



CHALLENGE BOOKLET 2012

Jointly Organised By:



Partners:



Sponsors:



TABLE OF CONTENTS

1. SINGAPORE AMAZING FLYING MACHINE COMPETITION
(SAFMC) 2012 1

2. CATEGORY A: PAPER PLANES 6

3. CATEGORY B: UNPOWERED GLIDER..... 12

4. CATEGORY C: RADIO CONTROL FLIGHT 20

5. CATEGORY D: SEMI-AUTOMATED/AUTOMATED 27

6. CATEGORY E: UNCONVENTIONAL 40

7. IMPORTANT DATES 50

1. SINGAPORE AMAZING FLYING MACHINE COMPETITION (SAFMC) 2012

1.1. INTRODUCTION

An exciting and unique event organised by DSO National Laboratories and Science Centre Singapore, and supported by the Defence Research and Technology Office (DRTech), Ministry of Defence, the Singapore Amazing Flying Machines Competition (SAFMC) is the nation's search for a flying wonder! Opened to all schools and students who want to reach for the sky, this annual competition promises loads of fun starting with special talks, workshops and live demonstrations.

1.2. CATEGORIES

A – Primary Schools (Primary 3 onwards): Paper Planes & 2½D Planes

- Fold Origami planes (using A4 size paper) to achieve the longest flight endurance, to perform loops.
- Design and build a 2½D plane to achieve the longest flight range.

B – Integrated Programme (IP) / Secondary Schools: Unpowered Glider

- Design and build a small unpowered glider of limited wingspan to be bungee from a launcher to achieve the longest range, the best track and the optimal performance.

C – Secondary Schools / IP / Junior Colleges / Institute of Technical Education: Radio Control Flight

- Design and build a small remote-controlled air platform to fly and manoeuvre through a series of obstacles.

D – Polytechnics / Universities / Public: Automated

- Design and build a small air platform (Semi-autonomous / Fully-autonomous) capable of completing a series of tasks, identifying items and precision release of consignment.

Note:

Universities include undergraduate and post graduate. Public is ONLY allowed to participate in the **Fully-autonomous category**.

E – Open: Unconventional

- Design and build a unique and innovative air platform to perform a series of tasks.

1.3. FORMAT OF COMPETITION

After the Challenge Announcement on 29 October 2011, teams will work on the different aspects of the competition, the Challenge and the Presentation.

For the Challenge aspect, the teams are to design, build and fly their flying machines to overcome different challenges for different categories of the SAFMC events. Their flying machines will compete with one another during the challenge week.

For the Presentation aspect, besides building the flying machine, the teams are to present their flying machine design and their learning journey in this competition to a panel of judges.

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 on the final day of the SAFMC.

1.4. PRESENTATION WEEK (5 – 9 MARCH 2012)

During the presentation week, teams will be allocated a specific time slot to present about their flying machine in Science Centre Singapore. Teams will present to a panel of judges the work they have done for this competition. These teams will be assessed for a number of awards. These include:

- The Most Creative Award
- The Theory of Flight Award
- The Best Aesthetic Award
- The Best Presentation Award

The presentation session consists of the preliminary round and the final round.

During the preliminary round, teams will be allotted a specific time slot on one of the days to make their presentations to a panel of judges on the work they have done for this competition.

After the preliminary round, outstanding teams will be shortlisted for a final round of presentation. During the final round, teams will be allotted a specific time slot to make their presentations to a panel of judges; with focus to the award they are being shortlisted.

Each team is given only **TEN (10)** minutes [**FIVE (5)** minutes for presentation, **FIVE (5)** minutes for Questions & Answer session] for the preliminary and final rounds.

Presentations using laptops will not be allowed. Each team from all categories will be allowed the maximum TWO (2) A1 size posters as visual aid for their presentation. Laptops can be used as the tech-platform to showcase ONLY the flight ability of Category C, D & E flying machines entries. These teams will need to bring their own laptop. No setup time will be allocated and the team is expected to load, prepare and ready the presentation slides in the laptop before entering the presentation room.

The presentation plays an integral part for those teams who wish to vie for the SAFMC Championship Award. Teams are required to bring the flying machines that they are using in the competition for their presentation. Teams that did not bring their flying machines for the presentation will be disqualified immediately.

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

1.4.1. FOR CATEGORY A ONLY

At the allocated time slot, the team shall report to the Folding Point. At the Folding Point, SAFMC official will supply the team with the required SAFMC papers (Standard 80 GSM A4 size paper) for Origami plane segment, and the required SAFMC papers (Standard 160GSM A4 size paper) for the 2½D plane segment.

Each team is given a total of **SIXTY (60)** minutes for them to fold up to a maximum of **SIX (6)** paper planes for the various missions, **ONE (1)** 2½D plane, and **ONE (1)** additional origami plane for the Best Aesthetic Award. The seven mission-based planes will be used throughout the competition, for both the presentation and challenge rounds. The planes will be stored and quarantined in a box given by SAFMC official for the challenge rounds after the presentation. No books, manuals, note and any material related to folding instruction is allowed in the Folding Point.

1.4.2. FOR CATEGORY C, D AND E ONLY

During the presentation at the allocated time slot, the team will be assessed on the airworthiness of their constructed flying machine based on the following criteria:

Criteria	Areas of Consideration
Airworthiness	Centre of Gravity (CG) balancing Yaw control Pitch control Roll control Throttle control

1.4.3 FOR CATEGORY E ONLY

“E” here stands for EXPLORE, ENHANCE and ENTERTAIN. The spirit of Category E is to encourage participants to come up with unconventional and innovative flying air platforms; and/or have fun while doing so.

An “E-factor” which accounts for the extent contestants innovate and try out new flying concepts will be awarded during the presentation. This E-factor will affect the team’s scoring in the challenge week. More details on how the E-factor affects scoring can be found in section 6.

Teams are judged and awarded the E-factor based on the following criteria:

Criteria	Areas of Consideration
Explore	Is the flying concept totally new Has the concept been explored by previous SAFMC contestants
Enhance	To what extent the flying platform has been enhanced from existing concepts In what way flying platform achieve this enhancement – apart from increasing thrust via better engine and propellers
Entertain	Efforts and thoughts invested into impressing the audience

The values for the E-factor ranges from 0.5 to 1.0. The maximum E-factor a team can obtain is based on how much effort the team has put in to explore new concepts, or enhance existing concepts. The minimum E-factor is 0.5. More details can be found in the table below:

Concept of flying machine	Maximum E-Factor
Entirely new concept to the judges, concepts not seen or relative new in previous SAFMC	1.0
Reuse of tried and tested concept in previous SAFMC, but enhances and modifies the concept to achieve better performance	0.8
Simple reuse of concepts seen in previous SAFMC with little or no improvement.	0.6

For example : A flying platform that is merely a repeat of previous/existing ideas with little-to-no significant improvements will get a low E-factor of about 0.6. While a platform that demonstrates an entirely new concept would get about 1.

Please refer to section 6 for details on how the E-factor will affect competition scores.

1.5. CHALLENGE WEEK (12 – 16 MARCH 2012)

Teams will spend a full day at the competition venue, **Annexe Building in Science Centre Singapore** during the challenge week. They will be informed of their allocated competition day prior to the challenge week. Teams should make sure their representative contacts (Team Manager, Teacher-in-charge or someone from the team) are registered.

Each team will be assigned a booth located within the main competition hall. The booth is the team's "pit" where the team can work on their flying machines.

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

- The competition hall will open at 8am. Only registered team members of the participating teams can enter the competition hall from 8am to 6pm. There is a quarantine period in the morning and in the afternoon.
- Supporters may use a separate entrance to reach the spectator hall.
- No trial runs will be allowed on the flying areas. For categories involving wireless transmission, all transmitting devices **MUST** be surrendered to SAFMC officials. No transmitting devices, including spares, will be allowed in the competition hall.
- No team is allowed to charge batteries within the competition hall. The team is required to bring sufficient batteries for all the missions.

1.6. GENERAL RULES

- There is no limit to the number of entries from each school or organisation.
- Each member can only participate in one team within a category. However, the person can participate as 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 Categories B, C, D or E. Secondary school students are allowed to take part in Categories C, D or E.
 - Students from different schools or employees of different organisations are allowed to participate as a team. The team will be registered as 'Independent' instead of under a school or organisation. This includes graduating students from the same school who register as a team and may be posted to different schools in the following year when the competition will be held. The team will have to appoint a Team Manager, who will need to provide his/her particulars and contact details for billing during registration.
 - Only 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.
 - Cash prize will be awarded equally to each participant in the team, while the non-cash prize will be restricted to one each per participant in the team.
 - **All participants must finalise their registrations with Science Centre Singapore by 31 January 2012.**

2. CATEGORY A: PAPER PLANES

2.1. CATEGORY A CHALLENGES

(i) Origami Plane

The team is expected to fold Origami planes to achieve the longest flight endurance, and to perform loops.

(ii) 2½ D Plane

The team is expected to fold a 2½ D plane to achieve the longest flight range.

2.2. COMPETITION SETUP

Figure 2.1 shows the competition setup for Category A. The paper planes are required to perform **THREE (3)** missions, namely:

(i) Origami Planes – **TWO (2)** missions:

- Endurance – Challenge is to achieve the longest flight time.
- Acrobatics – Challenge is to achieve the most loops around a pole.

(ii) 2½ D Plane – **ONE (1)** mission:

- Range – Challenge is to achieve the longest flight range.

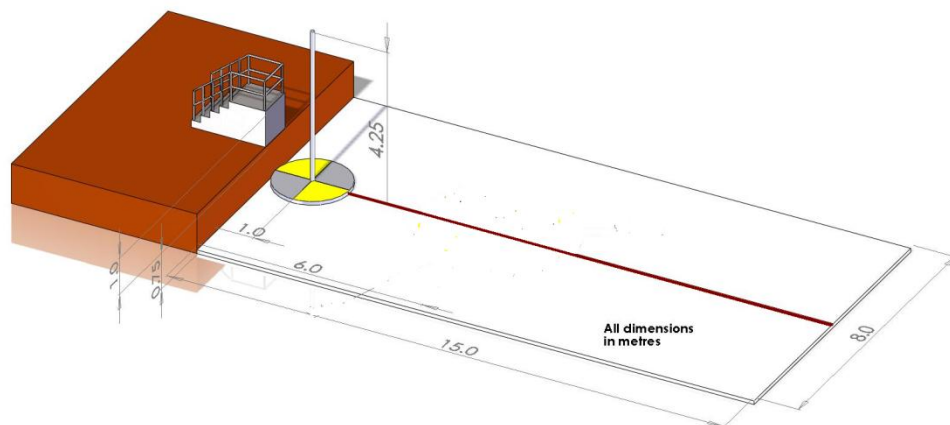


Figure 2.1: Competition Setup of Category A

2.2.1. COMPETITION ARRANGEMENT

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

- All teams shall go to a Reporting Point for allocation of their team booth and to obtain the competition schedule for their teams. The teams will also be collecting the box containing the paper planes made and quarantined during the presentation week. After the completion of the missions in the morning, the box with all the paper planes will be quarantined again during lunch time. The box will be returned back to the team after lunch for the mission in the afternoon.
- At the allocated competition schedule, the team shall report to the Inspection Point. A flying machine inspector shall check the paper planes for any violation with the category rules and regulations. After inspection, the team and their paper planes will be quarantine in the Holding Area prior to the mission.
- Each team must complete **THREE (3)** attempts for each mission during the competition. An attempt starts when the paper plane leaves the hand of the thrower. Only **ONE (1)** paper plane can be launched at each attempt. Each team is given a total of **FIVE (5)** minutes for them to perform each mission. After each attempt, the team is allowed to repair or modify the paper plane before the next attempt.
- Origami Planes can only be launched by hand unaided from a raised platform. 2½D planes can only be launched by hand unaided within a marked box. No run-up, fast walk or jump out from the raised platform as part of the launch is permitted.
- After each mission, the teams and their paper planes will return to their respective team booth.

