Category E
Challenge Booklet 2019

Organised by:

DSO NATIONAL LABORATORIES

SCIENCE CENTRE singapore

Supported by:

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SAFMC 2019 CAT E CHALLENGE BOOKLET CHANGE LOG

Version	Release Date	Description
1.0	30 Nov 2018	Official challenge booklet release
2.0	10 Jan 2019	Insertion of SAFMC 2019 Competition Schedule

SAFMC 2019 COMPETITION SCHEDULE

Date	Event	Competition Venue
14 March 2019	Category A	Nanyang Technological University, The Wave
14-15 March 2019	Category C2	ITE College Central, K503 Lab
16 March 2019	Category C3	ITE College Central, K503 Lab
18 March 2019	Category B	ITE College Central, Multi-Purpose Hall
19 March 2019	Category C1	ITE College Central, Multi-Purpose Hall
20-21 March 2019	Category D1 and D2	ITE College Central, Multi-Purpose Hall
22 March 2019	Category E	ITE College Central, Multi-Purpose Hall
23 March 2019	Awards Presentation Ceremony	ITE College Central, The Hall

CONTENTS

SINGAPORE AMAZING FLYING MACHINE COMPETITION 2019

1. INTRODUCTION

Singapore Amazing Flying Machine Competition (SAFMC) is an exciting and unique event organised by DSO National Laboratories and Science Centre Singapore, and supported by Ministry of Defence (MINDEF). Open to all schools and students who want to explore the science behind flight and create their very own flying machines, this annual competition promises a fun-filled learning journey with special talks, workshops and live demonstrations.

2. CATEGORIES

CATEGORY A – PAPER PLANES *(Primary Schools)*

Each team should consist of **TWO (2)** to **THREE (3)** members.

Design and fold paper planes to achieve the longest, farthest or most accurate flight.

CATEGORY B – UNPOWERED GLIDERS *(Secondary Schools / Integrated Programme)*

Each team should consist of **TWO (2)** to **FIVE (5)** members.

Design and build small unpowered gliders to be bungee-launched from designated launcher in a bid to fly the furthest.

CATEGORY C – RADIO CONTROL FLIGHT *(Secondary Schools / Integrated Programme / Junior Colleges / Institute of Technical Education)*

Category C1: Fixed Wing Radio Control Flight

Each team should consist of **TWO (2)** to **FIVE (5)** members.

Design and build a small remote-controlled fixed-wing air platform to navigate an obstacle course.

Category C2: FPV Flight **– Tiny Whoop** *(All Schools)*

Each team should consist of **ONE (1)** to **TWO (2)** members.

Bring or design a FPV (first-person view) Tiny Whoop class drone to navigate an obstacle course.

Category C3: FPV Flight **– Micro** *(All Schools)*

Each team should consist of **ONE (1)** member.

Bring or design a FPV (first-person view) Micro class drone to navigate an obstacle course.

CATEGORY D – SEMI-AUTONOMOUS / AUTONOMOUS *(Polytechnics/Universities)*

Category D1: Semi-Autonomous

Each team should consist of **TWO (2)** to **FIVE (5)** members.

Design and build a semi-autonomous small air platform to perform a multitude of tasks in an indoor open course.

Category D2: Autonomous

Each team should consist of **TWO (2)** to **FIVE (5)** members.

Design and build an autonomous small air platform to perform a multitude of tasks in an indoor open course.

CATEGORY E – UNCONVENTIONAL *(Open to Public)*

Each team should consist of **TWO (2)** to **FIVE (5)** members.

Design and build unconventional air platforms or showcase co-operative technology, and demonstrate its flight within a confined indoor area.

3. GENERAL SAFMC 2019 RULES

- **The deadline for the competition registration is 31 January 2019.**
- Participants registered under a school must be a full-time student at the point of competition.
- Home-schooled participants and teams consisting of students from different schools should register as “Independent teams”.
- Participants will be notified upon successful registration within two weeks of the registration deadline. The decision made by the SAFMC organising committee is final, and is subject to the availability of the competition schedule and logistics support.
- Each member can only participate in one team within a category. However, the person can participate as a member in different categories, i.e. a person can be a member for a team in Category B and another team in Category C but the person cannot be a member for two teams in Category B.
- Teams are allowed to take part in categories higher than their educational standard, i.e. Primary school students are allowed to take part in Category B, C, D or E. Secondary school students are allowed to take part in Category C, D or E.
- Members and family members of the organising committee are not allowed to participate in SAFMC.
- The organisers reserve the right to amend the rules and regulations. In the event of any change, all teams will be informed **FOUR (4)** weeks prior to the start of the competition.
- Prizes will be issued to the Team Manager.
- A safety net will be set up around the perimeter of the competition field for Categories B, C, D, and E. There will be a top net approximately **EIGHT (8) meters** above the ground, which will limit the maximum flight altitude of flying machines. During the challenge attempts, teams are strongly encouraged to fly their aircraft a safe distance from the netting to avoid accidental entanglement.
- The organisers of SAFMC 2019 will not be held responsible for any damage to, or the loss of, any flying machine(s) throughout the entire competition.

