Northrop Grumman Aerospace Systems (NGAS)
Higher Colleges of Technologies (HCT)
Association for Unmanned Vehicle Systems International (AUVSI) Foundation

UAE Innovation Challenge 2012

Soaring to New Heights

Welcome to the Higher Colleges of Technologies – UAE Innovation Challenge 2012. This year's challenge is "Soaring to New Heights." Eligibility and requirements are listed below. Good luck and have fun!

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Design, Build, and Test Phase: December 2011 – April 2012

Competition Days:

- 22-23 April – Team Presentations
- 24-25 April – Flight Competition at the Abu Dhabi Cricket Stadium, Abu Dhabi, UAE

Awards Ceremony:

- 26 April – Health Sciences Auditorium, CERT Technology Park, Abu Dhabi, UAE

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1. Purpose for Student Involvement

- Northrop Grumman signed a MOU with the United Arab Emirates (UAE) Higher Colleges of Technology on 22 April 2010.
  - The desire was to work together to explore possible areas of common interest in providing educational programs in areas that build local capacity across various sectors in the UAE.
  - The agreement was to explore ways in which NGC could collaborate with HCT to enhance Science, Technology, Engineering and Math (STEM) education.
- Doing a project that is similar to something that is already being worked on at Aerospace Systems (UAV Systems) will provide a medium to:
  - Motivate UAE college students to pursue science, technology, engineering, and mathematics careers.
  - Introduce students to the competitive nature of real-world engineering (e.g., competitive bidding).
  - Teach students the design and development process of an engineering project (e.g., project management, requirements, time management, costing, interdisciplinary integration).
  - Help students apply classroom lectures and textbook knowledge to field applications.

2. The Challenge

BACKGROUND INFORMATION

Northrop Grumman's UAE Innovation Challenge 2012 encourages students to apply their math and science knowledge to real world engineering projects. Students will learn the entire engineering process from designing, to building, to testing their devices, and then will compete against other student teams. Students will also develop teamwork and presentation skills.

COMPETITION OBJECTIVE

One of the challenges of aircraft design is to maximize the endurance, range, and sometimes speed, without sacrificing payload. This year teams will design and build an automated unmanned aerial vehicle that possess both qualities of climb performance and endurance. There will be two days of flight competition where students can evaluate their design against other teams. Day One of the competition will consist of each team's first attempt at their best score. Day Two of the competition the teams will have the chance to improve their first score. The combination of climb performance and endurance competition will challenge students to design an aircraft that is not only fast, but efficient. Each team is

also required to present their design and engineering methods to a panel of judges in the form of a formal presentation.

3. Guidelines

- Northrop Grumman engineering mentors will travel to the UAE four times between December and April to assist students.
- A mentor will be available for the entire week leading up to competition day.
- Mentors will be available via e-mail on weekdays when not in the UAE and via AUVSI website (coming soon) to answer questions.
- A forum will be established to discuss team status and concerns. Weekly mentor meeting can be scheduled via the internet if requested.
  - The purpose of this is to ensure all teams get similar information and avoid any unfair advantages.
  - To gauge relative team performance.
  - To amend competition rules if necessary.
  - To pose questions and resolve them.
  - ***If you are uncertain about any competition guidelines regarding the design or competition in general, please ask the mentor.***
- Mentors will provide guidance in the following areas:
  - Design.
  - Project scheduling.
  - Presentation composition.
  - Assisting in the use of potentially dangerous tools (i.e. soldering iron).
- Mentors will NOT:
  - Give students the answers without prompting (e.g., give a personal design concept that the students have not researched themselves).
- Mentors will ensure that teams follow the competition design rules.
- Mentors will ensure that the aircraft is compliant with the safety regulations.

4. Innovation Challenge Rules

These rules reflect the current understanding of how the organizers envision the competition to be conducted and are subject to change based on unforeseen complications encountered during the design phase.

Eligibility

- This contest is open to teams of students from the UAE Higher Colleges of Technologies. More than one team may represent each college campus, with a recommended maximum of six students per team (all students are encouraged to participate, but we may only be able to accommodate 6 students and 1 advisor per team).