2.3. GENERAL RULES AND REGULATIONS

- Each team consists of **TWO (2) to THREE (3)** students.
- Each team is to make **TWO (2)** identical origami planes for each mission as follows:
 - a. Endurance – longest flight time
 - b. Acrobatics – most horizontal loops around a pole
- Each team is to make **ONE (1)** 2½D plane for the mission as follows:
 - a. Range – longest flight distance

2.3.1. Origami planes will be made according to the following rules:

- a. Each origami plane is made from only one standard 80GSM A4 size paper provided by the SAFMC officials. Use of own paper is not allowed.
- b. Crayons, colour pencils, markers, double-sided tape and glue may be used, but will not be provided. No other materials are allowed.
- c. Crushed paper is not allowed as an origami plane for the competition d. Paper once cut and detached from the sheet of A4 paper, cannot be

reattached back to the origami plane by any means. This is to prevent the use of more than one sheet of A4 size paper for one origami plane.

- d. The only materials allowed on the plane are: paper, double-sided tape and glue, and colouring tools. No materials such as paper clip, pins, staples, cellophane tape etc other than those allowed can be used on the plane.

2.3.2. 2½D planes will be made according to the following rules:

- a. Each 2½ D plane is made from no more than one standard 160GSM A4 size paper provided by the SAFMC officials. Use of own paper is not allowed.
- b. Crayons, colour pencils, markers, double-sided tape and glue may be used, but will not be provided. No other materials are allowed.
- c. Only paper cut and detached from the same sheet of A4 (160gm) paper can be re-attached back to the 2½ D plane by means of double-sided tape and glue only. This is to prevent the use of more than one sheet of A4 size paper for one 2 ½ D plane.
- d. The only materials allowed on a plane are: paper, double-sided tape and glue, and colouring tools. No materials such as paper clip, pins, staples, cellophane tape etc other than those allowed can be used in a plane.

2.4. COMPETITION DAY

- No team will be allowed to step into the flying area at all times during the competition. Non-compliance may lead to disqualification.
- Teams shall make sure their representative contacts are contactable and must be present at their team booth **FIFTEEN (15)** minutes before the allocated time. Latecomers may lead to disqualification.

2.4.1. FLYING MACHINE INSPECTION

- Before each mission, a flying machine inspector will check the paper planes for compliance with the Rules and Regulations.

In the event of the paper plane fails the inspection, the team is given **FIVE (5)** minutes to rectify the problem. If the team is unable to rectify the problem within the given timeframe, that mission will be declared as void.

2.4.2. SCORING

- The endurance of the origami plane is the flight time measured from the moment the origami plane leaves the thrower's hand to the moment the origami plane first touches the floor or any other object.
- The acrobatics points are based on the number of horizontal loops the origami plane flew around a pole (counted to the nearest quarter-turn completed) before it touches the floor or any other object. Vertical loops are not allowed.
- The range points are awarded based on the distance measured from the moment the 2½D plane leaves the thrower's hand to the moment the 2½D plane first touches the floor or any other object.

-
- The referees make all scoring decisions and their decision is **FINAL**. For arbitrary cases, the Chief Referee will have the **FINAL** say.

2.5. AWARDS

The judges make all scoring decisions and their decision is **FINAL**. For arbitrary cases, the Chief Judge 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.

The winning paper planes will be displayed in Science Centre for public viewing during the Award Presentation Day on **17 March 2012**.

2.5.1. THE CHAMPIONSHIP AWARD

This is the most prestigious award that any team can win. It is bestowed on the team that embodies the spirit of SAFMC. Teams are considered for the Championship Award based on their overall excellence and total learning experience during the course of the competition.

Award	Weightage
Endurance	20%
Range	20%
Acrobatics	10%
Aesthetic	0%
Creativity	15%
Theory of Flight	20%
Presentation	15%
Total	100%

2.5.2. THE BEST ENDURANCE AWARD – PAPER PLANE

For the team whose paper plane has the best flight endurance. The flight endurance of the paper plane is the flight time measured from the moment the paper plane leaves the thrower's hand to the moment the paper plane first touches the floor or any other object. The best flight endurance score is taken from the best of the **THREE (3)** attempts.

2.5.3. THE BEST ACROBATICS AWARD – PAPER PLANE

For the team whose paper plane is able to make the most number of horizontal loops (to the nearest quarter-loops). The acrobatics points of the paper plane are awarded based on number of horizontal quarter-loops loops the paper plane flew around a pole before it touches the floor or any other object. The best acrobatics score is taken from the best of the **THREE (3)** attempts.

2.5.4. THE BEST RANGE AWARD – 2½D PAPER PLANE

For the Team whose 2½D plane has the best flight range. The flight range of the paper plane is the distance measured from the moment the 2½D plane leaves the thrower's hand to the moment the 2½D plane first touches the floor or any other object. The best flight range award score is taken from the best of the **THREE (3)** attempts.

2.5.5. THE BEST AESTHETIC AWARD

For the team whose paper plane that is the most artistically decorated. As it does not contribute to flying qualities, it does not contribute to the scoring for the Championship Award.

2.5.6. THE MOST CREATIVE AWARD

For the team that shows the most innovative and original design in their paper planes.

Criteria	Areas of Consideration
Creativity	Unique Design or Strategy Flair and Appearance Functionality

2.5.7. THE THEORY OF FLIGHT AWARD

For the team that best demonstrates a sound understanding and the appropriate application of aerodynamic design principles, as shown by their paper planes.

Criteria	Areas of Consideration
Aerodynamics	Aerodynamics Control & Stability Design and Integration

2.5.8. THE BEST PRESENTATION AWARD

For the team that best exhibit creativity, fluency, confidence and flair in the presentation of their team's work, and demonstrates that "WOW" factor during the interview sessions.

Criteria	Areas of Consideration
Presentation	Fluency Confidence Flair

3. CATEGORY B: UNPOWERED GLIDER

3.1. CATEGORY B CHALLENGE

The team is expected to design and build a small unpowered glider (of limited wingspan) to be bungee-launched from a designated launcher to compete for best range, best track and optimal performance. Teams that meet the minimum range of greater or equal to 11 metres will be invited to compete in the “Precision” round (See Para 3.5).

3.2. COMPETITION SETUP

Figure 3.2 shows the competition setup for Category B.

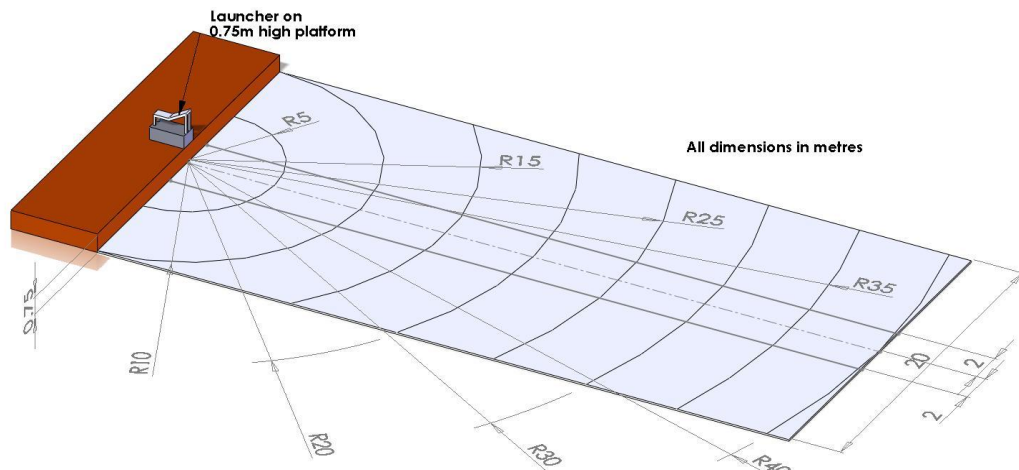


Figure 3.2: Competition Setup of Category B

3.2.1. COMPETITION ARRANGEMENT

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

- All teams shall go to the Reporting Point for allocation of their team booth and to obtain the competition schedule for their teams.
- At the allocated competition schedule, the team shall report to the Inspection Point. A flying machine inspector will check the unpowered glider for any violation with the category rules and regulations.
- The inspector will also place the unpowered glider onto the launcher (in the inspection area) to ensure that all obstructions or equivalent that might hinder the launch are removed.
- After inspection, the unpowered glider will be quarantine in a Holding Area prior to the launch of the glider. The SAFMC referee will get the teams ready for the next launch.
- During the launcher setup, the team will place the unpowered glider on the launcher via the adaptor plate. The position and orientation of the launcher will be fixed by the SAFMC officials and cannot be adjusted by the team. Each team is given a total of **THREE (3)** minutes to setup their unpowered glider on the launcher.

- Each team will only be given **TWO (2)** attempts during the competition. The attempts will not be consecutive, and will be in different sessions.
- After the launch of the unpowered glider, teams are advised to return to their respective team booth. The team is allowed to repair or make simple modification to the glider before the next attempt.
- When all competing teams had completed their two attempts, eligible teams that met a minimum range of 11 metres will be invited to compete in the “Precision” round (See Para 3.5).

3.2.2. UNPOWERED GLIDER LAUNCHER

The unpowered glider launcher prototype for the challenge is shown in Figure 3.3.

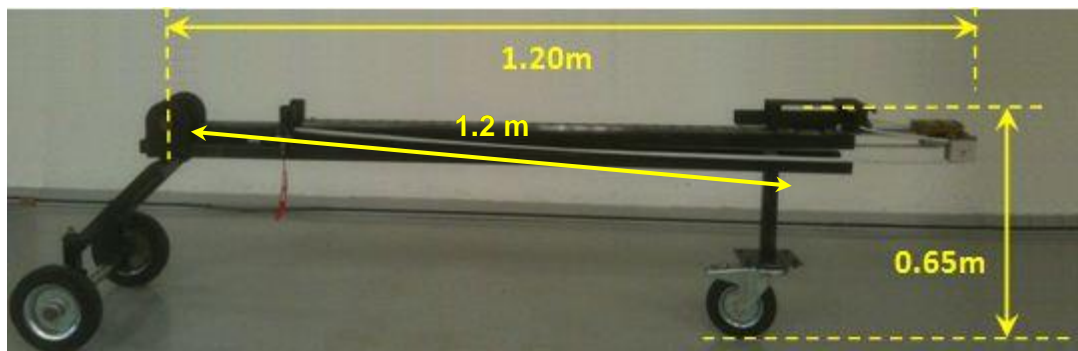


Figure 3.3: Unpowered Glider Launcher

The launcher is 1.90m (Length) x 0.50m (Width) x 0.65m (Height). The launcher will be elevated at an inclination of 0°. The launch rail distance is 1.20m long. Upon tension to the launch position, the total pulling locking force on the adaptor plate is about 10kgf. During the competition, the launcher will be placed on a 0.75 m high platform on the stage.

Each team will be given two pieces of an attachment, as shown in Figure 3.4. The weight of the attachment is approximately 20g. Additional attachment can be purchased from organiser at \$12 each. The attachment It will should be installed onto the underbelly of their glider, as illustrated in Figure 3.5. The glider will then be mounted onto the launcher via the adaptor plate for launching. The glider adapter plate is 210mm (Length) and 220mm (Width), as shown in Figure 3.6.

It is the responsibility of the team to ensure that the attachment is firmly installed on the glider and will not fall off the launcher during launching. The team must ensure that in the design of the glider, there are no components of the glider that come into contact with the launcher at any time during the launch. The teams are encouraged to do a fit check and test on the actual launcher during the launcher trials.

