detail 5 6 7 8 9 10 11	Showcase' finish quality on all components. Exceptional attention to detail. Two drones are identical. 12 13 14 15 16 17 18 19 20	
Assembly	Poorly assembled 1 2 3 4	Generally well assembled and engineered 5 6 7 8 9 10 11	Professional assembly, highly engineered. Sound techniques 12 13 14 15 16 17 18 19 20	

Manufacturing Total /40

DRONES IN SCHOOL

CAD & Analysis Total + Manufacturing Total = Engineering Judging Total = /100