- Schools must provide for the students' and advisors' transportation to and from the Higher Colleges of Technology.
- A release form and a liability form shall be signed for each team member who will be competing as required by the Higher Colleges of Technology.

Logistics

Northrop Grumman will provide each team with a complete set of materials (a kit). All electronic parts, propulsion parts, and necessary materials to manufacture the aircraft will be provided. Any remaining materials from the kit may be kept by the school for future competitions. Teams may purchase and/or use materials other than those provided except as follows: all teams must use and may not modify the provided battery, motor, speed controller, auto pilot components and transmitter radio unless prior approval is provided by the Northrop Grumman Engineering team.

Safety

Safety regulations must be adhered to at all times. Violation of safety rules may result in heavy penalization or disqualification.

Aircraft Requirements

- There is no weight restriction. Weight is measured with the aircraft in the flight configuration. Repairs and/or modifications done to the aircraft during the competition require an updated measured weight for scoring purposes.
- The aircraft may be of any configuration except rotary wing or lighter-than-air.
- No structure/components may be dropped from the aircraft during flight.
- The aircraft must be capable of self-powered take-off or being hand-launched safely.
- All teams must use and may not modify the provided battery, motor, speed controller, auto pilot components and transmitter radio, unless prior approval is provided by the Northrop Grumman Engineering team.
- All aircraft must have a mechanical onboard radio Rx switch or battery disconnect on the outside of the aircraft. **SWITCH or BATTERY DISCONNECT MUST be mounted on the outside the aircraft** (they cannot be behind an access panel or door).
  Note: The battery switch must be set to the "off" position or battery disconnected any time the aircraft is being manually moved.
- Decals and individual design schemes are encouraged but must be respectful and tasteful. Any potentially offensive design choices may be disqualified.

General Requirements

- Competition judges are the final authority in all matters of the rules and scoring.
- Teams are encouraged to demonstrate flightworthiness of their designed aircraft by the last mentor visit prior to the competition. This is to ensure that no newly designed aircraft will make their maiden flight on the day of the competition. No significant changes should be made to the competition aircraft between the flight demonstration and the competition. Mentors will reserve final judgment as to what is construed as a "significant" change.

- Teams are highly encouraged bring a second aircraft or spares of critical components (like wings) as a backup in the event that the first suffer any irreversible crash damage.
- Safety Inspection: All vehicles will undergo a safety inspection immediately before the competition at the team tent by a designated contest safety inspector prior to being allowed to make any competition or non-competition (i.e. practice) flight. All decisions of the safety inspector are final. Safety inspections will include the following as a minimum.
    1. Physical inspection of the vehicle to ensure structural integrity. Each aircraft will be held up by the tips of both wings to verify wing strength.
    2. Verify all components adequately secured to vehicle. Verify all fasteners are tight and have either safety wire, loctite (fluid) or nylock nuts. Clevises on flight controls must have an appropriate safety device to prevent their disengaging in flight.
    3. Verify motor structural and attachment integrity.
    4. Visual inspection of all electronic wiring to assure adequate wire gauges and connectors in use.
    5. Radio range check, motor off and motor on.
    6. Verify all controls move in the proper sense.
- Flight worthiness. Teams must demonstrate the flight worthiness of the airplane before the competition. At a minimum, flight worthiness is usually comprised of:
    1. Controlled take-off.
    2. One complete figure 8.
    3. A controlled climb and controlled descent.
    4. A controlled landing.
- Mentors will be on hand during the meetings leading up to the competition to test fly the aircraft. Mentors will also be available to fly the aircraft during the competition. Teams may provide their own pilots for the competition, but they must have demonstrated their proficiency by at least the last mentor visit.

Flight Requirements

- While at the Higher Colleges of Technologies, no flight, practice or competition may be done without the approval of the event coordinators.
- If at any time during a flight the event coordinators feel it necessary to abort the flight, the pilot must land the airplane immediately.
- Airplanes can only be checked/powered-up in designated pit area assigned to each team and in the designated take-off area before a flight.
- All flights must stay within the designated flight perimeters.