- All participants will be held responsible for the safe flying of their flying machine(s) throughout the entire competition. The organisers reserve the right to ground the flying machine(s) of any team.

For any queries regarding the competition, please send an email with the title addressed to the relevant category *(e.g.: [CAT E] - Clarification about task locations)* to the following email address: SAFMC@science.edu.sg

4. FORMAT OF COMPETITION

Once the teams have confirmed their registration for the competition, they are expected to start work on the different aspects of the competition, the Challenge and the Presentation *(excluding Category C2 and C3 which do not require presentation).*

Teams are encouraged to give equal attention to both the Challenge and the Presentation aspects of the competition.

The top team from each category will be bestowed with the championship award to be presented at the SAFMC 2019 Awards Presentation Ceremony.

4.1 PRESENTATION

During the presentation, teams will be allocated a specific time slot to present about their flying machine in ITE College Central. Teams will present their flying machine design and learning journey in this competition to a panel of judges. These teams will be assessed for a number of awards.

The presentation plays an integral part for teams who wish to vie for the SAFMC Championship Award. Teams that do not bring their flying machines for the presentation will be disqualified immediately. Depending on the category, there may be additional requirements to the Presentation segment.

The Chief Referee or Judge for each category reserves the right to deduct points if the flying machine used in the Challenge is drastically different from the flying machine presented at the Presentation.

4.2 CHALLENGE

For the Challenge aspect, teams *(except Category C2 and C3 which allow commercial off-the-shelf products)* are to design, build and fly their flying machines to overcome various challenges for the different SAFMC categories.

For Category C, D and E participants, tables may be provided within the main competition hall as common areas for teams to work on their flying machines. Alternatively, teams may be assigned a designated area instead.

Teams should expect the following during the course of the competition:

- The competition hall will open at 8 am. Only registered team members of the participating teams can enter the competition hall from 8 am to 6 pm.
- As for spectators, there is a separate entrance to the spectators' viewing gallery and they are not permitted to enter the competition zone (playing field and team booths).
- No trial runs will be allowed in the flying area unless specified by the officials.
- For Category C1, D and E participants, all transmitting devices **must** be surrendered to SAFMC officials.
- For Category D and E participants, no video transmitting devices, including spares, should be powered on in the competition hall unless specified by the officials.
- For Category C1, D2 and E participants, no team is allowed to charge batteries within the competition hall. The team is required to bring sufficient batteries for all the missions.

5. CATEGORY E AWARDS

Award winners will be selected based on either presentation scores, competition day performances, or a combination of both.

All scoring decisions made by the judges are **final**. For arbitrary cases, the organising committee will have the **final** say.

There is no limit to the number of awards that a team can win, but there may not be a winner for every award. Awards may not be given out if the teams do not meet the minimum standard determined by the SAFMC organising committee, or if there are insufficient participants for each category.

5.1 CHAMPIONSHIP AWARD

The championship awards are awarded to the teams that have the three (3) highest total score from Presentation and Challenge. There will be **THREE (3)** championship awards for Category E.

5.2 COOPERATIVE THEME AWARD

This award is given to the top team participating under the cooperative theme demonstrating a high degree of autonomy with their platform. Teams which use manual piloting to synchronize their platforms will not be considered. Examples of autonomous behaviour include anti-collision logic, particle swarm optimization, flocking etc. A swarm of drones following one master human controlled drone is also eligible. There may be no winner for this award.

5.3 JUDGES' COMMENDATION AWARD

This award is given out to teams (outside of the top 3 teams) exhibiting a high quality in Design and/or Performance. Overall scores may be taken into consideration for this Judges' Commendation Award. There may not be a winner for this award.

