31st Annual
American Helicopter Society International
Student Design Competition

2013 Request for Proposal (RFP)
for

X-VTOL

Sponsored by

AgustaWestland
A Finmeccanica Company

In collaboration with

ART | Advanced Rotorcraft Technology INC.

and

AHS INTERNATIONAL

REVISION 1 – JANUARY 20TH, 2014

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1.0 Basic Proposal Information

AgustaWestland extends greetings and invites you to participate in the 31st Student Design Competition (SDC) of the American Helicopter Society, International (AHS). This Request For Proposal (RFP) is divided into two sections. Section 1 (this section) provides a general description of the competition and the process for entering. This section covers the rules (both general and proposal specific) and schedules that the sponsor requires of the participants. It also describes the awards and provides contact information. Section 2 describes the specific challenge by AgustaWestland.

1.1 Rules

1.1.1 Who May Participate

All undergraduate and graduate students from any school (university or college) may participate in this competition, regardless of nationality. A student may be full-time or part-time; their education level will be considered in the classification of their team (see 1.1.3).

1.1.2 Team Size and Number of Teams

We encourage the formation of project teams. The maximum number of students on a team is ten (10); the minimum team size is one (1), an individual. Schools may form more than one team, and each team may submit a proposal, but each team is limited to a maximum of ten students. A student may be a member of one team only.

We look favorably upon the development of multi-university teams for the added experience gained in education and project management. The maximum number of students for a multi-university team is twelve (12), distributed in any manner over the multi-university team.

The members of a team must be named in the Letter of Intent. The Letter of Intent is drafted by the captain of a team and sent to the American Helicopter Society International by the date specified in section 1.3. Information in the Letter of Intent must include the name of the university or universities forming the team, the name of the team, the printed names of the members of the team from all the universities in the team, the e-mail addresses and education level (undergraduate or graduate) of each team member, the affiliation of each student in the case of a multi-university team, and the printed names and affiliations of the faculty advisors.

1.1.3 Categories and Classifications

The competition has two categories that are eligible for prizes. They are:

- Undergraduate Student Category

- Graduate Student Category

The classification of a team is determined by the highest education level currently pursued by any member of the team.

A "new entrant" is defined as any school (undergraduate or graduate) that has not participated in at least two of the prior three competitions. An additional prize will be awarded for the best proposal by a new entrant.

1.1.4 Language of Proposal

Regardless of the nationality of the teams, all submittals and communications to and from the American Helicopter Society International will be in English. All technical data shall be presented in English units

1.1.5 Proposal Format, Length and Medium

Two separate files comprise the Final Submittal and both must be present for a submission to be considered complete. The judges shall apply a significant penalty if either file is missing.
The two files are the Executive Summary and the Final Proposal. Each are described herein.

The first file is called the Final Proposal. It is the complete, self-contained proposal of the team. It shall be submitted in PDF form readable with Adobe Acrobat. Exceptions will be considered with advance request.

Undergraduate category Final Proposals shall be no more than 50 pages and graduate category Final Proposals shall be no more than 100 pages. This page count includes all figures, diagrams, drawings, photographs and appendices. In short, anything that can be read or viewed is considered a page and subject to the page count, with the following exceptions. The cover page, acknowledgement page, signature page, posting permission page (see section 1.1.9), table of contents, list of figures, list of tables, nomenclature, reference pages and the Executive Summary are excluded from the page count for the Final Proposal. See sections 1.1.6 for specific information about the signature page.

Pages measure 8 ½ x 11 inches. Undergraduate submissions may have four (4) larger fold-out pages with a maximum size of 11 x 17 inches, and graduate submissions may have eight (8) larger fold-out pages with a maximum size of 11 x 17 inches. If a submission exceeds the page limit for its category, the judges will apply a penalty equal to ¼ point per page over the limit.

All proposals and summaries shall use a font size of at least 10 point and spacing that is legible and enhances document presentation.