COMPETITION SCORING

The final competition score by which the 1st, 2nd, and 3rd prizes will be awarded will be a function of the presentation, time aloft, aircraft weight, and a potential bonus for an autonomous landing:

$$Final\ Score = 50\left(\frac{Presentation\ Score}{100}\right) + 40\left(\frac{your\ time}{\max time}\right) + 10\left(\frac{min\ weight}{your\ weight}\right) + 10(Bonus)$$

Presentation

All teams will present a 15 to 20 minute presentation on the design, strategy, and challenges of their unmanned aerial vehicle followed by a 10-minute question and answer session. Each student must present at least one slide. A panel of judges including representatives from Northrop Grumman Engineering, Higher Colleges of Technologies, Association for Unmanned Vehicle Systems International (AUVSI) Foundation and Abu Dhabi Autonomous Systems Investments (ADASI) will score each presentation, and the average score will be awarded to the team. The presentation must be in a format compatible with MS Office (e.g., PowerPoint). Backup copies on CD or flash drives brought on the day of the competition are encouraged for last minute changes. Teams are encouraged to bring their aircraft to the presentation for demonstration purposes.

The presentation will be scored on a scale of 100 and will be broken down according to the following rubric:

Max Possible Pts	Criteria
10	Visuals (slides are illustrative and easy to read, points are clear)
10	Delivery (evidence of preparation; thoughts are clearly articulated)
5	Organization (overview, content, conclusion)
5	Time Limit (each team member contributes; team stays within time limit)
15	Design Methodology (explanation of the strategy taken to meet the mission)
15	Autopilot Explanation and Implementation (basic use; any code modifications)
15	Design Discussion and Documentation
15	Testing (methodologies and results of tests performed)
5	Project Management (requirements, schedule, budget, etc)
5	Questions (audience / panel questions addressed adequately)

Figure 1: Presentation Scoring Breakdown

Soaring Segment

Each team will compete in the soaring segment and will earn points based on how long the aircraft can stay aloft once the power to the motor is cut. This type of challenge is demonstrates the capability for an autonomous aircraft to remain airborne over a designated area, usually for surveillance purposes.

Each team's aircraft will have pre-determined amount of time (tentatively 1 minute) to climb to its maximum possible altitude. After that time (1 minute) the motor will be shut off and the goal of the aircraft is to have the maximum time aloft. Students will use the provided autopilot system to control the aircraft during the flight. However, Northrop Grumman mentors will be available to fly any portion of the flight or to regain control of the aircraft if it deviates from its course. Flight times will be penalized

if Northrop Grumman pilots must take over control by subtracting half time for any amount of time the aircraft is not under autonomous control. For instance, if the aircraft was able to remain in the air for 300 seconds but of those 300 seconds the aircraft was piloted by a Northrop Grumman pilot for 30 seconds, then the team's final flight time will be 285 seconds. If the entire 300 seconds was piloted by a Northrop Grumman pilot then the team's final flight time will be 150 seconds.

The flight order for the soaring segment will be determined based on the presentation scores. There will be as many flight "slots" as there are total number of competing teams. The team with the highest presentation score will be given first pick of their flight slot. The team with the 2nd highest presentation score will receive second pick from the remaining slots. This process will continue until all teams have picked their flight slot.

The flight clock starts when the aircraft leaves the ground or the launcher's hand. Teams have 20 seconds from takeoff to initialize the autopilot program before penalties are incurred. If teams are not attempting an automated landing, pilots will take control of the plane at approximately 20 m above ground, or at the pilot discretion for a safe landing. The flight clock stops when the plane makes first contact with the ground.

Time = (Flight Clock) – (Total Penalty Time / 2)

Spot Landing Bonus

A 10% total bonus will be awarded to aircraft that is able to spot land in the designated area under the control of the autopilot. Major aircraft components must remain intact to receive spot landing bonus points. No spot landing points are awarded if the landing is done by the Northrop Grumman pilots.