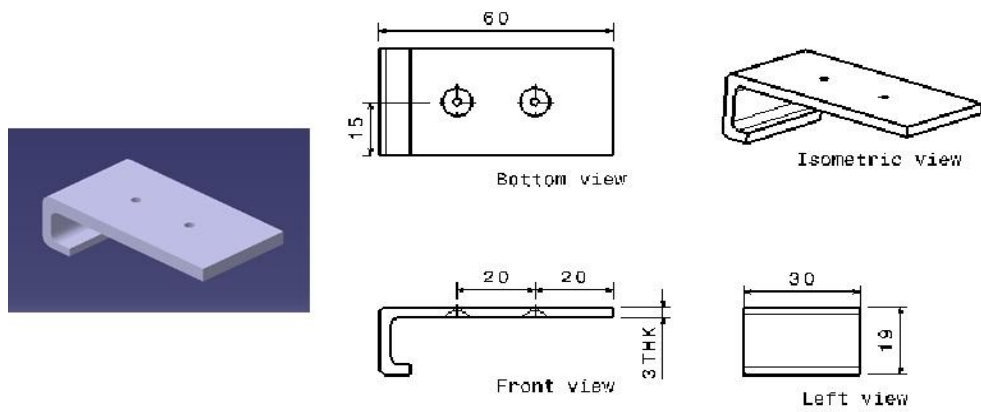


Figure 3.4: Glider Attachment (dimension in mm)

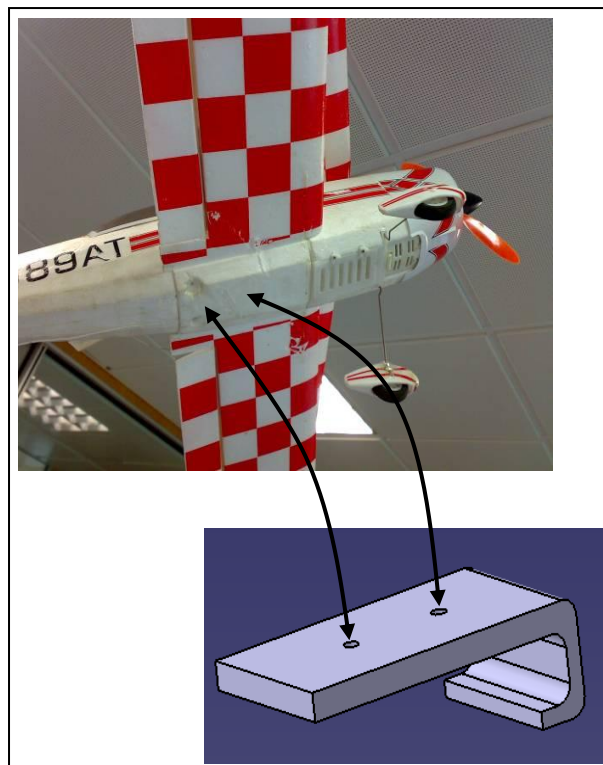


Figure 3.5: Installation of attachment



Figure 3.6: Adapter Plate

3.3. GENERAL RULES AND REGULATIONS

- Each team consists of **TWO (2) to FIVE (5)** students.
- Each team is to design and build an unpowered glider based on the following guidelines:
 - a. All parts of the glider must be fabricated by the teams. Kits or off-the-shelf models or parts, i.e. servo motor, receiver, transmitter are not allowed.
 - b. The glider must have a wing span of between 0.5m and not more than 1.0m.
 - c. The glider must be capable of being launched from a launcher via a glider attachment, which will be provided to all participating teams to be attached to the base of the glider.
 - d. No balloon and airship design will be allowed. No gaseous substance lighter than air will be allowed.
- Teams are must bring their gliders during presentation. Teams are to submit **TWO (2)** photos of sized 4R during the presentation. Teams will **NOT** be allowed to make major changes to their glider design after the presentation. Non-compliance may lead to **VOID** of presentation.
- Each participating team will be allowed to bring up to **TWO (2)** IDENTICAL gliders into the competition hall.

3.4. COMPETITION DAY

- The organiser will not be responsible for any damage to the unpowered glider throughout the competition.
- No teams will be allowed to step into the landing zone at all times during the competition. Non-compliance may lead to disqualification.
- Teams shall make sure their representative contacts are contactable and must be present at their team booth **FIFTEEN (15)** minutes before the allocated time. Latecomers may lead to disqualification.

3.4.1. FLYING MACHINE INSPECTION

- Before each launch, a flying machine inspector will weigh the unpowered glider and measure its wing span.
- The inspector will check whether the glider attachment is firmly attached to the unpowered glider, and there are no components of the glider that come into contact with the launcher.
- The inspector will also place the unpowered glider onto the launcher (in the inspection area) to ensure that all obstructions or equivalent that might hinder the launch are removed.
- In the event the flying machine fails the inspection, the team is given **FIVE (5)** minutes to rectify the problem. If the team is unable to rectify the problem within the given timeframe, that attempt will be declared as **VOID**.

3.4.2. SCORING

- After the unpowered glider is launched, the first contact of the glider with the landing zone will be the landing point (assuming the glider remains intact).
 - a. In the event that the glider hit the safety net at either sides of the landing zone prior to landing, the landing point will be at the point of contact between the glider and the safety net. If the glider flew for more than the maximum distance planned and hit the furthest safety net, the landing point will be at the point of contact between the glider and the furthest safety net.
 - b. In the event that the glider breaks into pieces or drops any loose parts during the flight:
 - The range measurement will be taken from the launcher tip to the glider or glider part contact point, whichever is the shortest.
 - The track measurement will be taken from the launcher centerline to the glider or glider part contact point, whichever is the furthest.
- A team member will accompany the referees to determine the landing point of the glider after the launch.
- The better measurements between the two attempts will be taken to vie for “The Best Range”, “The Best Track” and “Optimal Performance” awards. Teams are to note that the better measurements taken will be independent of each other, i.e., range reading can be from Attempt 1 and track reading from Attempt 2.
- The shortest distance from the launcher centre-line to the glider is measured. Participating teams are to note that no track measurement will be taken if **any** part of their glider drifts out of the track envelope of $\pm 2.00\text{m}$ from the launcher centre-line during flight. A **minimum range of 10.00m** will be required for the track distance to be recorded.

Optimal performance for each attempt (for each team) is obtained with the following equation:

OP =

$$\left(\frac{\textit{Glider Weight for the Attempt}}{\textit{Heaviest Glider for the Session}} \right) \times \left(\frac{\textit{Glider Range for the Attempt}}{\textit{Best Range for the Session}} \right) \times 100$$

Optimal performance scoring will be recorded after each of the **TWO (2)** sessions. The team with the highest value will win this award (Maximum value of 100).

The referees make all scoring decisions and their decision is **FINAL**. For arbitrary cases, the Chief Referee will have the **FINAL** say.

3.5. PRECISION ROUND

Teams with at least one attempt with range equal or above 11 metres are invited to compete in the "Precision" round to earn additional points for the overall championship award.

Points will not be deducted if eligible teams decide not to participate in this additional round.

3.5.1 COMPETITION SETUP

Eligible teams will be given two attempts to hit a single standing object placed at the 10 metre mark. The exact location of the standing object shall be decided by the judging committee on the competition day itself.

3.5.2 COMPETITION ARRANGEMENT

As per Para 3.2.1

3.5.3 LAUNCHER

The same launcher used for range and track shall be used.

3.5.4 GENERAL RULES AND REGULATIONS

Teams must adhere to Para 3.3 and the following:

- The same unpowered glider used for range and track is to be used in this "Precision" round.
- Teams are allowed to make modifications to the unpowered glider after the two attempts on range and track.
- Teams are to provide their own modification materials.
- Teams are not allowed to make two consecutive launches unless approved by the Chief Referee.
- Any contact by the unpowered glider onto the standing object after the unpowered glider has landed will NOT be considered as a "hit".

3.5.5 FLYING MACHINE INSPECTION

As per Para 3.4.1

3.5.6 PARA 3.5.5 SCORING

A "hit" shall be awarded so long as any part of the unpowered glider contacts the standing object while the unpowered glider is in flight. Teams that managed a "hit" on the first attempt will not need to conduct the second attempt.

3.5.7 The referees make all scoring decisions and their decision is FINAL. For arbitrary cases, the Chief Referee will have the FINAL say.

3.6. AWARDS

The judges make all scoring decisions and their decision is **FINAL**. For arbitrary cases, the Chief Judge 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.

The winning gliders will be displayed in Science Centre for public viewing during the Award Presentation Day on **17 March 2012**.

3.6.1. THE CHAMPIONSHIP AWARD

This is the most prestigious award that any team can win. It is bestowed on the team that embodies the spirit of SAFMC. Teams are considered for the Championship Award based on their overall excellence and total learning experience during the course of the competition.

Award	Weightage
Range	20%
Track	15%
Optimal Performance	15%
Precision	10%
Aesthetics	0%
Creativity	10%
Theory of Flight	15%
Presentation	15%
Total	100%

3.6.2. THE BEST RANGE AWARD

For the team whose unpowered glider has the furthest range. The range of the glider is the distance between the tip of the launcher and the landing point of the glider for the best attempt. In the event of a tie, the heaviest glider will win the award.

3.6.3. THE BEST TRACK AWARD

For the team whose unpowered glider has the shortest track. Track is measured by the shortest distance between the launcher centre line and the glider landing point. In the event of a tie, the glider with the best range will win the award.

3.6.4. THE OPTIMAL PERFORMANCE AWARD

For the team whose unpowered glider has the optimal performance. In the event of a tie, the heaviest glider will win the award.

3.6.5. THE BEST AESTHETIC AWARD

For the team whose flying machine that is the most artistically decorated. As it does not contribute to flying qualities, it does not contribute to the scoring for the Championship Award.

3.6.6. THE MOST CREATIVE AWARD

For the team that shows the most innovative and original design in their unpowered glider.

Criteria	Areas of Consideration
Creativity	Unique Design or Strategy Flair and Appearance Functionality

3.6.7. THE THEORY OF FLIGHT AWARD

For the team that best demonstrates a sound understanding and appropriate application of aerodynamic design principles, as shown by their unpowered glider.

Criteria	Areas of Consideration
Aerodynamics	Aerodynamics Control & Stability Design and Integration

3.6.8. THE BEST PRESENTATION AWARD

For the team that best exhibit creativity, fluency, confidence and flair in the presentation of their team's work, and demonstrates that "WOW" factor during the interview sessions.

Criteria	Areas of Consideration
Presentation	Fluency Confidence Flair

4. CATEGORY C: RADIO CONTROL FLIGHT

4.1. CATEGORY C CHALLENGE

The team is expected to design and build its own radio-controlled fixed wing plane or kite plane to fly and manoeuvre through a series of obstacles.

4.2. COMPETITION SETUP

Figure 4.1 shows the competition setup for Category C. The runway area is 3m x 4m while the pilot's area is 40m x 1.2m.

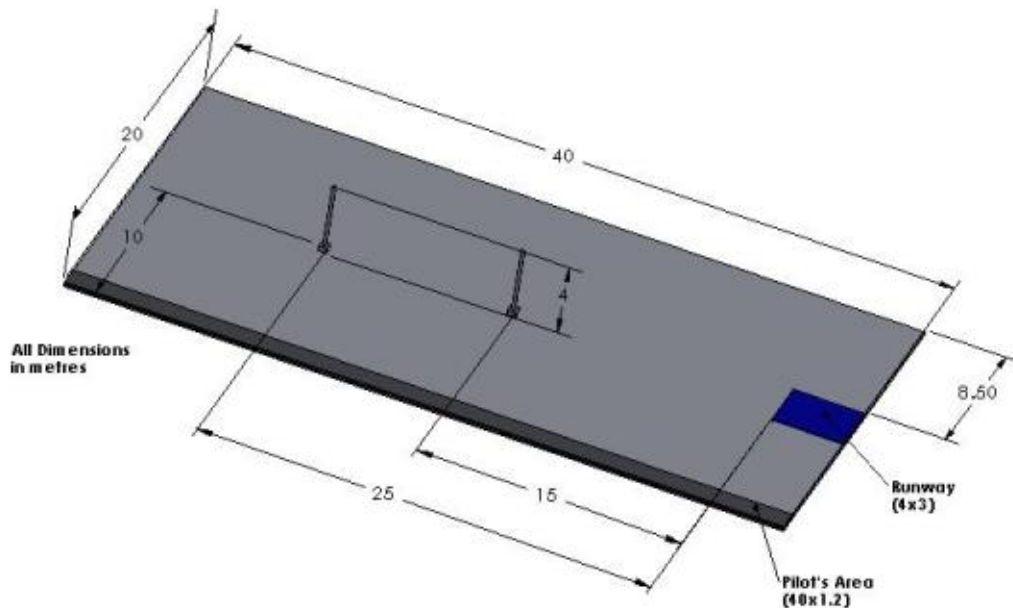


Figure 4.1: Competition Setup of Category C

The fixed wing plane or kite plane is required to perform **TWO (2)** missions. The team has to demonstrate to SAFMC official adequate fulfillment of the Basic Mission in order to qualify for the Detail Mission.