The second file is a PDF file called the Executive Summary. This is a self-contained "executive" briefing of the proposal. Both undergraduate and graduate category Executive Summaries are limited to twenty (20) pages measuring 8 ½ x 11 inches, with no more than four (4) larger fold-out pages of a maximum size of 11 x 17 inches. The Executive Summary can take the form of a viewgraph-style presentation, but it must be a PDF file readable with Adobe Acrobat. No additional technical content may be introduced in the Executive Summary. The judges shall apply the same page count penalty to the Executive Summary score as with the Final Proposal. The Executive Summary shall account for no more than 10% of the total score of the complete submission.

All submissions shall be made on a compact disc (CD). A back-up submission via e-mail to the AHS may also be provided by a team, but the submission will not be considered executed without receipt of a compact disc by the submittal deadline.

1.1.6 Signature Page

All submittals must include a signature page as the second page, following immediately after the cover page. The signature page must include the printed name, e-mail addresses, education level, (undergraduate or graduate), and signature of each student that participated. In the case of a multi-university team, the page must also indicate the affiliation of each student.

The submittals must be wholly the effort of the students, but Faculty advisors may provide guidance. The signature page must also include the printed names, e-mail addresses and signatures of the Faculty Advisors.

Design projects for which a student receives academic credit must be identified by course name(s) and number(s) on the signature page.

1.1.7 Withdrawal

If a student withdraws from a team, or if a team withdraws their project from the competition, that team must notify the AHS Headquarters Office in writing immediately.

1.1.8 Proposal Posting

The AHS will post the winning entries in the undergraduate and graduate categories on their web site. Other entries will be posted if the teams provide written permission by their team captain or designated point of contact and a faculty advisor at the time of submission. The written permission shall appear on a separate page immediately following the signature page. This permission page will not count against the total page count.

1.2 Awards

AgustaWestland is very pleased to sponsor the AHS Student Design Competition this year and will provide the funds for the awards and travel stipends.

Submittals are judged in two (2) categories.

Undergraduate category:

- 1st place - $800
- 2nd place - $400

Graduate category:

- 1st place - $1300
- 2nd place - $700

In addition, the best "New Entrant" (defined in section 1.1.3) will be awarded $300.

Certificates of achievement will be presented to each member of the winning team and to their faculty advisors for display at their school. The first place winner or team representative for the graduate and undergraduate categories will be expected to present a technical summary of their design at the 2015 AHS International Annual Forum. Presenters receive complimentary registration and will be provided up to $1000 in expenses to help defray the cost of attendance.

1.3 Schedule

Schedule milestones and deadline dates for submission are as follows:

Milestone	Date
AHS Issues a Request For Proposal	August 9, 2013
Submit Letter of Intent to Participate	No Later Than (NLT) February 14, 2014
Submit Requests for Information/Clarification	Continuously, but NLT March 7, 2014
AHS Issues Responses to Questions	NLT March 21, 2014
Teams submit Final Submittal (Final Proposal and Executive Summary)	NLT June 6, 2014
Sponsor notifies AHS of results	August 1, 2014
AHS announces winners	August 8, 2014
Winning team presents at AHS Forum	May, 2015

We reiterate; if you intend to participate, your Letter of Intent must arrive at the American Helicopter Society, International no later than February 14, 2014. The signature page must include all of the information requested in section 1.1.6.

All questions and requests for information/clarification that are submitted by teams to the AHS will be distributed with answers to all participating teams and judges. Entrants' requests for information and clarification will be answered as soon as possible. All of the questions and answers will also be distributed collectively to all entrants no later than March 21, 2014.

The Final Submittal must be postmarked by June 6, 2014.

1.4 Contacts

All correspondence should be directed to:

Ms. Kay Brackins, Deputy Director
AHS International
217 N. Washington Street
Alexandria, Va. 22314
Phone: (703) 684-6777
Fax: (703) 739-9279
E-mail: kbrackins@vtol.org

1.5 Evaluation Criteria

The proposals shall be judged on four (4) primary categories with weighting factors specified below.

