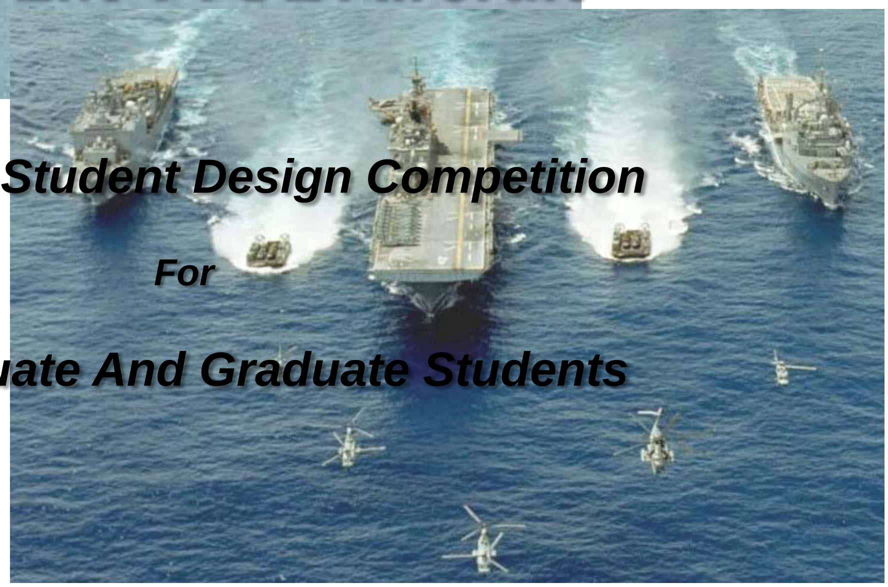
2005 Request For Proposal (RFP)

For a

Heavy Lift VTOL Aircraft



22nd Annual Student Design Competition

For

Undergraduate And Graduate Students

Sponsored by:

BOEING

And

AHS International
The Vertical Flight Society

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Section 1.0 Basic Proposal Information

I. Rules

1. Competition categories include:

    Graduate Student Team

    Undergraduate Student Team

    New Entry Team - from school which has not participated in at least 2 of the last 3 years

2. Schools are encouraged to form project teams, which can be based on applicable course curriculum or a special student activity. The maximum number of students on each team is 9.

3. All undergraduate and graduate students may participate in this competition. The classification of a team is determined by the highest education level of any member of the team. Part time students may participate at the appropriate graduate or undergraduate level.

4. "New Entry" team proposals will be judged in their appropriate graduate or undergraduate level competition, and evaluated for the New Entry Award from the group of all New Entry teams.

5. Only one design proposal may be submitted by each student or team; however, any number of design proposals are permitted from a university or college.

6. Final Proposals must be submitted to the AHS in digital format readable using Microsoft Word 2000, Microsoft PowerPoint 2000, and/or Acrobat Reader 5.0. (Requests for exceptions will be considered in advance). All Word documents submitted shall be double-spaced with a font of at least 10 point. All material must be legible.

    The Final Proposal will be due June 1, 2005. It shall be limited to no more than 75 pages (including all graphs, drawings, photographs, and appendices). Up to 8 of the 75 pages may be larger than 8½"x11", such as fold-outs up to a maximum size of 11"x22".

    The Final Proposal must include a self-contained Executive Summary briefing, in PowerPoint format, limited to no more than 20 pages. This summary is not to be considered a part of the 75 page limit.

7. All submittals must include a page which includes the printed name, educational level and signature of each student who participated. Submittals must be the work of the students, but guidance may come from Faculty and/or Industry Advisor(s), and must be acknowledged on this signature page.

8. All Submittals are to be provided to:

    Kim Smith, Deputy Director
    American Helicopter Society (AHS)

217 N. Washington Street
Alexandria, Virginia 22314
Tel. # ....(703) 684-6777
Fax # ....(703) 739-9279
Email ....kim@vtol.org

9. The Awards shall be:

Graduate Category

1st Place	$1000
2nd Place	$500

Undergraduate Category

1st Place	$1000
2nd Place	$500

New Entry Category

Best overall	$500

10. Certificates will be presented to each member of the winning teams, and to their Faculty Advisors for display at their school.