Launch Window

Each team will have 20 minutes of "range-time" on the morning of the first flight day, during which they can check, fly and fine-tune their aircraft and programming of the autopilot. Only two teams will be allowed on the field at any given time. Over the two days, each team will have at least two (2) opportunities to fly their aircraft for a score. More attempts may be allowed depending on time and other conditions.

Each team has a 10 minute window during which to make a successful launch. The launch window clock starts after the previous team's aircraft has been cleared from the recovery area and the area has been declared safe by the competition director. Launch window rules are subject to change the day of the event and are at the discretion of the Northrop Grumman engineering team.

The flight clock starts when the aircraft leaves the ground or the launcher's hand. Teams are permitted to attempt as many re-launches as desired prior to the expiration of their launch window. Teams are permitted to make field repairs in the event the aircraft sustains any damage during the flight attempts. However, teams must continue the flight if the aircraft is airborne at the expiration of the launch window. Any subsequent and irreversible contact with the ground will result in the stop of the flight clock. Teams will not be permitted to change out their batteries during their launch window.

Aircraft Weight

Prior to takeoff, the gross weight of the aircraft (including batteries, ballast, and all sensor payloads) will be weighed and used to compute the final score.

Example Scoring

An example scoring scenario is laid out below for a tournament with 4 teams: team A, team B, team C, and team D.

$$Final\ Score = 50\left(\frac{Presentation\ Score}{100}\right) + 40\left(\frac{your\ time}{\max time}\right) + 10\left(\frac{min\ weight}{your\ weight}\right) + 10(Bonus)$$

Presentation Score:

Place	Team	Presentation Score	Pres Score / 100	Final Pres Points
1st	B	85	0.85	42.5
2nd	A	83	0.83	41.5
3rd	D	74	0.74	37.0
4th	C	72	0.72	36.0

Weight Score:

Place	Team	Aircraft Weight	Min Wt / Wt	Weight Points
1st	C	3.50	1.00	10
2nd	A	3.57	0.98	9.8
3rd	B	4.02	0.87	8.7
4th	D	4.12	0.85	8.5

Flight Time Score:

Place	Team	Flight Time	Penalty Time	Penalty Time / 2	Scoring Time	Time/ Max Time	Final Time Points
1st	C	13:35	0	0	13:35	1.00	40.0
2nd	A	13:15	0:10	0:05	13:10	0.98	39.2
3rd	B	12:13	0:30	0:15	11:58	0.87	34.8
4th	D	11:32	0	0	11:32	0.85	34.0

The final score and ranking for this hypothetical tournament will be tabulated as follows:

Team	Pres Points	Time Points	Weight Points	Landing Bonus	Total Score	Final Ranking
Team A	41.5	39.2	9.8	0	90.5	2nd
Team B	42.5	34.8	8.7	10	96.0	1st
Team C	36.0	40.0	10	0	86.0	4th
Team D	37.0	34.0	8.5	10	89.5	3rd

AWARDS*

The first place team will receive an all expenses paid trip to AUVSI convention in Las Vegas, Nevada. The students will display their winning aircraft design along with other colleges from around the world and they will present their concept design to the AUVSI audience at the college forum.

- Northrop Grumman will provide airline tickets, hotel accommodations and transportation.
- The AUVSI Foundation will provide access to the AUVSI Convention and arrange the opportunity to present their project at the symposium.

The second place team will receive a prize sponsored by ADASI and the details will be announced shortly. ADASI also has scholarships available to grant to students with superior grades.

*All Awards are subject to certain eligibility requirements, including, but not limited to, U.S. immigration, legal or ethical restrictions.

5. Materials Provided to School

Northrop Grumman provided a complete set of components and tools necessary to fabricate a functional automated unmanned aerial vehicle. Teams are responsible for replacing lost or damaged parts.

Teams may purchase and/or use materials other than those provided except as follows: all teams must use and may not modify the provided battery, motor, speed controller, auto pilot components and transmitter radio unless prior approval is provided by the Northrop Grumman Engineering team.

A listing of Northrop Grumman provided materials as well as links to the suppliers is attached below.

Team Parts List.xlsx