A. Basic Mission

- a. Take off from the designated runway (4m x 3m) area.
- b. Fly around.
- c. Land back onto the same runway area successfully.

B. Detail Mission

- a. Take off from the designated runway (4m x 3m) area
- b. Figure of 8 – Challenge is to fly in between the two vertical poles and perform as many figure-of-eight by flying round the two poles.
- c. Land back onto the same runway area successfully.

4.2.1. COMPETITION ARRANGEMENT

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

- All teams shall go to a Reporting Point for allocation of their team booth as well as the competition schedule for their teams. The team shall

surrender the radio control transmitter of the flying machine and will be placed in a box provided by SAFMC to be quarantined at the Storage Point.

- At the allocated competition schedule, the team shall report to the Inspection Point. A flying machine inspector will check the flying machine for any violation with the category rules and regulations. The box with the transmitter will be handed over to the team if the inspection is successful. After inspection, the flying machine will be quarantined in a Holding Area prior to the mission attempt.
- At the Holding Area, as long as the frequency does not clash with frequency of the flying machine inside the flying area, the SAFMC referee will hand over the transmitter back to the team to conduct Airworthiness and Failsafe check on the flying machine. The team is also given a total of **THREE (3)** minutes for the final adjustment on the flying machine prior to mission, after which the transmitter will be switched off and quarantined in the box again.
- Prior to the mission, the radio control transmitter will be handed back to the team. Each team is given a total of **ONE (1)** minute to setup their flying machine inside the flying area.
- Team must setup failsafe capability in the R/C transmitter. The team must inform Chief Referee of the location of the failsafe switch. When failsafe is activated, the electric motor shall switch off. The failsafe capability will be demonstrated in the holding area prior to actual flight.
- For the Basic Mission, a total of **TWO (2)** attempts will be given to the team. The team is given **TWO (2)** minutes to complete each attempt. The start of an attempt is defined as the ability of the flying machine to perform rolling takeoff from the runway area. The completion of the attempt is defined as:
 - a. when the flying machine lands back on the runway, or
 - b. touches the floor of the flying field and cannot take-off again, or
 - c. hits the safety net and cannot resume flight, or
 - d. exceeds **TWO (2)** minutes flight time.
- For the Detail Mission, a total of **TWO (2)** attempts will be given to the team. The team is given **THREE (3)** minutes to complete each attempt. The start of an attempt is defined as the ability of the flying machine to perform rolling takeoff from the runway area. The completion of the attempt is defined as:
 - a. when the flying machine lands back on the runway, or
 - b. touches the floor of the flying field and could not take-off again, or
 - c. hits the safety net and could not resume flight, or
 - d. exceeds **THREE (3)** minutes flight time.
- Once the time limit is up, the pilot will have to land their aircraft regardless of whether they have completed. Time taken to clear circuit will be recorded as a yardstick for judges to decide a winner in the event of a tie-situation.
- No repairs are allowed within the given attempt.

-
- At the end of each attempt, the radio control transmitter of the flying machine will be immediately switched off, placed back into the box and surrendered to the SAFMC referee
 - After the completion of the first attempt, teams are advised to return to their respective team booth before their next attempt. The team is allowed to repair or make modification to the flying machine without the transmitter in preparation for the next attempt.

4.3. GENERAL RULES AND REGULATIONS

- Each team consists of **TWO (2) to FIVE (5)** students.
- Each team is to design and build a radio-controlled flying machine based on the following guidelines:
 - a. Most parts of the fixed wing plane or kite plane must be fabricated by the teams. No kits or off-the-shelf flying models are allowed.
 - b. The fixed wing plane or kite plane must be radio controlled by off-the-shelf radio systems.
 - c. Only electric flight is allowed. Both brush and brushless motors are allowed. No modification to the motors is allowed.
 - d. No internal combustion or gasoline engines will be allowed.
 - e. Teams are strongly encouraged to bring their fixed wing plane or kite plane during presentation and show a short video clip of their model plane flying capability. Teams are to submit **TWO (2)** photos of sized 4R during the presentation. Teams will **NOT** be allowed to make major changes to their flying machine after the presentation. Non-compliance may lead to **VOID** of presentation.
 - f. Each participating team will be allowed to bring up to **TWO (2)** IDENTICAL fixed wing plane or kite plane into the competition hall.

4.3.1. RULES ON FIXED WING PLANE OR KITE PLANE

Physical

- a. No Vertical Takeoff Landing (VTOL) flying machine is allowed. All flying machines must conduct rolling takeoff at designated runway area on the flying field.
- b. Minimum Dimensions: Length (400mm) x Width (500mm)
- c. Maximum Dimension : Height (500mm)
- d. The flying machine must not exceed a maximum all-up weight (AUW) of 500 grams.

Battery

- a. There is no limit on the number of batteries used, in series or parallel.
- b. Only Lithium Polymer (Li-Po), Nickel Metal Hydride (Ni-MH) or Nickel Cadmium (Ni-Cd) batteries is allowed.

R/C Radio

- a. Based on guidelines from Infocomm Development Authority of Singapore (IDA), the following R/C frequency ranges are recommended: **29.700 – 30.000MHz**
- b. The organiser understands the proliferation of 2.4GHz 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.
- c. Team must register their R/C frequency with SAFMC officials prior to the challenge week.
- d. Team must be able to demonstrate the failsafe capability in their R/C transmitter. When failsafe is activated or when there is a loss of link between the R/C transmitter and the R/C receiver on the aircraft (demonstrated by switching off the transmitter), the electric motor must be switched off. The Chief Referee and Safety Officers reserve the rights to request the R/C pilot to activate failsafe if they deemed the fixed wing plane or kite plane is uncontrollable in flight and poses safety concerns.

Speed Controller

- a. Only Electronic Speed Controller is allowed.

Servo

- a. Only standard R/C servos are allowed. There is no limit on the number of servos used.

4.4. COMPETITION DAY

- The organiser will not be responsible for any damage to the flying machine throughout the competition.
- No team is allowed to have any radio control transmitter (including backup) in the competition hall. All radio control transmitters are to be surrendered to the referee. Non-compliance may lead to disqualification.
- No radio control transmitter is to be turned on within the competition hall, unless permitted to do so in the Holding and Flying Area. Non-compliance may lead to disqualification.
- No team is allowed to charge batteries within the competition hall. Non-compliance may lead to disqualification.
- Teams shall make sure their representative contacts are contactable and must be present at their team booth **FIFTEEN (15)** minutes before the allocated time. Latecomers may lead to disqualification.
- The pilot is **ONLY** allowed to walk in the designated Pilot's Area when piloting.

4.4.1. FLYING MACHINE INSPECTION

- Before each launch, a flying machine inspector will take dimensions and weigh the flying machine.
- In the event the fixed wing plane or kite plane fails the inspection, the team is given **THREE (3)** minutes to rectify the problem. If the team is unable to rectify the problem within the given timeframe, that attempt will be declared as **VOID**.

4.4.2. SCORING

- Scores will be awarded to the team based on the sum of all points allocated to tasks successfully completed by the flying machine during the flying circuit in each attempt. There will be a PENALTY of **FIVE (5)** points for each touch (anywhere) in the flying area.

Flying Tasks	Allocated Points
Basic Mission	
Proper take-off from the runway area	5 points
Proper landing on the runway area	5 points
Detail Mission	
Proper take-off from the runway area	5 points
Fly around structure 1 (S1)	10 points
Fly around structure 2 (S2)	10 points
Proper landing on the runway area	5 points
No of complete "8 shapes" routine flight	1 point per cycle (a maximum of 15 cycles)
Touch penalty	Deduct 5 points
Score	Total of allocated points and penalty (Lowest score is zero)

The better score between the two attempts will be taken to vie for the "Best Performance Award".

The referees make all scoring decisions and their decision is **FINAL**. For arbitrary cases, the Chief Referee will have the **FINAL** say.

4.5. AWARDS

The judges make all scoring decisions and their decision is **FINAL**. For arbitrary cases, the Chief Judge 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.

The winning flying machine will be displayed in Science Centre for public viewing during the Award Presentation Day on **17 March 2012**.

4.5.1. THE CHAMPIONSHIP AWARD

This is the most prestigious award that any team can win. It is bestowed on the team that embodies the spirit of SAFMC. Teams are considered for the Championship Award based on their overall excellence and total learning experience during the course of the competition.

Individual Category	Weightage
Performance	55%
Aesthetic	0%
Creativity	10%
Theory of Flight	20%
Presentation	15%
Total	100%

4.5.2. THE BEST PERFORMANCE AWARD

For the team whose flying machine has the highest performance points in their best attempt.

4.5.3. THE BEST AESTHETIC AWARD

For the team whose flying machine that is the most artistically decorated. As it does not contribute to flying qualities, it does not contribute to the scoring for the Championship Award.

4.5.4. THE MOST CREATIVE AWARD

For the team that shows the most innovative and original design in their flying machine.

Criteria	Areas of Consideration
Creativity	Unique Design or Strategy Flair and Appearance Functionality

4.5.5. THE THEORY OF FLIGHT AWARD

For the team that best demonstrates a sound understanding and appropriate application of aerodynamic design principles, as shown by their flying machine.

Criteria	Areas of Consideration
Flying Machine Design	Aerodynamics Control & Stability Design and Integration
Airworthiness	Centre of Gravity (CG) balancing Yaw control Pitch control Roll control Throttle control

4.5.6. THE BEST PRESENTATION AWARD

For the team that best exhibit creativity, fluency, confidence and flair in the presentation of their team's work, and demonstrates that "WOW" factor during the interview sessions.

Criteria	Areas of Consideration
Presentation	Fluency Confidence Flair

5. CATEGORY D: SEMI-AUTOMATED/AUTOMATED

5.1. CATEGORY D CHALLENGE

Teams will be required to design and build a small flying machine (semi-autonomous / fully autonomous) or modify or enhance a commercial-off-the-shelf product (COTS product that is capable to flying in either semi-autonomous or fully autonomous) that is capable of completing a series of tasks in a complex environment.

Note: For teams modifying or enhancing a COTS product, the machine **MUST** be able to hold and release the designated payload (a ball).