11. Graduate and Undergraduate winning teams are invited to make a presentation of their Executive Summary at AHS Annual Forum 62, May 2006. One representative of each team will receive complimentary registration to the Forum. Travel funds, up to $1000 per team, are available to reduce the cost of attendance.

II. Schedule & Activity Sequences

Scheduled milestones and deadline dates for submission of the proposal and related material are as follows:

A. AHS Issue of Request for Proposal (RFP).. August 1, 2004...
B. Teams Submit Requests for Information/Clarification........ up until February 15, 2005
C. AHS Issue Responses to Questions & Requests for Clarifications .... within 1 month
D. Teams Submit Final Proposals.. June 1, 2005
E. AHS Announces Winners.. June 10, 2005
F. Winning Teams Present "Executive Summary"...................... at Forum 62, May, 2006

Questions regarding clarification of the RFP put forward to the AHS (item B above) will be distributed with answers to all participating teams.

III. Proposal Requirements

The content of the full proposal response 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. The following should be used as guidance while developing a response to the Request For Proposal (RFP).

1. Demonstrate a thorough understanding of the RFP requirements.
2. Describe the proposed technical approach that 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
3. Identify and discuss critical technical problem areas in detail. Descriptions, method of attack, system analysis, sketches, drawings, and discussions of new techniques should be presented in sufficient detail to assist in the engineering evaluation of the submitted proposal. Exceptions to RFP technical requirements must be identified and justified.
4. Describe the results of tradeoff studies performed to arrive at the final design. Include a description of each trade and the list of assumptions. Provide a brief description of the tools and methods used to develop the design.
5. The data package which must be provided in the proposal is described in Section 2.0, IV.

The proposal package must also contain an Executive Summary Briefing (MS PowerPoint) highlighting critical requirements, trade studies conducted, aircraft concept design and capabilities, and your compelling story.

IV. Basis For Judging (Weighting Factors)

1. Technical Content (40 points)
    - Design meets RFP technical requirements
    - Assumptions clearly stated and logical
    - Major technical issues considered
    - Appropriate trade studies performed to direct/support the design process
    - Well balanced and appropriate substantiation of complete system
    - Technical drawings accurately describe the complete aircraft and its subsystems
2. Organization & Presentation (15 points)
    - Self contained Executive Summary which contains all pertinent information and makes a compelling case for why the proposal should win.
    - Introduction clearly describes the major features of the proposed aircraft
    - All pertinent and required information included and easy to find
    - Continuity of topics
    - Figures, graphs and tables are uncluttered and easy to read and understand
    - All previous relevant work cited
    - Overall neatness of report
3. Originality (20 points)
    - Treatment of problem shows imagination
    - Concepts show originality
    - Unique vehicle attributes and subsystem integration show innovative thinking
    - Vehicle aesthetics
4. Application & Feasibility (25 points)
    - Current and advanced technology levels used are justified and substantiated.
    - Particular emphasis should be directed at identification of critical technical problem areas.
    - How affordability considerations influenced the design process.
    - How reliability and maintainability features influenced the design process.
    - Manufacturing methods and materials are considered in the design process.
    - Proposal shows an appreciation of how the vehicle will be used by the operator.
    - Consideration of additional applications and capabilities other than those in the RFP.

Section 2.0 Design Objectives and Requirements

I. Mission Need

As the military continues to evolve its concept of operations, they are increasingly looking for ways to bypass traditional ports of debarkation for conflicts in and near unfriendly territories, and are attracted to the benefits of runway independence and "vertical envelopment" tactics. This project is a request for proposals for a Heavy Lift VTOL aircraft concept which can transport light combat vehicles over military ranges of interest, while being able to operate off of air capable naval ships. Currently, the development of US Army Future Combat Systems vehicles is approaching 20 tons for their heaviest configurations, and there is renewed emphasis for flexible mission basing, including 'from the sea'. There are currently no shipboard compatible rotorcraft which can lift and transport such vehicles.

II. Project Objectives

The objective of this design competition is to develop the conceptual design of a modern military Heavy Lift VTOL aircraft. The vehicle must be able to live on (i.e. be maintained) and operate from existing naval ships, yet be able to transport a 20 ton FCS combat-ready vehicle. A balanced approach to shipboard compatibility, cruise speed, method of vehicle handling, and load/unload timelines is needed in order to provide an effective asset. The primary measure of merit will be the timeline for one aircraft to deliver (4) FCS combat vehicles versus the predicted acquisition cost of the aircraft.