A. Technical Content (40 points)

The Technical Content of the proposal requires that …

- The design meets the RFP technical requirements
- The assumptions are clearly stated and logical
- A thorough understanding of tools is evident
- All major technical issues are considered
- Appropriate trade studies are performed to direct/support the design process
- Well balanced and appropriate substantiation of complete aircraft and subsystems is present
- Technical drawings are clear, descriptive, and accurately represent a realistic design
- (Graduate) The simulation is of high quality and correctly portrays how the actual vehicle would operate

  NOTE for Graduate submittals: the simulation task will be judged up to 15 points. Of these, up to 10 points will be assigned for the quality of the simulation, while the additional 5 points will be assigned for use of Flightlab software.

B. Application & Feasibility (25 points)

The proposals will be judged on how well current and anticipated technologies are applied to the problem, and on the feasibility of the solution. The proposals must …

- Justify and substantiate the technology levels that are used or anticipated
- Direct appropriate emphasis and discussion to critical technological issues
- Discuss how affordability considerations influenced the design process
- Discuss how reliability and maintainability features influenced the design process
- Discuss how manufacturing methods and materials were considered in the design process
- Show an appreciation for the operation of the aircraft

C. Originality (20 points)

The originality of the proposal shall be judged on …

- How innovative is the solution
- How much does the solution demonstrate originality and show imagination
- Vehicle/system aesthetics

D. Organization & Presentation (15 points)

The organization and presentation of the proposal requires …

- A self-contained Executive Summary that contains all pertinent information and a compelling case as to why the proposal should win. It must be a separate file.
- An introduction that clearly describes the major features of the proposed system
- A well organized proposal with all information presented in a readily accessible and logical sequence
- Clear and uncluttered graphs, tables, drawings and other visual elements
- Complete citations of all previous relevant work (the State-of-the-Art)
- Professional quality and presentation
- The proposal meets all format and content requirements

The RFP describes the contest and the requirements including schedule, page count and other limits, and the basic rules.

1.6 Proposal Requirements

The Final Submittal needs to communicate a description of the design concepts and the associated performance criteria (or metrics) to substantiate the assumptions and data used and the resulting predicted performance, weight, and cost. Use the following as guidance while developing a response to this Request for Proposal (RFP):

A. Demonstrate a thorough understanding of the RFP requirements.

B. Describe how the proposed technical approach complies with the requirements specified in the RFP. Technical justification for the selection of materials and technologies is expected. Clarity and completeness of the technical approach will be a primary factor in evaluation of the proposals.

C. Identify and discuss critical technical problem areas in detail. Present descriptions, method of attack, system analysis, sketches, drawings, and discussions of new approaches in sufficient detail in order to assist in the engineering evaluation of the submitted proposal. Identify and justify all exceptions to RFP technical requirements. Design decisions are important, but so are process and substantiation.

D. Describe the results of trade-off studies performed to arrive at the final design. Include a description of each trade and a thorough list of assumptions. Provide a brief description of the tools and methods used to develop the design.

E. Section 1.1.5, titled “Proposal Format, Length and Medium” describes the data package that a team must provide in the Final Submittal. Specifically, the Final Submittal must contain at least two files transmitted on a Compact Disc. The first file is the Final Proposal, which is the full length, complete and self-contained proposed solution to the RFP. By self-contained, we mean that the proposal does not refer to and does not require files other than itself. The second file is an Executive Summary, which presents a compelling story why the sponsor should select your design concept. The Executive Summary should highlight critical requirements and the trade studies you conducted, and summarize the aircraft concept design and capabilities. Additional file required to run the team’s optional X-Plane model may also be included in the CD submission.