5.2. COMPETITION SETUP

Figure 5.1 shows the competition setup for Category D

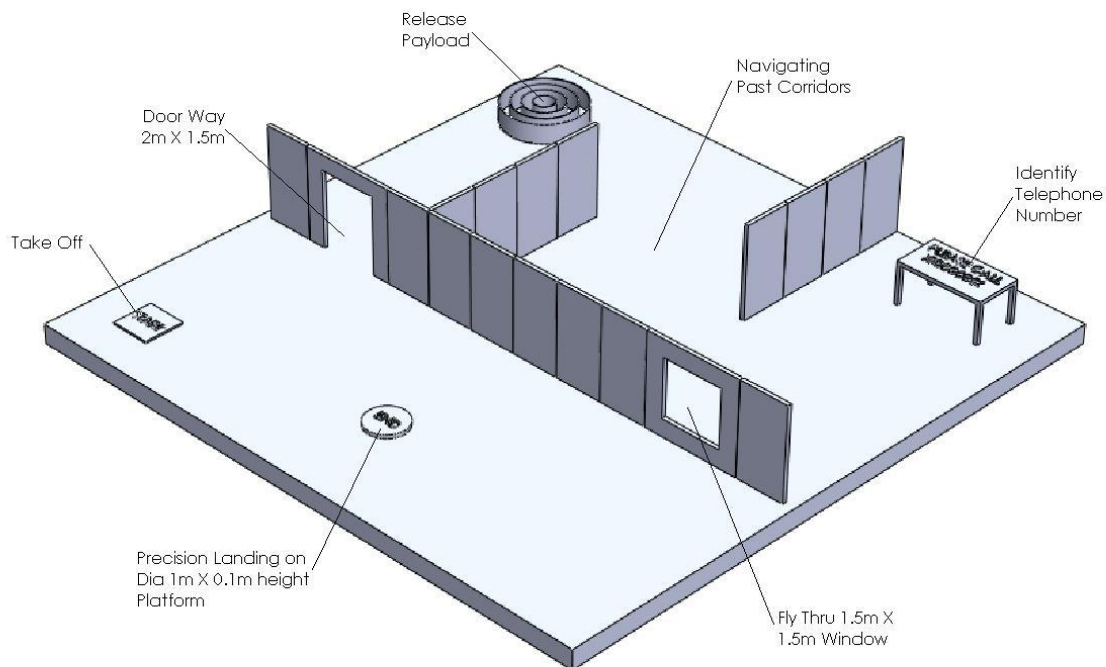


Figure 5.1: Competition Setup of Category D (Isometric View)

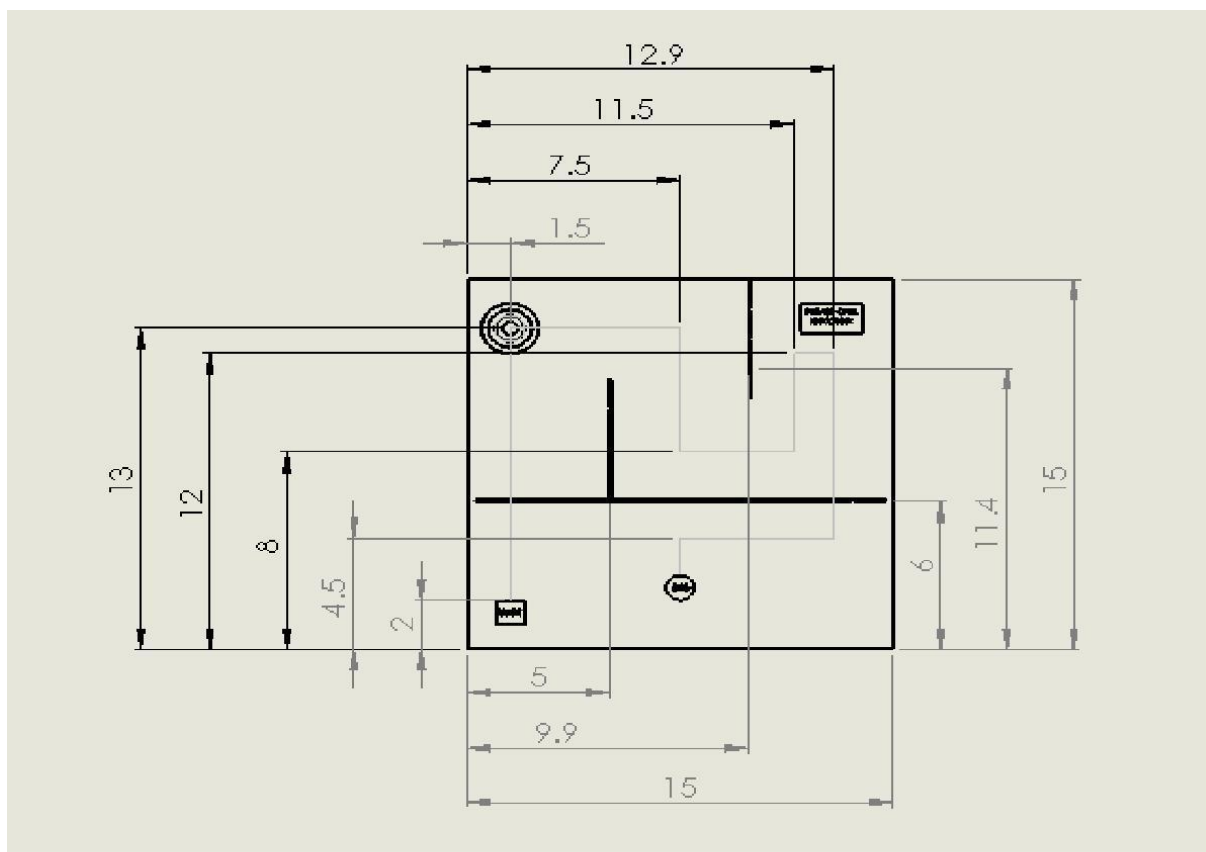


Figure 5.2: Competition Setup of Category D (Plan View, measurement in metres)

The flying machine is required to perform **SEVEN (7)** tasks, namely:

- **Take off** - Challenge is to perform take-off from the designated area.
- **Enter Doorway** - Challenge is to enter an approximate 2m (Height) x 1.5m (Width) doorway.
- **Release payload** - Challenge is to release a payload during flight on a target with 4 rings as shown in Figure 5.3 with vertical walls at radius of approximate 0.25m, 0.5m, 0.75m and 1 m from the centre. The height of the walls is approximate 0.5m. The air vehicle must be airborne at all times. The payload is a ball of diameter approximate 50mm and weighs around 20 grams. It will be provided to the team prior to the Challenge. Additional payload can be purchased from organiser at \$2 each.
- **Navigating past the corridors** – Challenge is to navigate through the partition walls (approximate 2.4 meter high)
- **Identify telephone number** - Challenge is to identify **EIGHT (8)** numbers in correct sequence placed on the table. As a guideline, the visual system should be able to pan downwards to at least 11° from the vertical. The air vehicle must be airborne at all times.

- **Fly Through Window** - Challenge is to fly through an approximate 1.5m (Height) x 1.5m (Width) window.
- **Precision Landing** - Challenge is to perform precision landing within a given space, denoted by a circle with a green border. The centre of the aircraft, as designated by the team, must be within the circle to receive points for precision landing; however, it is not required to fit the whole UAV within the circle. The diameter is approximate 1m.

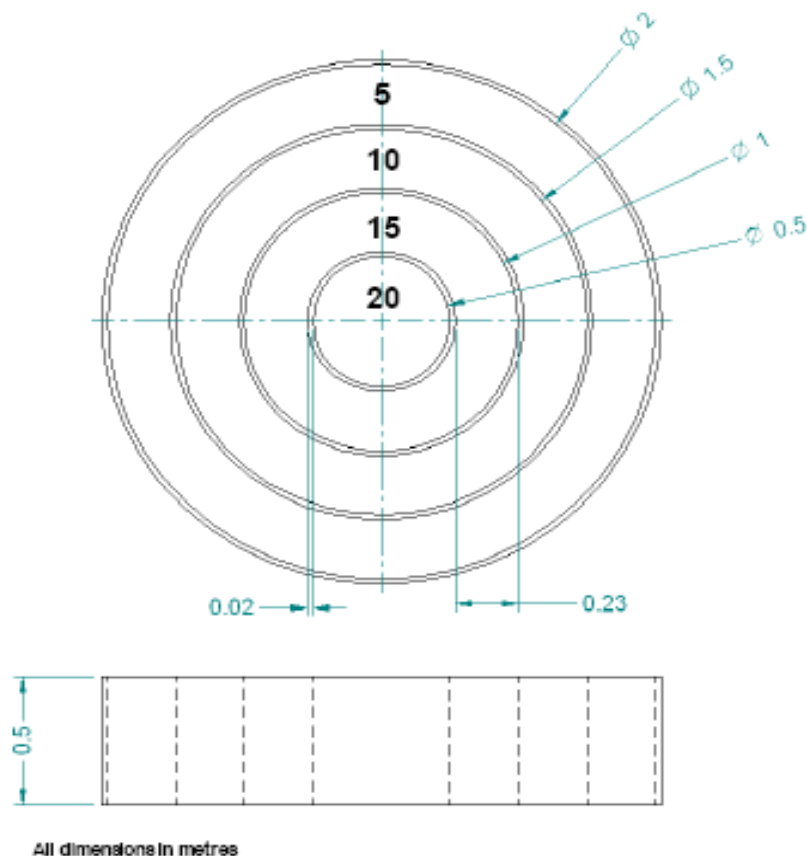


Figure 5.3: Dimensions of the Target Setup

5.3. COMPETITION ARRANGEMENT

5.3.1. PRESENTATION SEGMENT

There will be a **competition segment** and a **presentation segment**. During the presentation segment, teams are required to:

- Submit **TWO (2)** photos of sized 4R during the presentation.
- Declare their mode of flight (semi-autonomous / autonomous).
- Bring the actual flying machines for a visual inspection.

-
- d. Prepare a video presentation clearly showing that the platform is flight capable.
 - e. Prepare an oral presentation describing the platform's
 - Size, form factor
 - Mechanical design and aesthetical design
 - Aerodynamic design
 - Electronics design (i.e.: explaining choice of sensors)
 - Software design, in particular describing how their proposed semi autonomous / autonomous concept will work.

Teams will **NOT** be allowed to make major changes to their flying machine design after the presentation. Non compliance may lead to **VOIDANCE** of the presentation.

Note: For autonomous flight, the team need to inform the judges what kind of external aids (such as markers, indicators, etc) they will be using inside the race course to perform autonomous flight. The used external aids is subjected to the approval by the organising committee / judges

5.3.2. COMPETITION SEGMENT

Teams shall be expected to comply with the following during the competition segment:

- All teams shall go to a Reporting Point for allocation of their team booth as well as the competition schedule for their teams. The team shall surrender the radio control transmitter, datalink transceiver, video receiver and any other wireless device used to communicate with the flying machine and will be placed in a box provided by SAFMC to be quarantined at the Storage Point. If the video transmitter on the aircraft (or a camera with an integrated transmitter) is powered through a separate battery, this battery (and any other spare batteries) shall also be placed in the box and quarantined at the Storage Point.
- At the allocated competition schedule, the team shall report to the Inspection Point. A flying machine inspector will check the flying machine for any violation with the category rules and regulations. The box with the transmitter and all wireless system will be handed over to the team if the inspection is successful.
- The box will remain sealed and shall not be opened by the team. After inspection, the flying machine will be quarantined in a Holding Area prior to the mission attempt.
- At the Holding Area, as long as the frequency does not clash with frequency of the flying machine inside the flying area, the SAFMC referee will only hand over the transmitter back to the team to conduct Airworthiness and Failsafe check on the flying machine. The team is also given a total of **THREE (3)** minutes for the final adjustment on the flying machine prior to mission, after which the transmitter will be switched off and quarantined in the box again.
- Prior to the mission, the radio control transmitter, datalink transceiver, video receiver and any other wireless device for the flying machine will be handed back to the team. Each team is given a total of **FIVE (5)** minutes to setup their flying machine inside the flying area.

-
- Team must setup failsafe capability in the R/C transmitter. The team must inform Chief Referee of the location of the failsafe switch. When failsafe is activated or when there is a loss of link between the R/C transmitter and the R/C receiver on the aircraft (demonstrated by switching off the transmitter), the electric motor shall switch off. The failsafe capability will be demonstrated in the holding area prior to actual flight.
 - Each team will only be given **TWO (2)** attempts during the competition and a total of **TEN (10)** minutes per attempt to perform the mission. The **TEN (10)** minutes start after a maximum of **FIVE (5)** minutes setup time, regardless of whether the setup has been completed. Any extra setup time needed will be accounted for as part of the **TEN (10)** minutes mission time. Once the time limit is up, the pilot will have to land their aircraft regardless of whether they have completed. Time taken to clear circuit will be recorded as a yardstick for judges to decide a winner in the event of a tie-situation.
 - The team are allowed to repair their flying machine if it crashes during the flight. However, the repair time will be accounted for as part of the **TEN (10)** minutes mission time. After the repair, the team may: continue on its circuit if there are still flight time available, or terminate the flight and scores given before the crash will be used to determine the final score for that attempt.
 - At the end of each attempt, the radio control transmitter, datalink transceiver, video receiver and any other wireless device for the flying machine will be switched off, placed back into the box and surrendered to the SAFMC referee.
 - After the completion of the first attempt, teams are advised to return to their respective team booth before their next attempt. The team is allowed to repair or make modification to the flying machine without the transmitter in preparation for the next attempt.
 - For autonomous flight, the team is allowed to place any amount of external aids such as markers, indicators, etc (the used external aids is subjected to the approval by the organising committee) inside the race course during the **allocated setup time** to aid / guide their flying machine to perform autonomous flight.

