NERC Build & Fly

Rationale:

Agricultural development is the most crucial part in development of Pakistan's economy having a share of 23.4% and engaging almost 45% of workforce. Local Farmers deal with countless pressures and challenges such as increasing sustainability, maximizing yields to meet demands, maintaining margins, and managing water usage. Around the world, to cope with the challenges farmers are using precision agricultural techniques with the aid of aerial and ground robots. Farmers have always collected field data. This process can be as simple as walking through a field and making observations, but farmers are limited by time, data recording and the capabilities of analysis tools when making visual observations. A farmer simply can not walk every row of the crop field to collect data. Drones or unmanned aerial vehicles represent a prime example of a new technology that has the potential to provide even more valuable decision making data to farmers. Just recently, the Government of Punjab announced the permission of using drone technology in Agriculture. Drone technology and relation information system is being used for crop monitoring, pesticide spraying, and fruit picking. Drones have tremendous potential to be an eye in the sky for farmers. There is a huge opportunity for innovators to bring ideas that can help to integrate information system, current mobile network, and drone technology to bring a system that can evolutionize precision agriculture in Pakistan.

The Unmanned Aerial Vehicles (UAVs) specially the RC planes have been in the agricultural market for a decade. However, the technology has evolved over the years. Now, multicopters and RC planes are being used in different agricultural monitoring applications. With the increased number of usage of these technologies more human resource will be required that can fly and know the basic understanding of these R.C UAVs (R.C planes and quadcopter).

The Department of Mechatronics, NUST College of Electrical and Mechanical Engineering have realized the potential of promoting and producing human resource for drone technology. The department is organizing an aerial drone competition that includes fixed wings and rotary wings drones/UAV during NERC 2018. The NERC-Aero has three categories, **Aerial aerobatics, Build and Fly aeroplanes, and build**

and fly quadcopter. The contest will provide a real world aircraft build and fly experience to the participants by giving them the opportunity to validate their analytic studies. The department will also conduct workshops to learn building and flying planes and quadcopters before the event.

Introduction

Student teams will design, fabricate, and demonstrate the flight capabilities of an unmanned, electric powered, radio controlled aircraft that can best meet the specified mission profile. The goal is a balanced design possessing good demonstrated flight handling qualities and practical and affordable manufacturing requirements while providing a high vehicle performance.

It is the responsibility of the teams to know and follow all provided rules, the FAQs, and all contest day briefings.