5.4 PRIZES

CATEGORY E				
Awards	**Medals**	**Trophy**	**Cash Prize**	**Remarks**
Cat E Championship Award	✓	✓	$3000	
Cat E Championship 1st Runner Up	✓		$1500	
Cat E Championship 2nd Runner Up	✓		$1000	
Cat E Cooperative theme Award	✓		$1000	Based on Judges' discretion
Cat E Judges' Commendation Award	✓		$500	Based on Judges' discretion

6. CATEGORY E CHALLENGE

6.1 COMPETITION OBJECTIVE/SCENARIO

- Teams are to design and build flying platforms to fulfil a mission.
- Teams are given the flexibility to design their own mission. However, teams are to note that their mission **must fulfil one of the following themes AND must utilise at least one of the following props**.
- Please refer to *Section 8* for more details of the themes.
- Teams are to come up with a mission demonstration that will showcase the unique capabilities of their flying platform.

7. MISSION PROPOSAL

7.1 CREATE YOUR OWN STORY!

- Teams are to create a mission as an overarching storyline to link the chosen theme with the tasks that they intend to do.

7.2 SUBMISSION OF MISSION BRIEF

- Teams are to **submit the mission brief (Form Appendix A1) by 24 February 2019** by emailing safmc@science.edu.sg with the title "[CAT E] Submission of Mission Brief (Team Name)"
- Two (2) copies of the final completed hardcopy of the mission brief are to be submitted on the competition day during registration.
- The mission brief should include the following:
  a) Mission (storyline)
  b) Features (What the team intends to demonstrate)
  c) Parts/concepts reused from previous SAFMC participation. Elaborate on changes/improvements made.
  d) Props used and if you are bringing your own props, please include a picture of them along with a brief description (weight, quantity, dimensions)
  e) Photo of the platform
- A sample of a completed mission brief is shown in appendix A2.
- In the event that the flying platform(s) of the team is not ready, the team may exclude the photo for the mission brief that is to be submitted by 24 February 2019. However, the photo must be included in the final hardcopies that is to be submitted on the competition day.
- The purpose of the submission before 24 February 2019 is purely to evaluate safety concerns. There will be strictly no technical feedback or evaluation provided to teams prior to the competition day.

- The SAFMC Organising Committee reserves the right to reject missions that are deemed unsafe and hazardous. These teams will be informed and will be advised to revise their missions.
- Teams will be notified within **two (2)** weeks from submission if they are required to revise their proposal. As such, teams are encouraged to submit their mission briefs early.
- Teams should email an updated mission brief as soon as possible should there be any changes to the planned mission or changes in the props used.
- The SAFMC Organising Committee reserves the right to deny teams from using their own props and/or demonstrating the mission on the Competition Day, should teams fail to submit or submit late mission briefs and intend to execute demonstrations that are deemed unsafe.

8. THEMES

- There are **two (2)** main themes (Cooperative and Unconventional Platform), with each theme further divided into sub-themes
- Teams must pursue at least one of the **five (5)** sub-themes (Cooperative Flight Display, Cooperative Task, Transformable Platform, Underwater Launch, Unconventional Feature)

8.1 THEME 1: COOPERATIVE FLYING

- Teams are to demonstrate swarm ability or co-operation between multiple flying platforms

8.1.1 Co-operative Flight Display

- Teams are to put up an aerial performance of multiple platforms
- Examples:
    - UAV light show at NDP 2017
    - Formation Flight

8.1.2 Co-operative Task

- Teams are to demonstrate multiple platforms working together semi-autonomously/autonomously to achieve a common goal or to complete a task.
- Teams are reminded to showcase some form of autonomy between platforms

Examples:

- Two flying platforms carrying an object (demonstrate ability to maintain sufficient distance without dropping the object)
- Two flying platforms; one shooting a ball into the hoop held by the other.

8.2 THEME 2: UNCONVENTIONAL PLATFORM

- Teams are to demonstrate unconventional platforms that are either transformable, able to launch from underwater or able to demonstrate an unconventional feature.

8.2.1 Transformable

- Teams are to design and build platforms that can demonstrate at least **two (2)** distinct motions, of which one must be flying.
- Teams are also to demonstrate their platform's ability to transit seamlessly into and/or from flight from other motions.
- Examples of motions include (but are not limited to):
  - Rolling
  - Crawling
  - Climbing
  - Walking
  - Swimming
  - Hovering before fixed wing flight

- Teams are allowed to use **two (2)** separate systems on the same platform for the different motions, (e.g. wheels and propellers for rolling and flying respectively), and demonstrate how the platform is able to transform from one system to the other.
- Alternatively, teams can also show actual “transformation” of the platform to be in different configurations for the different motions. Example: Motors rotate such that the same set of motors are used for both rolling and flying

8.2.2 Underwater Launch

- Teams are to launch their flying platform from underwater
- For this competition, the definition of underwater means that majority of the platform must be able to remain under the water surface for at least ten (10) seconds without human intervention (e.g. pushing on it to stay in place with a hand). Prearranged timer launch (e.g. programmed to release weight or inflate ballast tank after 15 seconds) of platform before placing the platform in the water is allowed.
- Judges will first decide on the team’s eligibility to participate based on visual inspection of the flying machine’s water-proofing.