5.4. GENERAL RULES AND REGULATIONS

- Each team shall be comprised of **TWO (2)** to **FIVE (5)** people.
- Each team is to design and build a radio controlled flying machine based on the following guidelines:
 - a. Off-the-shelf products and components are allowed in the competition. However, the team will need to demonstrate certain level of system integration.
 - b. For safety consideration, total **weight of flying machine cannot exceed 1.5kg** (including payload).
 - c. The flying machine must be able to be radio controlled by off-the-shelf radio systems.
 - d. The flying machine must carry a video transmitter.
 - e. Only electric flight is allowed. Both brush and brushless motors are allowed. No modification to the motors is allowed.
 - f. No internal combustion or gasoline engines will be allowed.

g. No tethering or umbilical wires are allowed during flight.

5.4.1. The participating team must choose one of the following modes of flight:

- a. Semi – autonomous flight
- b. Autonomous flight

5.4.2. Semi-autonomous or flight control module is defined as the ability of the flying machine to:

- a. Perform flight stabilization through feedback and/or feed forward control
- b. Reduce response errors when given reference commands, and
- c. Improve response time to flight commands

The pilot on the ground may only provide reference commands (i.e.: MEMs, altitude, velocity and heading commands, or forward, backward, left and right commands) to manoeuvre the platform. The pilot may not control the flying machine using lower level commands (i.e.: elevator, rudder, aileron, throttle commands) sent either directly to the flight actuators, or to the on board servo mixer. RC take-off and landing are allowed in the semi-autonomous mode. **The pilot is expected to fly by video from their video transmitter when clearing the obstacle course at the assigned location.**

5.4.3. Autonomous is defined as the capability of the platform to:

- a. Read and process sensor information (cameras, ultrasound, , etc) to arrive at a decision to guide the platform. The decision making process should be in the form of an algorithm implemented onboard the platform's flight computer or electronics.
- b. The decision should be in the form of a reference command which is sent to the platform's flight control module, and not sent directly to the platform's actuators.
- c. External aids such as markers, indicators, etc (the used external aids is subjected to the approval by the organising committee) are allowed to be use to aid or guide the flying machine to perform autonomous flight.

RC take-off and landing are allowed in the autonomous mode. However, no points will be given for RC take-off and landing. The pilot needs to inform and demonstrate to the judges that they are switching from RC mode to autonomous mode after the take-off. Note that clearing of obstacles has to be only in **AUTONOMOUS** mode.

5.4.4. Teams may choose to demonstrate the innovative use of Man Machine Interaction (MMI) concepts and tools (i.e.: use of laptops as a ground control station, use of Wii controllers, voice commands, etc). Points will be given for the team's ability to demonstrate:

- Intuitive control of their flying machine
- Improved situational awareness of the RC pilot with their MMI tools

5.5. RULES ON FLYING MACHINE

Avionics System

- a. There is no limit on the number of gyros used in the flying machine.
- b. There is no limit on the number of onboard flight computers used in the flying machine.

Battery

- a. There is no limit on the number of batteries used, in series or parallel.
- b. Only Lithium Polymer (Li-Po), Nickel Metal Hydride (Ni-MH) or Nickel Cadmium (Ni-Cd) batteries is allowed.

R/C Radio

- a. Based on guidelines from Infocomm Development Authority of Singapore (IDA), the following R/C frequency ranges are recommended: **26.96 - 27.28 MHz** and **29.700 - 30.000 MHz**.
- b. 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.
- c. Team must register their R/C frequency with SAFMC officials prior to the challenge week.
- d. In any mode of flight, the team must be able to demonstrate the failsafe capability in their R/C transmitter. The electric motor must switch off when failsafe is activated or when there is a loss of link between the R/C transmitter and the R/C receiver on the aircraft. The Chief Referee and Safety Officers reserve the rights to request the R/C pilot to activate failsafe if they deemed the flying machine is uncontrollable in flight and poses safety concerns.

Datalink

- a. Only the RF frequencies the following frequency ranges are allowed for datalink:
433.05 - 434.79MHz @ 10mW Effective Radiation Power (e.r.p.),
2.4000GHz - 2.4835GHz @ 200mW e.r.p.
5.150GHz - 5.350GHz @ 200mW e.r.p.
- b. Team must register their datalink frequency and e.r.p. with SAFMC officials prior to the challenge week.

Videolink

- a. Only the RF frequencies the following frequency ranges are allowed for videolink:
26.96 – 27.28 MHz @ 100mW e.r.p.
34.995 – 35.225 MHz @ 100mW e.r.p.
40.665 – 40.695 MHz @ 500mW e.r.p.

40.77 – 40.83 MHz @ 500mW e.r.p.
72.13 – 72.21 MHz @ 500mW e.r.p.
2.4000GHz 2.4835GHz @ 200mW e.r.p.

- b. Team must register their videolink frequency and e.r.p. with SAFMC officials prior to the challenge week.

Sensors

- a. Teams seeking to use off-board sensors must get permission to do so from the challenge officials. Otherwise, all sensors should be on the aircraft.

Other wireless link types

- a. Wireless wifi routers will be allowed in this competition. Participants may choose to bring their own wireless routers, or use one that will be provided.
b. Allow setup of external wireless device/s for purpose of performing autonomous flight.

5.6. COMPETITION DAY

- The organizer will not be responsible for any damage to the flying machine throughout the competition.
- No team is allowed to have any radio control transmitter, datalink transceiver and video receiver (including backup) in the competition hall. All radio control transmitters, datalink transmitters and video receivers are to be surrendered to the referee. Non-compliance may lead to disqualification.
- No radio control transmitter, datalink transmitter and video transmitter and receiver are to be turned on within the competition hall, unless permitted to do so in the Holding and Flying Area. Non-compliance may lead to disqualification.
- **No team is allowed to charge batteries within the competition hall.** Non-compliance may lead to disqualification.
- Teams shall make sure their representative contacts are contactable and must be present at their team booth **FIFTEEN (15)** minutes before the allocated time. Latecomers may be disqualified.

In both modes, the pilot must be stationed at the designated Pilot's Area when piloting the aircraft. All other team members will be stationed outside the arena. The pilot's area is also out of the arena. Only one other team mate is allowed to aid the pilot in completing the obstacles. No other team members are allowed to communicate with the pilot. Any violation of the rules will result in penalties. .

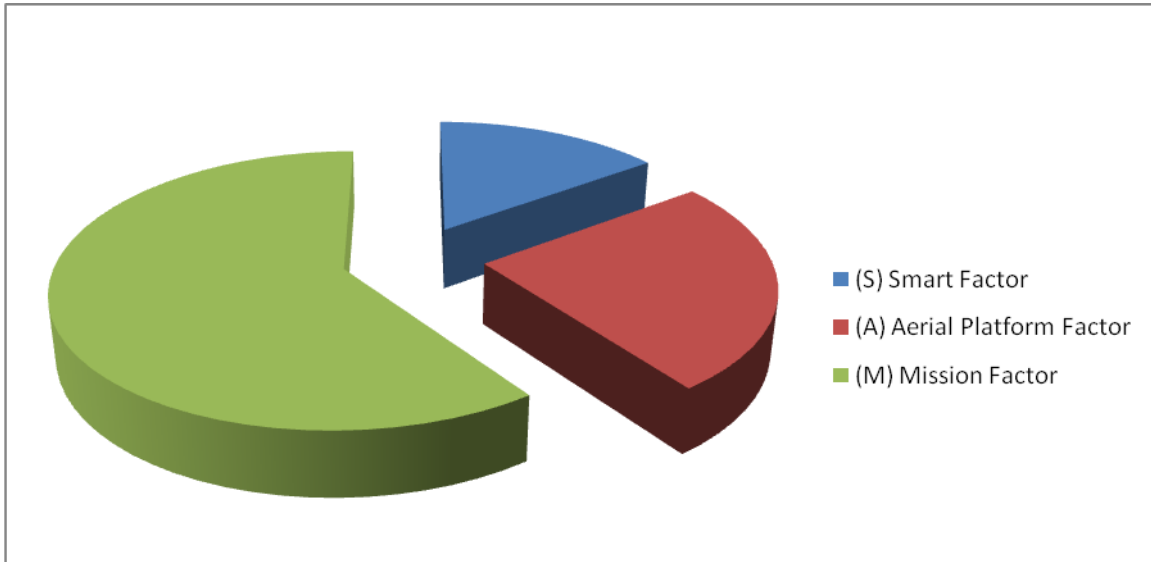
5.6.1. FLYING MACHINE INSPECTION

- Before each launch, a flying machine inspector will check the flying machine for compliance with Rules and Regulations.
- The flying machine inspector will check the weight and condition of the SAFMC supplied payload. The payload may be replaced with a new one if it differs too much from the SAFMC supplied payload. The payload **MUST** be carried on the vehicle, regardless of whether an attempt will be made to clear the release payload challenge.

- In the event the flying machine fails the inspection, the team is given FIVE (5) minutes to rectify the problem. If the team is unable to rectify the problem within the given timeframe, that attempt will be declared as **VOID**.

5.6.2. SCORING

There are a total of **Three (3)** scoring components, and each of the scoring components (S, A, F, M) will have a value of maximum 100 points each.



The total score (T) is the addition of individual scoring components comprising the Smart factor (S), Aerial platform factor (A), Mission accomplish factor (M):

$$T = S \times 0.15 + A \times 0.25 + M \times 0.60$$

The weightage of the scoring components are listed as follows:

Factor Name	Percentage Weightage
Smart Factor	15% weightage
Aerial Platform Factor	25 % weightage
Mission Accomplished Factor	60 % weightage
Total	100%

So, if (for example) a team scores 80 points for the “Aerial Platform” factor. That score will be normalized to 80 points x 25 % of the total = 20 marks towards the total score.

- The **Smart factor (S)** is a measure of the team’s ability to leverage on MMI tools and concepts, Teams are not required to implement this; however doing so will score additional points. Scoring will take place over the course of the presentation segment and the competition segment. Criteria for scoring are as follows:

Control inputs to platform	Displaying telemetry information to pilot
- Innovative approaches to controlling the platform and onboard camera,	- Able to demonstrate a more effective means of communicating information

<p>resulting in more intuitive control.</p> <p>- Overall reduction of the pilot's workload (ie: able to control the platform using 1 button rather than 10 buttons)</p>	<p>to the pilot, improving situational awareness.</p>
---	---

- The **Aerial platform factor (A)** will be awarded based on the ability of the teams to demonstrate the following:
 - i. Mechanical and aesthetical design
 - a. Quality of fabrication, workmanship
 - b. Platform weight
 - c. Lower points for usage of commercial off the shelf products
 - ii. Aerodynamic design
 - a. Center of gravity placement
 - b. Design factors affecting platform's flight stability, responsiveness and controllability
 - iii. Electronics design
 - a. To explain choice of sensor suite for the given environment
 - b. To explain choice of embedded computer / microprocessor
 - iv. Software design, in particular describing how their proposed semi-autonomous / autonomous concept will work.
 - a. To explain effectiveness of semi-autonomy/ flight control strategy
 - b. To explain how semi-autonomy design was translated into software
 - c. To explain effectiveness of autonomy strategy
 - d. To explain how autonomous design was translated into software
 - e. Lower points will be given for unreferenced use of open-source code. Teams should reference the use of open source codes where it is used.

Scoring will take place over the course of the presentation segment and the competition segment

- The **Mission Accomplished factor (M)** will be awarded to the team based on the sum of all points allocated to tasks successfully completed by the flying machine during the flying circuit. The best total score of two attempts will be taken to vie for the Best Performance Award.

Flying Tasks	Allocated Points
Takeoff from the runway	10 points.
Enter the doorway	15 points for successful flying through the doorway. 5 Points will be deducted for any collision around the doorway.
Precision Drop of payload	0, 5, 10, 15 or 20 points will be allocated based on the final position of the payload within the target patch
Navigating past the corridors	Maximum 10 points. -2 points per collision against the walls, capped at -6. Minimum of 4 points awarded for successfully navigating past all the corridors regardless of number of collisions.