Contest Categories

1. Exhibition Flying - Quadcopters, Helis, Planes
2. Build And Fly Aeroplanes
3. Build And Fly Quadcopter

Contest Structure

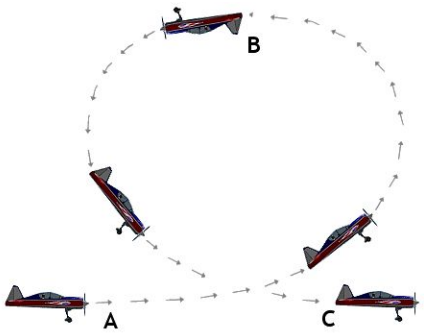
Build And Fly Aeroplanes

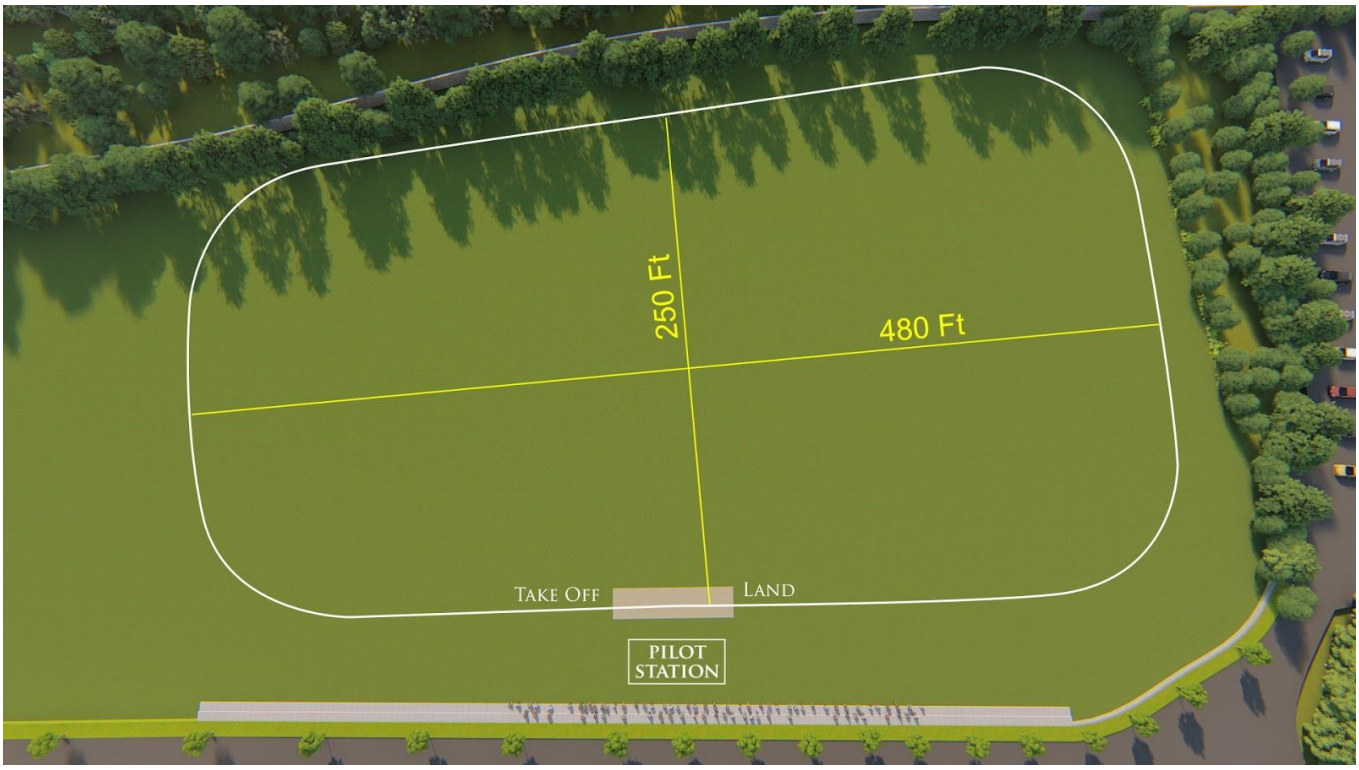
EME build and fly consists of four stages. In the first stage, each team will have an interview and inspection of the plane with the inspection team, and will submit a design report. The second stage will consist of flying mission-1. Teams that will qualify from stage-1 will compete in stage-2. Teams that will qualify stage-2 will compete in stage-3. Stage-3 consists of mission-2 and mission-3. Points earned for each stage will determine the team standings and their qualification for the next stage, top 8 scoring teams will be selected for stage-2, top 4 teams from stage-2 will go on to stage-3 for the semi-finals and the winners of the semi-finals will compete for the first position in the final stage. Course circuit is shown in figure 1. The scoring sheet is given below in table 1 under points section.

Mission Description:

- Mission 1:
  - Take Off
  - Fly 3 Laps
  - Land

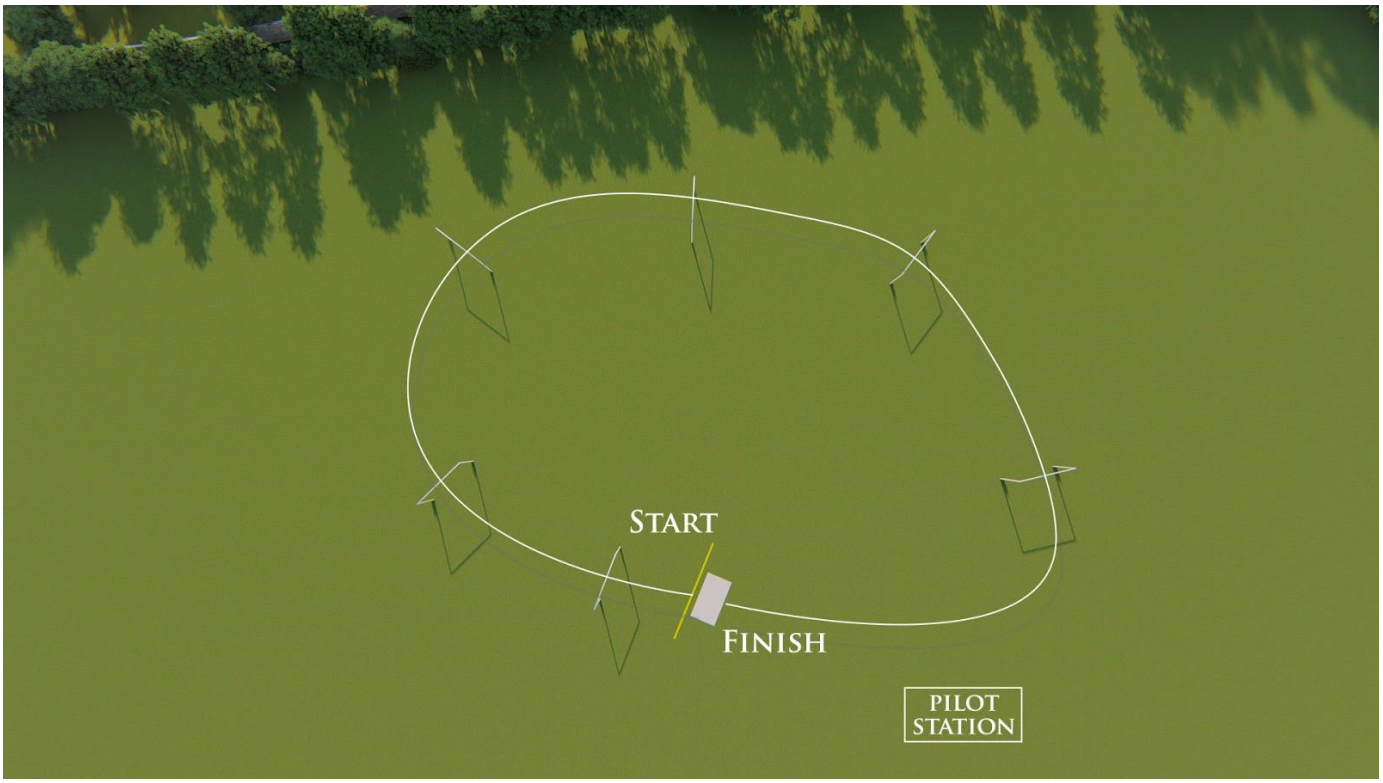
- Mission 2:
  - Install 150 grams Weight
  - Take Off
  - Fly 3 Laps
  - Land
- Mission 3:
  - Take Off
  - Fly 3 Laps
  - Perform an Inside Loop
  - Land





Build and fly Quadcopter

EME Build and fly consists of four stages. In the first stage each team will have an interview and inspection of the quadcopter with the inspection team. In the second stage the teams (that qualify the first stage) have to fly the quadcopter to show the judges panel; stability, basic maneuvering, and fixed point hovering. Teams that qualify the second stage will compete in the third stage. The third stage consist of 2 laps of the course circuit defined in figure 3. The teams have to complete the 2 laps in the shortest time possible. Teams will be sorted on the basis of shortest time to finish the 2 laps. The first two teams will take part in the final round that will consist of 3 laps of the course circuit. The team that will complete the 3 laps in the shortest time possible will be declared as the winner.



Exhibition Flying

EME build and fly Exhibition segment has no contest or course structure and its open to all types of electric aerial vehicles i.e helicopters , quadcopters, planes etc with no size limits. All teams are required to follow the field and safety rules as mentioned in the rules section below. Each registered team will exhibit their aircraft in the exhibition area defined by the organizing committee. Each team will be given 4 minutes each to exhibit their flying capabilities. The best exhibitionist team will be awarded with certificates and shield.