8.2.3 Unconventional Feature

- Teams are to design their flying platforms with an unconventional or unique feature or function that makes use of the props provided.
- Teams are highly encouraged to unleash their imagination to have free play!
- Examples of unique/unconventional feature/function
    - Open the door/latch
    - Place a book on the shelf
    - Stack pails
    - Fly through shelves and land/take-off from the middle rack
    - Throw a ball through a hoop, mimicking basketball.

- A zero or low score may be given if the judges deem that the feature is not unconventional. As such, teams are encouraged to challenge themselves in coming up with something that is truly unique and unexpected.

9. PROPS

- Teams are strongly encouraged to propose unique tasks involving the props that would not be the typical function of the usual UAV designs.
- Teams are to use **AT LEAST ONE** of the following:
  a) Water Tank
  b) Shelf
  c) Vertical Surface
  d) Vertical surface with holes
  e) Hoops
  f) Balls
  g) Pail
  h) Cardboard Box
  i) Balloons
- Items (a) to (e) would be provided on the challenge day and placed on the playfield.
- For the rest of the items listed, teams are to bring their own if they intend to use them. (e.g. bring their own pail)
- The judges reserve the right to penalise teams that did not use any of the listed props.
- Each team is to submit a mission brief by 24 February 2019, indicating the props that will be utilised and brought to the actual challenge. More information on the brief can be found in Section 7.2.
- Teams can bring their own additional props that are not stated above, subject to the SAFMC Organising Committee's approval. This is also to be

indicated on the mission brief that is to be submitted prior to the competition. The SAFMC organising committee reserves the right to reject requests to bring in certain props if it's deemed as unsafe or not practical.

9.1 PROP DIMENSIONS AND DETAILS

- Teams cannot bring props bigger than 1.4m in any length
- Dimensions of the props that will be provided and placed on the playfield are found in Appendix B.

9.2 PLAYFIELD DIMENSIONS

- The flying arena will have a netted flying area of around **40m (L) x 20m (W) x 8m (H)**. Teams are advised to keep these limits in mind when designing their airframes.
- The water pool will be placed at one corner of the playfield.
- With the exception of the water pool, vertical surface and window, teams are free to move the other items placed on the playfield.

10. HINTS

- Link the usage of the props with the themes. The following are possible examples:
  - **Theme: Cooperative Task**
    - Use 2 platforms to carry a pail of balls without dropping any across the competition field (Items used: pail, balls)
  - **Theme: Transformable Platform**
    - Transform from a flying platform and climb or crawl vertically on the vertical surface (item used: Vertical Surface)

11. SCORING

- The scoring of the competition consists of **two (2)** segments: Presentation (20%) and Mission Demonstration (80%)
- Points earned from both segments will be used to evaluate the winner of the Championship Award

11.1MISSION DEMONSTRATION SCORING:

- Judges will award a score to each team based on the following factors:

Factors	Definition
Creativity	Creativity of platform, creativity of tasks performed and creative use of props will be judged.
Degree of Difficulty	Level of technical difficulty and challenge of the demonstration. If platform/concept had been used in past SAFMC competition, improvements made will be used to judge this criteria.
Level of Execution	How well the performance was executed as plan.
Performance/"WOW" Factor	Entertainment Value.
Innovation	- Flying platforms will be categorised based on their types of design. - (hybrid/unique/outstanding, fixed wing, multi-rotors). - How unique their platform is as compared to other teams. - How novel their idea/concept is compared to existing platforms.