Shipboard compatibility presents many design challenges for vehicle concept design, including deck operations with other aircraft, and maintenance and support issues. While flight operations can be modified and adjusted for aircraft and operational peculiarities, there are a few ship-based constraints that must be taken into consideration early in the design, particularly to facilitate on-board maintenance activities. These include hangar deck access limits of maximum folded height, and elevator size and weight limits.

In apparent conflict with the need to control the folded height limit, there is a desire to maximize cruise airspeed by configuring a fuselage which will accommodate internal loading of the combat vehicles. Combat vehicle restraint schemes, and internal or external load/unload times, are important mission-time factors, also.

The aircraft size will determine whether they could potentially be based on the Amphibious Assault ships (L-Class), or if they will need to be based on larger aircraft carriers (CVN).

In addition to the primary role of transporting combat vehicles, the aircraft must be flexible enough to be configured for cargo sustainment missions, and be able to transport at least (2) 463L fully-loaded pallets.

III. Requirements and Constraints

1.0 General Requirements

The US Army requires a dual-piloted, vertical takeoff and landing (VTOL) aircraft. The aircraft shall incorporate high value technologies in airframe, propulsion, cargo handling, and aircraft human factors engineering. The new system will provide dramatic improvements in operational flexibility, and mission performance.

The aircraft must have capability for intra-theater deployment of 1000 nm range, without refueling.

It is anticipated that launch of the configuration will lead to Initial Operational Capability (4 aircraft delivered to operational users) in the year 2018. The anticipated fleet size is 200 aircraft, delivered over a 15 year manufacturing period.

2.0 Mission Profile Requirements

The aircraft mission performance needs to be sized to the sea-basing concept. For this Heavy Lift VTOL aircraft development, the objective landing zone is 100 nm inland from the shore, amphibious assault ships (L-class) will be able to operate in to 25 nm off the shore, and aircraft carriers (CVN) will limit their operations to 100 nm off the shore. The aircraft sizing trade study should be based on the following mission profile, all conducted for ISA + 20 degC ambient condition:

<u>Segment</u>
10 min. warmup @ idle @ Sea Level
1 min Hover OGE shipboard take-off. Additional time should be allotted for vehicle pickup, if necessary, such as for external load attachment and lift.
Climb to 3000’ altitude
Cruise at 99% best range speed for required outbound radius (with external drag, as applicable)
15 minute loiter near landing zone for mission cueing.
3 minute Hover OGE, at 3000’.
Add appropriate Hover and/or ground time allotment for combat vehicle disconnect and unloading.
Return cruise at 99% best range speed.
2 min Hover OGE for shipboard landing (Sea Level)
Land with 20 min. loiter fuel reserve @ 500 ft
Prepare and refuel (as required) for follow-on mission cycles.

3.0 System Capabilities Required

- The aircraft must also be capable of power-off glide/autorotation to a survivable emergency landing.

- Powered rotor blade folding is required, along with airframe folding if deemed necessary for elevator and/or hangar deck access.

- Normal load factor structural capability at design takeoff gross weight should be at least -0.5g to +2.5G. Sustained turn rate capability at cruise speed shall be at least 2x standard rate turn.

- For maximum takeoff and landing safety, the aircraft must provide a one engine inoperative (OEI), hover-out-of-ground-effect (HOGE) capability at 60% fuel and full payload capacity using no more than Emergency power at sea level, ISA+20°C ambient conditions.

- A flight crew of three is required, with side-by-side cockpit (pilot and copilot) seating, and cabin seating for a crew chief.

- Accommodation for an FCS vehicle crew of (2) must be provided. Consideration for cabin oxygen or pressurization is required if sustained cruise above 10,000’ pressure altitude is used.

- Missile warning systems and countermeasures must be included (RF and IR)

- The design must include a mission equipment suite (navigation, sensors, communication gear, etc.) suitable to perform flight operations in adverse weather conditions and night operations.

- The aircraft must be designed to facilitate basic aircraft maintenance. The design must facilitate access for inspection and rapid repair/replacement of all aircraft components (engines, transmission(s), avionics, hydraulic/electrical/fuel/cooling systems, flight controls, etc.).

- The design must consider the elements of good crashworthiness design, including:

    - Landing gear struts that do not penetrate the cabin area
    - High mass items (engine and transmissions) that have adequate crash protection to prevent entry into the cabin areas
    - Crashworthy fuel tanks,
    - Adequate seat stroke (at least 8 inches).