Rules and Requirements

Team Requirements:

All team members must be full time/part time students of any University, College or School. Each team can comprise of at maximum 5 students. Two or more schools/college/university may combine to submit a single entry.

Any member of the team can fly the plane, while rest of the team members can assist in navigation. It is preferred, but not required, for the team advisor or responsible faculty member to attend.

Each educational institution may submit more than one team. Each team should have their own aero plane to fly. During the inspection stage the team has to register the plane, after inspection, which they

will use during the competition. A flight order list will be generated using a draw during the inspection and will be communicated to the teams prior to the fly-off time.

Aircraft Requirements:

- The airframe of the aircraft must be fabricated from scratch using Depron, EPP, EPO foam or Balsa wood. Airframe may also be built using pre-cut balsa wood or depron kit if full assembling process is documented, photographed and submitted along with the design report.
- The aircraft may be of any configuration except rotary wing or lighter-than-air.
- Maximum wing span allowed is 2000 mm or 6.56 Feet.
- Only Electric Propulsion Power Systems are allowed, it could be EDF or Propeller driven. No restrictions on pusher or tractor style configuration.
- Maximum allowed battery size is 3 Cell 1P 3300 Mah Li Polymer (Lipo). For safety, battery packs must have shrink-wrap or other protection over all electrical contact points. Battery packs must be commercially available and the manufacturers label must be readable.
- No structure/components may be dropped from the aircraft during flight.
- No form of externally assisted take-off is allowed. All energy for take-off must come from the onboard propulsion battery pack(s).
- Aircrafts are required to be equipped with full range receiver with diversity Antennas.
- The aircraft must remain substantially the same as documented in the report (for example you cannot change a flying wing design to a conventional tail design).

Quadcopter Requirement:

- Allowed Frame for quadcopter race is ‘X’ or ‘H’ type, propelled by 4 motors.
- Carbon fiber, glass fiber, aluminium or plastic frame kits can be used to assemble the quadcopter.
- Maximum allowed frame size is 450mm.
- Max allowed battery size and type is 3 or 4 Cell 1p 3400mah lipo.
- Students are required to build their quads from scratch, using off-the-shelf parts i.e brushless motors, ESCs, Flight controllers, Video TX/RX and frames . No pre assembled RTF quads are allowed in the race.
- In case of FPV setup ,the power of Video Tx should not exceed 600mw, only 2.4 Ghz spectrum compatible VTX are allowed.
- All off-the-shelf ready to use **FPV goggles** are allowed.

Technical and Safety Inspection

All vehicles will undergo a safety inspection by a designated contest safety inspector prior to being allowed to make any competition flight. All decisions of the safety inspector are final.

- All Vehicles will be inspected against the given requirement.
- All Vehicles will enter Tech Inspection fully assembled and flight ready.
- The Aircraft will undergo the wing tip lift test with the maximum flight payload installed.
- Verify all components adequately secured to vehicle.
- Clevises on flight controls must have an appropriate safety device to prevent their disengaging in flight.
- Verify propeller structural and attachment integrity.
- Visual inspection of all electronic wiring to assure adequate wire gauges and connectors in use.
- Radio range check, motor off and motor on.
- Verify all controls move in the proper direction.
- Check general integrity of flying and control surfaces.
- All aircraft/quadcopter radios must have a fail-safe mode that is automatically selected during loss of transmit signal.
- Proper functioning of FPV setup, integrity of the video signal and range of VTX.

Ground Rules - Airplane

- The assembly crew member must load and prepare the aircraft for flight within the 10 minute window
- Only the assembly crew member, pilot and observer may go to and enter the Pilot Station area
- Aircraft will use ground rolling takeoff and landing
- Takeoff field length will be limited to 150 ft
- The initial upwind turn on the first lap of each mission will occur after passing the turn judge (signaled by raising a flag).
- The aircraft must remain in unaided visual control distance of the pilot at all times.
- Aircraft must complete a successful landing at the end of each mission for the mission to receive a score.
- Flight altitude must be sufficient for safe terrain clearance and low enough to maintain good visual contact with the aircraft. Decisions on safe flight altitude will be at the discretion of the Flight Line Judge and all rulings will be final.