- Details of the mission demonstration can be found in section 12.3

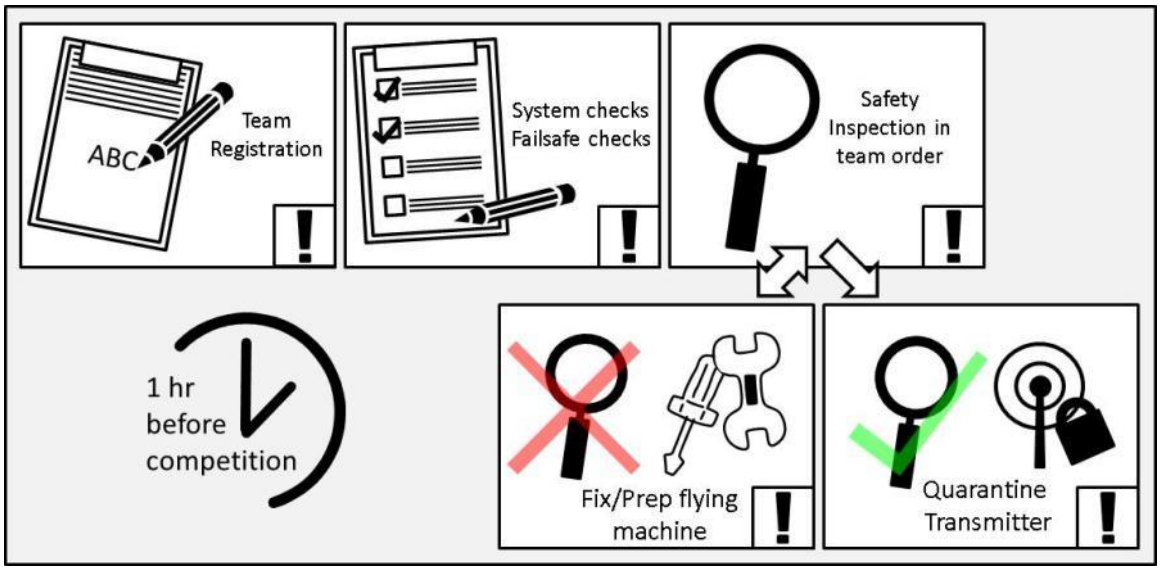
11.2 PRESENTATION SCORING CRITERIA:

- Teams will be assessed on the following:
  - Creativity (30%)
    - Judges will score based on creative use of props, themes, mission storyline, and creative concepts
  - Design of Mission (20%)
    - Interesting mission storyline that links the theme with the props provided.
  - Technical Competency (30%)
    - Ability to explain technical features of platform and challenges faced
  - Smoothness of Delivery (20%)
    - Speakers are concise and clear
    - Presentation flow is clear and teams are able to finish in the allocated time.
- Details of Presentation Requirements can be found in section 12.1

12. COMPETITION SEGMENTS

- The organisers will not be responsible for any damage to the flying machine(s) throughout the competition. Decisions made by the judges and referees are absolute and final.
- The competition sequence of events goes as follows:
  1. Pre-competition Check & Registration
  2. Product Presentation
  3. Final Pre-Flight Preparation
  4. Mission Demonstration

Pre-competition Checks & Registration



- All participating teams will assemble at the registration area to register their flying machines (including any spares & back-ups).
- At this point in time, all teams are free to do their own last minute preparation work such as system and failsafe checks.
- Teams will be called in sequence to the Inspection Point. The Judges and Organisers will check the flying machine(s) for the following:
  - Any violation of the category rules and regulations (details in section 13)
  - Simple flight functional check
  - Failsafe demonstration
- The failsafe check is as follows:
  a. All propellers and releasable payloads are to be removed from the platform.
  b. Flight motors will be armed and throttled up.
  c. While the motors are still spinning in the same flight mode, the R/C transmitter will be switched off to simulate a link loss.
  d. All motors should come to a **complete stop immediately**. The aircraft should not attempt a hover / controlled descent / to return home.

- In the event the teams' flying machine(s) fails the inspection, the team must rectify the problem before moving on to the product presentation.
- If their turn comes up for product presentation but team has yet to clear the inspection, the next available team will move forward.

12.1 PRODUCT PRESENTATION

- Teams need to prepare a poster presentation that should include the following:
  - Introduction of the team
  - Theme and Props chosen
  - Mission that the team intends to execute
  - Technical challenges faced (if any)
  - Highlight any unconventional features of their flying platform(s)
- A maximum of **TWO (2) A1-sized posters** can be used. Slide presentation via computers/laptops/tablets/smart phones is not allowed.
- Each team will be given **TEN (10) minutes** for presentation (A maximum of **FIVE (5)** minutes to present, and **FIVE (5)** minutes for Q&A). Penalties will be given to teams that exceed the presentation time given.
- Make use of vivid imagination in providing innovative solutions for the presentation segment. The flying platform should not incorporate real-life implementations that may inflict harm on people.
- Points will be deducted for making claims that are easily refuted (no 'sci-fi' claims!). However, points will also be awarded for making realistic and relevant claims on the product. Teams are advised to do some internet study to establish if a claim is realistic and be prepared to quote sources as proof.