	No point will be given if you skip / fly over this obstacle
Identify telephone number	All numbers: 15. Seven numbers: 14. Six numbers: 12. Five numbers: 10. Four numbers: 8. Three numbers: 6. Two numbers: 4. One numbers: 2. No number: 0. All numbers must be identified in the correct sequence. Team member have to read out to the referee what they see.
Clear the exit window	15 points for successful flying through the window. 5 Points will be deducted for any collision around the window.
Precision Landing	15 points. No point will be given if unable to land at the designated area or the flying machine fall off from the landing platform.
Mission accomplishment factor (M)	Summation of points (100 points)

*Note: Points maybe deducted from respective task/s if there is human intervention for that certain task/s inside the race course. Human intervention is defined as team member/s going into the race course to fix / tune / align / repair /assist their flying machine.

*Note for autonomous category: if any task requires human in the loop to assist the flying machine to complete that specific task, **prorated marks** will be given for that task. Example of human in the loop: switching from autonomous to RC mode to control the flying machine to clear the obstacle.

Eg. Navigating past the corridors obstacle and the flying machine is unable to navigate itself through and need human assistance. Assume it successful clear the corridor without any collision together with the help of human assistance. The prorated mark will be calculated as below:

$$\begin{aligned} \text{Prorate mark for that obstacle} &= \text{mark achieve for that obstacle} \times \text{prorate factor} \\ &= 10 \times \mathbf{0.4} \\ &= 4 \end{aligned}$$

Prorate factor is fix at 0.4.

*No point will be allocated if the specific task/s that is/are skipped.

The referees will make all scoring decisions and their decision is **FINAL**. For arbitrary cases, the Chief Referee will have the **FINAL** say. Unreasonable arguments with the judges will result in points lost.

5.7. AWARDS

The judges make all scoring decisions and their decision is **FINAL**. For arbitrary cases, the Chief Judge 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.

The winning flying machine will be displayed in Science Centre for public viewing during the Award Presentation Day on **17 Mar 2012**.

5.7.1. THE CHAMPIONSHIP AWARD

This is the most prestigious award that any team can win, and is bestowed on the team that achieves the highest total score $T = (S \times 0.15) + (A \times 0.25) + (M \times 0.60)$. Encompasses various technical aspects such as aircraft design & interface, quality of flight control / autonomy, and mission performance. There will be **two (2)** awards; one for the Semi-autonomous category and one for the Autonomous category.

Note: This Championship award may not be given out if all teams do not meet standard (eg. clearing at least 50% of circuit obstacles, skip any obstacle station is NOT considered as clearing) OR minimum teams for each category (Semi-autonomous / Autonomous). The chief judge will have the **FINAL** say and the decision made will be **FINAL**.

5.7.2. THE PERFORMANCE AWARD

For the team whose flying machine has the best performance score on the flying obstacle course. There will be **two (2)** awards; one for the Semi-autonomous category and one for the Autonomous category.

5.7.3. THE BEST VIDEO AWARD

For the team whose flying machine that is the most votes for video submitted. As it does not contribute to flying qualities, it does not contribute to the scoring for the Championship Award.

5.7.4. THE MOST CREATIVE AWARD

For the team that shows the most innovative and original design in their flying machine.

Criteria	Areas of Consideration
Creativity	Unique Design or Strategy MMI concepts or tools Autonomous concept and software design

5.7.5. THE THEORY OF FLIGHT AWARD

For the team that best demonstrates a sound understanding and appropriate application of aerodynamic design principles, as shown by their flying machine.

Criteria	Areas of Consideration
Aerodynamics	Mechanical Design Aerodynamics Design
Airworthiness	Flight control & stability Yaw control Pitch control Roll control Throttle control

5.7.6. THE BEST PRESENTATION AWARD

For the team that best exhibits creativity, fluency, confidence and flair in the presentation of their team's work, and demonstrates that "WOW" factor during the interview sessions.

Criteria	Areas of Consideration
Presentation	Fluency Confidence Flair

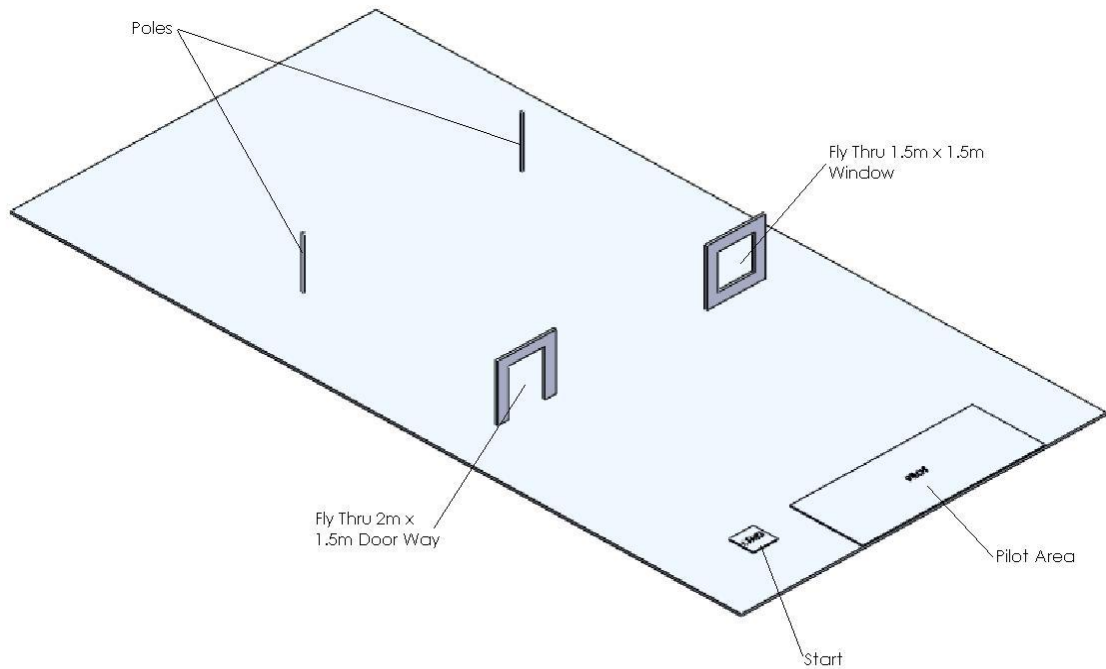
6. CATEGORY E: UNCONVENTIONAL

6.1. CATEGORY E CHALLENGE

The themes for this competition are: EXPLORE, ENHANCE and ENTERTAIN. Teams are expected to design and build a unique and innovative air platform to perform a series of tasks, as well as to "WOW" the audience.

6.2. COMPETITION SETUP

Figure 6.1 shows the competition setup for Category E. It consists of 3 main areas: (1) runway for takeoff and landing, (2) clearing of obstacles and (3) stunt area performance.



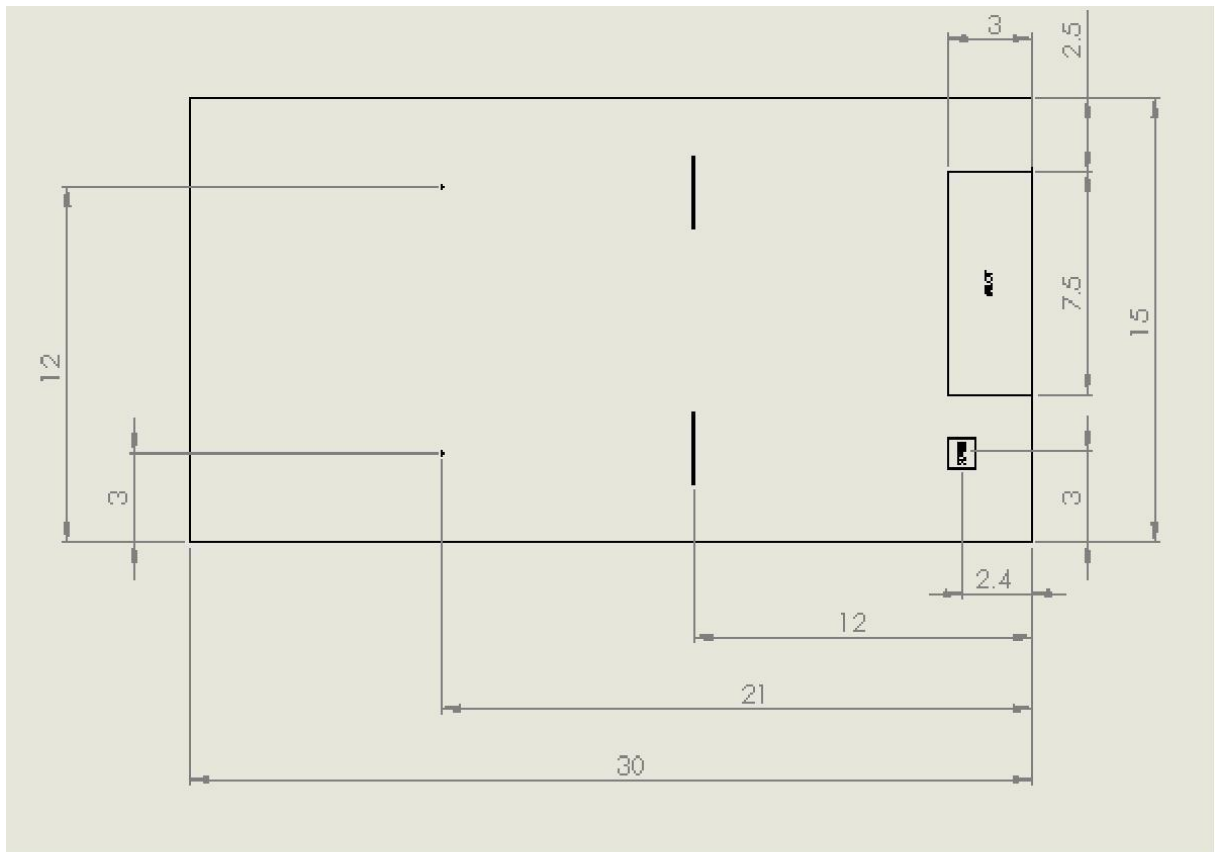


Figure 6.1: Competition Setup of Category E

The flying machine is required to perform **TWO (2)** missions, namely:

Complete Circuit Mission in the shortest time

- a. Take-off from start area. The stop watch will start once flying vehicle takes off.
- b. First Low obstacle – Challenge is to fly through a 2.0m x 1.5m gate.
- c. Figure of 8 – Challenge is to fly in between the two vertical poles and perform a figure-of-eight by flying round the two poles.
- d. Second Low obstacle – Challenge is to fly through the 1.5m x 1.5m hoop. Timing will stop once flying vehicle lands on the ground.

Stunt Mission

- a. Perform stunts within the entire flight arena.
- b. To “WOW” the audience with unconventional flying manoeuvres and stunts.
- c. Timing will start once the pilot has acknowledged the main referee in that area.
- d. After performing the stunts, land at the flying vehicle.