F. Judging will focus on innovative solutions, system performance, and system value.

2.0 System Objectives

2.1 Design Objectives

The United States Defense Advanced Research Projects Agency (DARPA), Tactical Technology Office (TTO), on February 25th, 2013 issued a Broad Agency Announcement (BAA) soliciting proposals on the design, development and demonstration of a Vertical Take-off and Landing (VTOL) experimental aircraft with exceptional performance in vertical and cruise flight, and operational capability through transition from vertical to forward flight.

The purpose of the DARPA VTOL program is to champion the design and development of sub-system technologies and integrated air vehicle configurations that will enable radical improvements in VTOL flight. AgustaWestland (AW) has decided that the general approach of this program is so interesting that, through the medium of the AHS Student Design Competition, students in academic institutions all over the world should be given the opportunity to submit their ideas for an advanced VTOL platform meeting the DARPA objectives.

References herein to the United States Defense Advanced Research Projects Agency or DARPA does not constitute or imply the endorsement, sponsorship or recommendation by the United States Government of this RFP, the American Helicopter Society International, the 31st Annual American Helicopter Society International Student Design Competition, Advanced Rotorcraft Technology or AgustaWestland. The views and opinions expressed in this RFP do not necessarily state or reflect those of the United States Government or DARPA.

2.2 Specific Objectives

2.2.1 Performance Objectives

The DARPA VTOL X-Plane is intended to establish key performance attributes to enable transformational mission capabilities on an objective aircraft. These include efficient sustained hover, long-range cruise, high useful loads and sustained flight at high speeds.

Specific performance metrics to be demonstrated jointly on the VTOL X-Plane are:
1. Sustained high speed flight at true airspeeds between 300 kt and 400 kt.
2. System (aircraft) hover efficiency within 25% of the ideal power loading (at sea-level standard conditions), which for open rotors (for example) is given by $PL = \kappa (2 \rho / DL)^{1/2}$, where $PL = T/P_{act}$, T = thrust required to hover, P_{act} = actual power required to hover, κ = aircraft non-dimensional coefficient of efficiency, ρ = density of air, DL = T/A, A = equivalent actuator disk area.
3. System (aircraft) cruise lift-to-drag ratio no less than 10.

4. Useful load fraction no less than 40% gross weight with a payload fraction no less than 12.5% gross weight.

The aircraft useful load for this program is defined as the aggregate weight of the fuel, flight crew, emergency and test equipment, and payload. Clear and detailed weight build-up statements will be required as part of the design submissions and must include aircraft empty weight, basic weight, operating weight and gross weights.
The submitted design shall be representative of a manned or unmanned flight demonstrator aircraft with a maximum gross weight between 10,000 lb and 12,000 lb.

Minimum vertical load factor envelope shall be -0.5 to +2.0G, throughout the speed range.
Structural safety margins shall be in accordance with relevant approved certification rules to be identified by the team (14CFR Part 27/29; MIL-HDBK-516B or similar). The chosen certification rule set shall be clearly identified in the proposal.

In a similar fashion to what is required in the DARPA BAA, the teams are mandated to select technologies that are conceivably scalable to be applicable on vehicles having a gross weight ranging between 4,000 and 24,000 lb. To this end a description of how each of the fundamental enabling technologies could be applied across this weight range will be required as part of the submittal.

The use of newer technologies (e.g., distributed systems, electric motors, hybrid and/or heterogeneous concepts) is welcomed, as long as it is explained how these technologies could be matured within the program to a level that would be suitable for inclusion on the proposed vehicle.

2.2.2 Powerplant model

In order to provide even judging of the proposals, it is required that the teams submit designs based on existing engine technology for all aircraft performance estimates.

Because of the tight timescale of the real program, even industry participants are limited to the use of existing engines.

In case that the actual performance datasets of the chosen engine are not available to the team, the engine performance model used to describe the engine shall be included in the report.