12.2 FINAL PRE-FLIGHT PREPARATION

- In the holding area, teams are required to power-down their flying machines and transmitters.
- Transmitters should be surrendered to the referees for quarantine.
- Flying machines will be weighed again at the start of the evaluation.
- Only the registered team members are allowed onto the flying arena when it is their turn. All spectators and waiting members are not permitted to enter.
- Teams ready to go into the demonstration will set up their flying machines. Once the previous team's flying machine powers down, the next team may then have their transmitters returned and perform a final power-on check.

12.3 MISSION DEMONSTRATION

- Teams are allocated a **20 minutes timeslot** to demonstrate their cooperative flying/unconventional platform. If teams exceed this timing, referee will call on teams to stop the demonstration.
- Teams are to keep to the mission brief that was earlier submitted as much as possible.
- The time taken to set up or move props is included within this 20-minute timeslot.
- In the event the team is unable to get their platform to take off after 10 minutes in the flying arena, the judges reserve the right to request the team to leave the flying arena for the next team. The team may or may not be allowed to re-attempt to fly, subject to the judges' decision.
- Teams are allowed to attempt their mission demonstration as many times as they want during the given timeslot. The judges will grade their performance based on their best attempt.
- In the event their flying machine(s) crashes, teams can continue from the spot where they have stopped or to restart.

- Spare flying machines may be used to reduce down-time; when the flying machine crashes, the pilot may power-on the spare machine and continue immediately while the rest of the team repairs the damaged machine.
- Teams are advised to assign specific roles for members during the demonstration: runner, repair specialist, pilot, and leader.
- Teams are encouraged to prepare a brief video (approx. 1 – 2 minutes) on their laptops that showcase a successful demonstration of their platforms. This video can be shown to judges in the event their platform fails on the competition day. However, judges will not award any "mission demonstration" scores to the team.

12.3.1 Additional Notes: Power-on restrictions and competition interference

- Only the team performing the demonstration is allowed to power-on their flying machines and transmitters. Non-compliance may lead to disqualification.
- No radio control transmitters are to be switched on within the competition area, unless permitted to do so in the Holding Area or Flying Area. If any team is found to interfere with the demonstration of other teams, they will be penalised even if found to be unintentional. Intentional interference will result in the disqualification of the team.
- The SAFMC committee takes fair-play very seriously and would like all teams to demonstrate fine sportsmanship during this competition.

12.3.2 Additional Notes: Water-damaged flying machines

- SAFMC will not be held responsible for any water damages caused to the flying machines. Teams should be aware of the tests and inherent risks before submitting their flying machines to the tests, hence all tests are presumed to be done with the team's approval and permission. At any point in time, teams may choose to abort the test in order to protect their flying machine.

- In the event that the flying machine is water-damaged, teams are allowed to use their spare flying machine to complete the challenge. However, the spare flying machine should have identical design and have very similar weight to qualify.

13. GENERAL RULES AND REGULATIONS

13.1 TEAM COMPOSITION

- Each team should consist of minimum **TWO (2)** and a maximum of **FIVE (5)** members.
- Pilots must be registered team members.
- Competition is open to public, except members and family members of the SAFMC Organising Committee.

13.2 FLYING MACHINE

- Off-the-shelf model flying machines are **not allowed** for the **unconventional** theme, unless they are significantly modified. The SAFMC Organising Committee reserves the right to disqualify teams with no modifications done to off-the-shelf flying machines. Higher scores will be given to teams which design and build their unconventional flying machines.
- Off-the-shelf model flying machines are **allowed** for the **cooperative** theme. However, the software must be significantly altered to allow the machines to gain some autonomy. Teams manually performing the cooperative task are not allowed to use off-the-shelf models.
- No dangerous goods such as firearms and flammable substances are allowed to be carried on-board the flying machine(s).
- Each team will only be judged on one set of flying machine, although the team may opt to bring along another set of identical flying machine as a backup.

- All flights are to remain within the netted flying arena.
- All platforms should allow complete manual pilot R/C over-write.
- For all teams who are attempting to use the water pool as part of their mission demonstration, propeller guards must be installed on their platforms.

13.3 WEIGHT AND DIMENSIONS

- All flying machines should not exceed **1.4m** in length in any direction.
- A maximum weight limit of **7kg** for each individual craft (inclusive of payload, if required) is imposed for safety reasons
- Payload refers to any object, including props that will be carried by the craft.
- For teams pursuing the "Co-operative" Theme, teams can use more than one craft, subject to the following:
  - Maximum number of crafts = 8
  - Maximum total weight of **all** crafts and payload(s) = 20 kg
  - Maximum weight of each individual craft = 7 kg
  - Maximum number of pilots allowed = 2
- Note that the flying arena will have a netted flying area of around **40m (L) x 20m (W) x 8m (H)**. Teams are advised to keep these limits in mind when designing their airframes.