6.2.1. COMPETITION ARRANGEMENT

Teams shall expect the following during the course of the competition day:

-
- All teams shall go to a Reporting Point for allocation of their team booth as well as the competition schedule for their teams. The team shall surrender the radio control transmitter of the flying machine and will be placed in the box provided by SAFMC to be quarantined at the Storage Point
 - At the allocated Reporting Point, the team shall report to the Inspection Point. A flying machine inspector will check the flying machine for any violation with the category rules and regulations. The box with the transmitter will be handed over to the team once the inspection is successful. After inspection, the flying machine will be quarantine in a Holding Area prior to the mission attempt.
 - At the Holding Area, as long as the frequency does not clash with frequency of the flying machine inside the flying area, the SAFMC referee will hand over the transmitter back to the team to conduct Airworthiness and Failsafe check on the flying machine. The team is also given a total of **THREE (3)** minutes for the final adjustment on the flying machine prior to mission, after which the transmitter will be switched off and quarantined in the box again.
 - Prior to the mission, the radio control transmitter of the flying machine will be handed back to the team. Each team is given a total of **TWO (2)** minutes to setup their flying machine inside the flying area.
 - At the flying field, the pilot must inform the accompanying referee whether the flying machine is performing Circuit or Stunt Mission so that the relevant officials are ready to provide scoring. The pilot is allowed to skip Circuit or Stunt Mission but will need to inform the referee of such decision before or during the flight attempt.
 - Team must setup failsafe capability in the R/C transmitter. The team must inform Chief Referee of the location of the failsafe switch. When failsafe is activated or when there is a loss of link between the R/C transmitter and the R/C receiver on the aircraft (demonstrated by switching off the transmitter), the electric motor shall be switched off. The failsafe capability will be demonstrated in the holding area prior to actual flight.
 - Each team will only be given **TWO (2)** attempts during the competition and a total of **TEN (10)** minutes per attempt to perform both the flying circuit and the stunt missions. Once the time limit is up, participants will have to land their aircraft regardless of whether they have completed. Time taken to clear circuit will be recorded as a yardstick for judges to decide a winner in the event of a tie-situation.
 - The team is allowed to repair their flying machine if it crashes during the flight. However, the repair time will be accounted for as part of the **TEN (10)** minutes mission time. After the repair, the team may
 - a. continue its Circuit or Stunt mission if there are still flight time available or
 - b. terminate the flight and scores given before the crash will be use to determine the final score for that attempt.
 - At the end of each attempt, the radio control transmitter for the flying machine will be switched off, placed back into the box and surrendered to the SAFMC referee.

-
- After the completion of the first attempt, referees will take control of the transmitter and the team is advised to return to their respective team booth before their next attempt. The team is allowed to repair or make modification to the flying machine without the transmitter in preparation for the next attempt.

6.3. GENERAL RULES AND REGULATIONS

- Each team consists of up to **FIVE (5)** members.
- Open to public, except members and family members from the organising committee.
- No conventional flying machine designs are allowed. 'Conventional' flying machine designs are defined as one or more of the following:
 - a. Helicopter, defined as one main rotor and one tail rotor. Fixed wing aircraft defined as one fuselage with wings (mono wing, biplane or triplane) with tail or flying wing.
 - b. 2-D Kite model flying machines such as Identified Flying Objects (IFOs).
 - c. Anything out of this definition will be considered. If the team is unsure whether their flying machine design is unconventional, please check with the Organiser way before the competition.
- Each team is required to seek approval from judges regarding the additional props they need for their stunts performance during their presentation day.
- Each team is to design and build a radio-controlled flying machine based on the following guidelines:
 - a. No kits or off-the-shelf model flying machines are allowed.
 - b. No restriction on dimensions but for safety consideration, total weight of flying machine cannot exceed 1.5kg, but do note that the width of the hoop for the circuit flying is 1.5m.
- Only electric flight is allowed. Both brush and brushless motors are allowed. Teams are to declare any motors that are not off-the-shelf or have any modifications.
- No internal combustion or gasoline engines will be allowed.
- No flammable substances are allowed in construction of the flying machine.
- The flying machine can either be hand-launched or ground takeoff from the designated runway area.
- The flying machine is allowed to perform any stunt during the stunt mission as long as it is deemed safe by the Chief Referee. Teams are allowed to bring their own props to help showcase their flying machine performance, but will require approval from the judges on their presentation day. Teams are encouraged to showcase their "WOW" factors but within the safety limits of the competition. Please refer to the list of manoeuvres provided in section 6.4.2 for reference.
- The flying machine is NOT allowed to fly beyond the competition area at all times.

-
- The same flying machine must be used for both the Circuit and Stunt Mission for each attempt.
 - Teams are strongly encouraged to bring their flying machine during presentation. Teams are to submit **TWO (2)** photos of sized 4R during the presentation. Teams are to submit short video clips showcasing flight capability of their design. Teams will **NOT** be allowed to make major changes to their flying machine design after the presentation. Non-compliance may lead to **VOID** of presentation.

6.3.1. RULES ON FLYING MACHINE

Battery

- a. There is no limit on the number of batteries used, either in series or parallel. Only Lithium Polymer (Li-Po), Nickel Metal Hydride (Ni-MH) or Nickel Cadmium (Ni-Cd) batteries is allowed.

R/C Radio

- a. Based on guidelines from Infocomm Development Authority of Singapore (IDA), the following R/C frequency ranges are recommended: **29.700 – 30.000 MHz.**
- b. 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 advice to conduct a radio control range check prior to flight.
- c. Team must register their R/C frequency with SAFMC officials prior to the challenge week.
- d. The team must be able to demonstrate the failsafe capability in their R/C transmitter. The electric motor must switch off when failsafe is activated. The Chief Referee and Safety Officers reserve the rights to request the R/C pilot to activate failsafe if they deemed the flying machine is uncontrollable in flight and poses safety concerns.

6.4. COMPETITION DAY

- The organiser will not be responsible for any damage to the flying machine throughout the competition.
- No team is allowed to have any radio control transmitter (including backup) in the competition hall. All radio control transmitters are to be surrendered to the referee.
- No radio control transmitter is to be turned on within the competition hall, unless permitted to do so in the Holding and Flying Area.
- No team is allowed to charge batteries within the competition hall.
- Teams shall make sure they are contactable and must be present at their team booth **FIFTEEN (15)** minutes before the allocated time. Latecomers may lead to disqualification.
- The pilot is **ONLY** allowed to walk in the designated Pilot's Area when piloting.

6.4.1. FLYING MACHINE INSPECTION

- Before each launch, a flying machine inspector will weigh the flying machine.
- In the event the flying machine fails the inspection, the team is given **FIVE (5)** minutes to rectify the problem. If the team is unable to rectify the problem within the given timeframe, that attempt will be declared as **VOID**.

6.4.2. SCORING

- This section describes the point awarding criteria for CAT E in the challenge week.
- During the presentation week, teams will be awarded an E-factor which will be multiplied against the maneuver scores obtained by the teams. Please refer to section 1.4.3 for explanation on how the E-factor is obtained.
- Teams shall be graded according to the list of maneuvers showed in table below:

Difficulty Level	Description	Points for successful execution
Basic	Control Take Off* Control Landing*	+4 each Max Total = 8
Intermediate	Maintain straight-level flight path Perform directional change Maintaining altitude Able to fly under gate-obstacle* Complete Figure-of-8* Fly through hoop*	+2 each Max Total = 12
Advance	One Flip / Roll Perform single vertical loops	+4 each Max Total = 8
Amazing	Multiple-Flips / rolls Multiple loops Cobra / hammerhead-maneuvers Any other amazing stunts that push platform to edge of flying envelope	+4 for any Max Total = 12
		GRAND TOTAL = 40

*Note: circuit mission

- By successfully completing the circuit mission, participants would have demonstrated intermediate level of difficulty; and scored most (if not all) of the points. To score points in the advance and amazing level would required participants to demonstrate more complex maneuvers during stunt performance.
- For each attempt on the Circuit mission, scores will be awarded to the team based on the sum of all points allocated to tasks successfully completed by the flying machine. There will be a **PENALTY** of **TWO (2)** points for each touch (anywhere) in the flying area. Lowest score for circuit is ZERO point.

- **IMPT:** An E-factor will be multiplied to the total points obtained from the circuit and stunts. This is to keep the scoring criteria in line with the spirit of the competition. An example of how the E-factor is applied is shown below:

Platform	Team A	Team B
E-factor*	0.8	1
Challenge Score	25	22
Final Challenge Score	20	22

*E-factor ranges from 0.5 to 1.

- To encourage contestants to make their performance entertaining, judges are also allowed to award up to a maximum of TEN(10) points for entertainment value.
- Entertainment value will be judged by the following criteria:

Entertainment Value
Creative aspect of stunt.
Perform stunt after stunt without any abrupt change in flight.
Visual effects of stunt.
General ability to attract interest of judges and crowd.

-
- A summary of the total points contestants could possibly score during competition day is shown below:

Flying Tasks	Maximum Allocated Points
Perform Maneuvers	40 points*
Entertainment Value	10 points

*Note: E-factor will be multiplied to this score to obtain the final challenge score.

The performance score is the sum of final challenge score and entertainment score. The better score between the two attempts will be taken to vie for the “Best Performance Award”.

A sample calculation for the performance score is given below.

Platform	Team A	Team B
Final Challenge Score (E-factor x Challenge Score)	20	22
Entertainment Score	7	6
Performance Score (Final Challenge Score + Entertainment Score)	27	28

The referees make all scoring decisions and their decision is **FINAL**. For arbitrary cases, the Chief Referee will have the **FINAL** say.

6.5. AWARDS

The judges make all scoring decisions and their decision is **FINAL**. For arbitrary cases, the Chief Judge 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.

The winning flying machine will be displayed in Science Centre for public viewing during the Award Presentation Day on **17 March 2012**.

6.5.1. THE CHAMPIONSHIP AWARD

This is the most prestigious award that any team can win. It is bestowed on the team that embodies the spirit of SAFMC. Teams are considered for the Championship Award based on their overall excellence and total learning experience during the course of the competition.

Individual Category	Weightage
Performance	50%
Aesthetic	0%
Creativity	25%
Theory of Flight	15%
Presentation	10%
Total	100%

6.5.2. THE BEST PERFORMANCE AWARD

For the team whose flying machine has the best performance score on the flying areas for Flying Circuit and Special Stunts in the best attempt.

6.5.3. THE BEST VIDEO AWARD

For the team whose flying machine that is the most vote for video submitted. As it does not contribute to flying qualities, it does not contribute to the scoring for the Championship Award.

6.5.4. THE MOST CREATIVE AWARD

For the team that shows the most innovative and original design in their flying machine.

Criteria	Areas of Consideration
Creativity	Unique Design or Strategy Flair and Appearance Functionality

6.5.5. THE THEORY OF FLIGHT AWARD

For the team that best demonstrates a sound understanding and appropriate application of aerodynamic design principles, as shown by their flying machine.

Criteria	Areas of Consideration
Aerodynamics	Aerodynamics Control & Stability Design and Integration
Airworthiness	Centre of Gravity (CG) balancing Yaw control Pitch control Roll control Throttle control

6.5.6. THE BEST PRESENTATION AWARD

For the team that best exhibit creativity, fluency, confidence and flair in the presentation of their team's work, and demonstrates that "WOW" factor during the interview sessions.

Criteria	Areas of Consideration
Presentation	Fluency Confidence Flair

6.5.7. OTHER AWARDS

- SPECIAL RECOGNITION AWARD

Apart from the awards listed above, the Judges may present up to **FIVE (5)** other awards to teams and/or individuals that have displayed outstanding attributes (in the competition) that set them apart in a unique way. These awards allow the judges the freedom to recognize the most remarkable teams for which a standard does not exist.

- BEST TEAM SPIRIT AWARD

For the school or team which has the best cheer to support their participating teams with the most innovative stunts, high-spirited members and spectacularly visual and audio cheers(s).

7. IMPORTANT DATES

7.1. PRESENTATION WEEK

5 to 9 March 2012

10 March 2012 – Presentation Finals

Schedule for Presentation preliminaries will be uploaded to the official SAFMC website <http://www.dsoamazingcompetitions.com.sg/safmc/>

7.2. CHALLENGE WEEK

12 to 16 March 2012

17 March 2012 – Award Presentation Ceremony

Schedule for Challenge preliminaries will be uploaded to the official SAFMC website <http://www.dsoamazingcompetitions.com.sg/safmc/>

7.3. CHALLENGE WEEK SCHEDULE (subject to change)

Time	Events
8.00am	Registration at Reporting Point
8.30am	Quarantine begins at Booth Area (Only participants are allowed in the area)
8.45am	Briefing for all teams in Flying Area
8.50am	Inspection begins
9.00am	Competition Starts
1.00pm	Quarantine ends at Booth Area
1.00pm	Lunch
1.45pm	Quarantine begins at Booth Area
1.50pm	Inspection begins
2.00pm	Competition Starts
6.00pm	Quarantine ends at Booth Area
6.00pm	End of Competition

Table 8.1: Category Challenge Preliminary Timetable (12 - 16 March 2012)