It is up to the sizing analyst to either derive or use appropriate component weight equations for all other aircraft components. A detailed weight breakdown of all components to Mil Standard 1374 is required.

2.2.3 Standardized Flight Profile for Derived Performance

Proposers are required to baseline and state the performance of their concepts and estimated efficiencies for a representative, standardized flight profile as given in Table 1. Specific performance information (e.g., power required, fuel burn for the segments, distances flown, ceilings, cruise altitudes, etc.) is requested against this profile. All analyses should be performed at the maximum gross weight of the vehicle. The flight profile is not intended to set a design point or mission scenario to size the proposed aircraft, but rather to set common rules from which concept capabilities can be ascertained.

Mission Segment	Time (min.)	Condition
Start-up/Warm-up/Taxi	10	Engine Idle, SLS
HOGE Take Off	1	95% Max. Power, SLS
Climb		To Best Alt., Vbroc
Cruise Out 1		Vbr, Best Alt., ISA
Cruise Out 2	15	Max. Sustained Speed, 95% Max. Power, Best Alt., ISA
Descend		To SLS, Vbroc
Mid Mission Hover	15	HOGE with Full Payload, 95% Max. Power, SLS
Climb		To Best Alt., Vbroc
Cruise In 1	15	Max. Sustained Speed, 95% Max. Power, Best Alt., ISA
Cruise In 2		Vbr, Best Alt., ISA
Descend		To SLS, Vbroc
HOGE Land	1	95% Max. Power, SLS
Shutdown/Taxi	5	Engine Idle, SLS

Table I – Standardized Flight Profile Description

In addition to the fuel necessary to perform the mission described in Table I, fuel capacity shall be determined so that reserve fuel for 20 minutes at Vbr, best altitude, ISA, remains on board upon landing.

2.2.4 Design

Inboard and outboard profiles of the aircraft showing locations of major components will be required as well as a weight, inertia, and C.G. analysis of the aircraft throughout its flight.

Preliminary structural design should show safe load paths for the major systems on board the aircraft and attention should be paid towards what happens to components in the unfortunate event of a crash.

2.2.5 Minimum Equipment List

Each aircraft must be configured with an avionics suite that meets minimum FAA requirements for flight in day VFR conditions. Appropriate weight allocation should be made for all components.

2.2.6 Additional Tasks (Graduate Category Only)

A simulation model of the vehicle must be developed by means of FLIGHTLAB software.
This model will represent the platform for carrying out the following activities:

- Performances and handling qualities analysis (with respect to Table I - Standardized Flight Profile Description)
- Development of flight control laws (FLIGHTLAB allows to obtain the whole set of on-axis and off-axis transfer functions for the basic control design).

Since the project will involve innovative and non-conventional vehicle configurations, it may be necessary (depending on the chosen configuration) to implement some additional functionalities in the FLIGHTLAB modeling environment, e.g. to model and control a multi-rotor configuration.
In order to develop an accurate simulation model, the following data shall be available as inputs to FLIGHTLAB:

- Geometry and inertial data (mass, moments of inertia, dimensions, CG/Weight envelope…)
- Aerodynamic data (rotor blades, fuselage, lifting and control surfaces…)
- Landing gears arrangement characteristics
- Engine characteristics and performance table (An ideal engine model is available into FLIGHTLAB, and can be used in a preliminary phase to establish the engine power requirements)

Teams must submit all the electronic files and documentation needed to run their model in the FLIGHTLAB environment or using other means.

Specific details for obtaining the necessary software license and support from ART will be provided to the Teams after receipt of the Letter of Intention to Participate.

ART will provide FLIGHTLAB licenses to all competing teams for the duration of the competition. ART will also provide a web-based training class on the use of FLIGHTLAB at the start of the competition and students will receive FLIGHTLAB documentation and training material with their FLIGHTLAB distribution. ART will also provide some Help Desk support to the competing teams during the competition but the teams should be aware that this support is limited.