13.4 PROPULSION SYSTEM

- Only electric flight is allowed. Both brush and brushless motors are allowed.
- No internal combustion or gasoline engines will be allowed.
- There are no limits on the number or size of engines on the flying machine.

13.5 REMOTE CONTROL (R/C) RADIO

1) Based on the Singapore Spectrum Management Handbook (Chapter 7, Issue 1 Rev 2.9, July 2017) from Infocomm Media Development Authority (IMDA) Singapore for short range devices, the following R/C frequency ranges are allocated for R/C cameras / toys / miscellaneous devices:
   - 26.96 – 27.28 MHz ≤ 100mW Effective Radiation Power (ERP)
   - 34.995 – 35.225 MHz ≤ 100mW ERP
   - 40.665 – 40.695 MHz ≤ 500mW ERP
   - 40.77 – 40.83 MHz ≤ 500mW ERP
   - 72.13 – 72.21 MHz ≤ 500mW ERP

2) The following R/C frequency ranges are allocated for R/C aircraft and gliders:
   - 26.96 - 27.28 MHz ≤ 500mW ERP
   - 29.700 - 30.000 MHz ≤ 500mW ERP

3) The organiser understands the proliferation of 2.4 GHz R/C systems and will allow its use for this competition. However, the organiser shall bear no responsibilities for any loss of control of flying machine due to radio frequency interference. The team is advised to conduct a radio control range check prior to flight.

4) In any mode of flight, the team must be able to demonstrate the failsafe capability in their R/C transmitter. All electric motors should come to a complete stop when failsafe is activated **and** when there is a loss of link between the R/C transmitter and the R/C receiver on the aircraft. Please refer to Section 12 for details on the failsafe check.

5) Please refer to the Singapore Spectrum Management Handbook on IMDA website for more details on the spectrum allocation and for the latest approved range of frequencies.

13.6 DATALINK / VIDEOLINK / OTHER WIRELESS LINK TYPES

1) The following frequencies are approved by IMDA for radio telemetry:

   - 433.05 - 434.79 MHz ≤ 10mW ERP
   - 866 - 869 MHz ≤ 500mW ERP
   - 920 - 925 ≤ 2000mW ERP

2) Wireless Wi-Fi routers will be allowed in this competition. Participants may choose to bring their own wireless routers.

3) Setup of external wireless device/s for purpose of performing autonomous flight is allowed. However, teams can only turn on their wireless routers and transmitters during the setup and flight phases (same restriction as R/C transmitters).

4) The following frequencies are approved by IMDA for wireless data communications / video transmitters / LAN:

   - 72.080, 72.200, 72.400, 72.600 MHz ≤ 1000mW ERP
   - 158.275 / 162.875 MHz ≤ 1000mW ERP
   - 158.325 / 162.925 MHz ≤ 1000mW ERP
   - 453.7250 / 458.7250 MHz ≤ 1000mW ERP
   - 453.7375 / 458.7375 MHz ≤ 1000mW ERP
   - 453.7500 / 458.7500 MHz ≤ 1000mW ERP
   - 453.7625 / 458.7625 MHz ≤ 1000mW ERP
   - 2.4000GHz - 2.4835GHz ≤ 200mW Equivalent Isotropically Radiated Power (EIRP)
   - 10.500 – 10.550 GHz ≤ 117dBμV/m @ 10m
   - 24.000 – 24.250 GHz ≤ 100mW EIRP

- 5.725GHz – 5.850 GHz ≤ 4000mW EIRP
- 5.150GHz - 5.350GHz ≤ 200mW EIRP
- 5.470GHz - 5.725GHz ≤ 1000mW EIRP
- 57 – 66 GHz ≤ 10W EIRP

5) Please refer to the Singapore Spectrum Management Handbook on IMDA website for more details on the spectrum allocation and for the latest approved range of frequencies.

13.7 GPS

- Teams are to note that the competition will be held indoor. As such, they would be operating in a GPS denied environment.

13.8 FLYING ARENA RULES

- Non-flying teams are not allowed to have any R/C transmitter (including backup) in the flying arena. No R/C transmitter is to be turned on within the flying arena, unless permitted to do so.
- Teams are only allowed into the designated Pilots' Area when it is their turn to fly.
- No charging of batteries will be allowed in the competition arena. Teams are encouraged to bring spare batteries and to ensure that all batteries are fully charged for the competition and safely stored.