- Emerging turboshaft engine technology levels may be assumed, including IHPTET III technologies.

4.0 Data Package

These data are provided as reliable estimates but should be afforded some level of scrutiny in any rigorous analysis. Changes are acceptable with supporting technical data.

Weights and Dimensions

Fixed Equipment Weights (as required)

Avionics	1200 lb

Personnel Weight

Flight Crew	200 lb each
FCS combat crew	220 lb each

Shipboard Hangar Deck Constraints (US Navy examples)

	CVN	L-class
Elevator Weight	130,000#	75,000#

This weight limit is applicable to aircraft weight empty, plus 5,000 lb margin for tug, personnel, and misc equipment.

	CVN	L-class
Max Folded Height	25 ft	19 ft
Elevator size	85’x52’	50’x44’
	1 open edge	3 open edges

FCS Combat Vehicle Dimensions

- Fits in C-130 cabin cross-section (102” high x 107” wide) x 240” long
- Tracked or wheeled vehicles
- 20ton combat-ready weight (includes partial fuel, water, ammunition, crew of 2)
- attachment points available for internal or external load carriage

463L Pallet

88” x 108” footprint
netted loads, up to 96” high, and up to 10,000 lb

IV. Proposal Data Package Requirements

The design proposed must meet the above stated objectives, requirements, and constraints. The following data shall be furnished:

1. Justification for the air vehicle design submitted. Include discussion of the tradeoff studies (describe analysis methods and tools) that were performed to arrive at the proposed design, including assessment of the timeline measure of merit versus acquisition cost. Present the aircraft mission performance, weight, handling qualities, reliability and maintainability, manufacturing materials and techniques, and cost criteria by which the final design was chosen. Include the sizing trade study results to show how the pertinent vehicle configuration parameters were chosen, such as rotor system size, type of anti-torque system, wing span and aspect ratio, engine size, etc.

2. A set of drawings which depict the air vehicle and includes, but is not limited to:
   - Fully dimensioned three view drawings
   - A dimensioned system integration/general arrangement (inboard profile) which shows the location and arrangement of the major subsystems.
   - If the proposed aircraft concept requires conversion between different flight modes, a description of the means to provide this shall be provided.

3. Acquisition cost of the air vehicles shall be estimated. Assume a production run of 200 aircraft. Include a description of the methods and data used for cost analysis.

For Graduate Teams, provide additional detail on 5 of the following:
For Undergraduate Teams, provide additional detail on 3 of the following:

A. The structural design, including materials, must be described. Weight breakdowns for the vehicles shall be provided in MIL-STD-1374, Part I format (or similar). Weight and balance charts must be provided with the weight statement. The center of gravity and its allowable travel shall be indicated on the three-view drawings, along with tip-over and tip-back angles. Landing Gear concepts and any kinematic arrangements are required.

B. Describe the analysis methods and the results of the flight performance (including rotor performance), stability and control, and handling qualities evaluations of the design. A description of the flight control system shall be provided. Flight stability should consider external load, if applicable to your design approach.

C. A description of the engine installation and drive system shall be provided, along with tables or graphs of powerplant performance (installed engine power and/or thrust available as appropriate for the aircraft concept, along with fuel flow, etc.). If the engines selected are not existing engines, provide a discussion of the technology involved and the current state of development of such engines.

D. A description and associated drawings of both the cockpit and cabin crew areas, with a description of the mission systems (avionics) suite. Existing equipment (off-the-shelf) as well as equipment with new/unique requirements shall be described.

E. Development of the subsystem approach for traditional functions of electrical, hydraulics, pneumatics, fuel, and environmental control system services and distribution. Load sizing, redundant distribution of system elements, and any unique approaches should be explained.

F. Reliability and maintainability aspects of the air vehicle design shall be addressed. Configuration and other features such as easy access to avionics, quick engine removal, minimum of special tool, unique designs, etc.

G. Manufacturing approaches and risks for non-traditional hardware designs shall be addressed. Identify specific material handling, manufacturing tolerance, or other unique concerns introduced by your design.

H. Optional discipline of specific interest to your team, with sufficient depth and air vehicle significance to demonstrate technical understanding of your analytical or test results, and potential aircraft issues.