Ground Rules - Quadcopter

- Only pilot and one spotter is allowed to enter pilot station

- All participating teams must keep their quads unarmed and batteries disconnected while on the ground.
- Participants in the active race can only power and arm their quads once they are in the pilot station.
- In case of FPV race, a spotter is required to stay with the FPV pilot in the pilot station.
- In case a video signal is lost, the FPV pilot is required to reduce the throttle to zero immediately.
- No teams except the ones participating in the active race are allowed to power on or test the Video TX while on the ground.
- A team can only use the transmission channel assigned to them while on the ground.

Sponsorship:

Teams may solicit and accept sponsorship in the form of funds or materials and components from commercial organizations. All design, analysis, and fabrication of the contest entry is the sole responsibility of the student team members.

Communications: Website and email

Mechatronics Department NUST maintains a NERC website (www.nerc.com.pk) page containing the latest information regarding the contest schedules, rules, and participating teams. An FAQ is maintained to share queries will all the other teams. Queries regarding the contest, schedules, or rules interpretation may be sent to the NERC coordinator through email at: info@nerc.com.pk

Registration for NERC Aero:

All registration to NERC Aero will be through the online form given on the NERC website (http://www.nerc.com.pk). Be sure to include all information requested in the form. One registration per team is required for any of the competition. The corresponding team member or team lead will register by filling the online form. He needs to mention all team members properly in the online form. The name of team members mentioned during the registration can be changed if requested during the inspection session. The registration fee could be submitted through bank challan generated and sent to the team leader via e-mail.

Point Scoring System / Judging

Students must design, document, fabricate, and demonstrate the aircraft they determine to be capable of achieving the highest score on the specified mission. Mission scores will be based on the demonstrated mission performance obtained during the contest. Each team must also submit a written Design Report. A maximum of 20 points will be awarded for the team design report. The overall team score is a combination of the Design Report score and Total Missions Score. The team with the highest overall team score will be declared the winner.

Aeroplane

Design Report - 20 Points

Mission 1 & 2 (max points 100)

Manuaor	**Points**
Take Off	20
Stability	20
Altitude	15
Turning	20
Landing	25

Mission 3 (max points 120)

Manuaor	Points
Take Off	20
Stability	20
Altitude	15
Turning	20
Inside Loop	20
Landing	25

Quadcopter

- Quadcopter segment has no point based scoring. Contest in this category is based on laps time, team with the shortest lap times advances through the heats and wins the final.
- Going through each air gate is mandatory.
- A team may attempt multiple times to go through a gate but can not proceed to the next gate unless having gone through the previous gate.
- The laps time starts when the quadcopter lifts off the ground and finishes when i goes through the last gate.

Design report

Design Reports will be submitted through the email or in person. The design report is only required in build and fly aeroplanes contest. Reports will be judged “as received”. No corrections /additions /changes will be allowed by the organizers, so check your reports carefully before submitting them. Once a Report is submitted, no changes are allowed.

Design report entries:

The design reports will be submitted during the inspection of the aircraft as a hardcopy. The report should be submitted before the start of inspection session.

Reports must have the University/College/School name on the cover page. Reports missing this identification information will not be scored. Maximum page count for the report is 60 pages.

Design report guidelines:

Please use the following guideline while preparing your reports.

Executive Summary -

- Summary description of the selected design and why it best meets the mission

Design

- Document dimensional parameters of final design
- Document structural characteristics/capabilities of final design
- Document Weight and Balance for final design
- Document Rated Aircraft Cost
- Document mission performance for final design
- 2d drawing with dimensions - front-view top-view, side-view.
- Payload accommodation drawing show its location within the fuselage.

Manufacturing Plan

- Document Manufacturing processes investigated and selection process
- Document Manufacturing milestones with charts.
- Document using photos of the manufacturing phase from start to finish.
- Format, Completeness, Readability.

Testing

Document test flight data and provide photos of test flight.

References

- List of all published works/material referenced in the design report and used during the project.