SAFMC CAT E MISSION BRIEF

Team Name :

School :

Mission :

_____

_____

_____

Key Highlight :

_____

_____

_____

Parts/Concepts reused from previous SAFMC participation and changes/improvements made (if applicable) :

_____

_____

_____

(List out ALL props that will be used on the competition day, INCLUDING items stated in the challenge booklet. Include dimensions of props) :

a)
b)
c)
d)
e)
f)
g)
h)

PHOTO

(of flying platform)

SAFMC CAT E MISSION BRIEF SAMPLE

Team Name : Flying Aces

School : Singapore Amazing Institution

Mission :

A lion has escaped from its enclosure and is lurking in the zoo. Thanks to the quick dissemination of information via social media, all visitors have safely left the premise and a search-and-tranquilize mission by the Singapore Drone Regime has been activated. A swarm of drones will sweep the zoo and converge on the lion when spotted, putting it to sleep with a tranquilizer gun.

Key Highlight :

Drones will fly in formation, avoiding collision automatically. One drone will be able to shoot a ping pong ball at a designated target.

Parts/Concepts reused from previous SAFMC participation and changes/improvements made (if applicable) :

Drone hardware reused from 2018 SAFMC. Software entirely updated with formation flight logic and anti collision. New ping pong ball shooting device added.

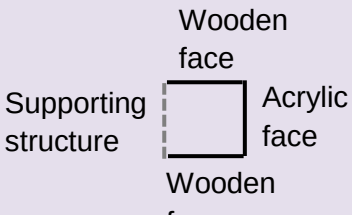
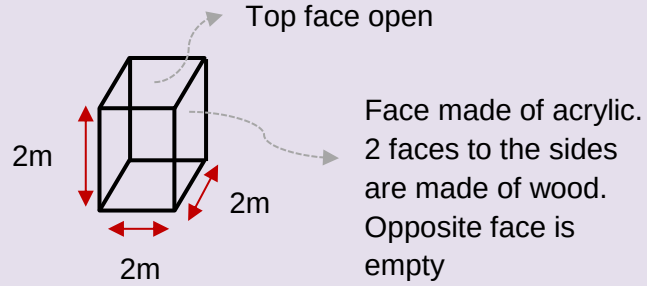
(List out <u>ALL</u> props that will be used on the competition day, <u>INCLUDING</u> items stated in the challenge booklet. Include Dimension of props) :

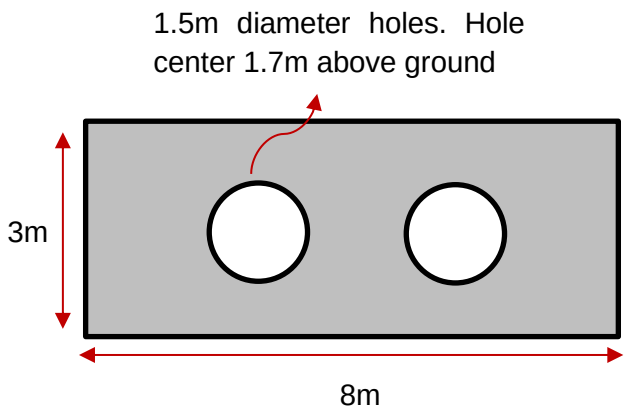
a) 3x ping pong ball
b) 5x Cardboard boxes (approx. 40cm x 30cm x 10cm)
c) 1x Small 15cm cone
d)
e)
f)
g)
h)

PHOTO

(of flying platform)

DETAILS OF THE PROPS PROVIDED

PROP	DETAILS
(A) WATER TANK	Dimensions: 2.2 m (L) X 1.1 m (W) X 0.5m (H) The water tank will be placed at one corner of the playfield and cannot be moved.
(B) SHELF	A 4 tier open shelving unit. Dimensions: 1.44m (L) X 0.5m (W) X 1.97m(H) The 4 shelves are placed at 0.16m, 0.185m, 1.35m and 1.87m height.
(C) VERTICAL SURFACES	Flat vertical surfaces that can be used to demonstrate wall climbing. Dimension per face (width x height): 2m x 2m The vertical surfaces will be placed at one side of the playfield and cannot be moved. **Top view**  

(D) VERTICAL SURFACE WITH HOLES	Dimension 8m (width) x 3m (height) with 2x 1.5m diameter holes. Wall surface will be wooden. 
(E) HOOPS	5x 1m diameter hoops.

ROUGH PROP LAYOUT