32nd Annual AHS International
Student Design Competition

2015 Request for Proposal (RFP)
For

Distributed Logistics in an Urban Setting Using Small Unmanned Aerial Vehicles

Sponsored by

and

August 25, 2014

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1.0 Basic Proposal Information

Thank you for your interest in participating in the 32nd Annual American Helicopter Society (AHS) International Student Design Competition (SDC). 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 the schedule required of the participants. It also describes the awards and provides contact information. Section 2 describes the specific challenge presented by The Boeing Company, which was developed by the AHS International Student Design Steering Committee, including representatives from The Boeing Company and the US Army's Aviation and Missile Research, Development and Engineering Center's (AMRDEC) Aviation Development Directorate (ADD).

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 from a single school 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 collaboration and project management. The maximum number of students for a multi-university team is twelve (12).

The members of a team must be named in a Letter of Intent. The Letter of Intent is submitted by the captain of a team and sent to AHS 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, as well as contact information for the team captain.

1.1.3 Categories and Classifications

The competition has three categories that are eligible for prizes, as well as a bonus category. They are:

- **Undergraduate Student Category (1st, 2nd, 3rd)**

- **Graduate Student Category (1st, 2nd, 3rd)**
  NOTE: The classification of a team is determined by the highest educational level currently pursued by any member of the team.

- **New Entrant**
  A new entrant is defined as any school (undergraduate or graduate) that has not participated in any of the last three prior competitions. Teams are eligible to win an award in the Undergraduate or Graduate Student Category and as a New Entrant.

- **Bonus: Hardware Validation (Optional)**
  A bonus is available to one undergraduate and one graduate team for successfully planning and conducting a hardware validation activity.

1.1.4 Language of Proposal

Regardless of the nationality of the teams, all submittals and communications to and from AHS International will be in English. Clarity of writing and proofreading are important.

1.1.5 Units Used in Proposal

All proposals shall provide numeric values in English units, with SI units desired. If the primary units are in SI, they shall be followed by English units in parentheses. The use of units shall be consistent throughout the proposal. All monetary amounts are to be in US Dollars.

1.1.6 Proposal Format, Length and Medium

Two (three including the optional Hardware Validation video file) separate files comprise the Final Submittal for undergraduate and graduate teams. Both must be provided 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 Final Proposal. If a team completes Hardware Validation, an addendum to the Final Proposal and a separate video file will be permitted. Each is described herein.

The first file is the Final Proposal. It is the complete, self-contained proposal from the team. It shall be submitted in PDF format. 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. Note that a 15-page addendum is permitted for teams completing the Hardware Validation task. The addendum should be a standalone section attached to the end of the Final Proposal; unused pages (i.e., if all 15 pages are not used) cannot be added to the page count for the Final Proposal itself. All pages are to be numbered. These page counts include 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 – these are excluded from the page count for the Final Proposal. See section 1.1.7 for specific information about the signature page.

Pages measure 8 ½ x 11 inches. Undergraduate submissions may have four (4) larger foldout pages with a maximum size of 11 x 17 inches, and graduate submissions may have eight (8) larger foldout 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 12 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 foldout 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 in PDF format. 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.

Hardware Validation video file (optional). If a team completes the optional Hardware Validation task, it may submit a video (up to 5 minutes in duration) of the experiment/test. Video format must be PC compatible. The file name must clearly indicate the team name.

All submissions shall be made electronically through secure file transfer means. The details will be provided to all teams who submit a Letter of Intent.

1.1.7 Signature Page

With the exception of the optional Hardware Validation video, 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. Industry and other outside advisors are permitted, as long as they do not steer the students and the work remains entirely that of the students. All advisors should be stated on the acknowledgement page.

1.1.8 Withdrawal

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

1.1.9 Proposal Posting

AHS will post the winning entries in the undergraduate and graduate categories on its website. By entering the competition, you are giving AHS International permission to post your entry online if selected as a winner. Other entries may 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 page count. Specific permission must be provided for the optional Hardware Validation video files to be posted.

1.2 Awards

The Boeing Company is very pleased to sponsor the AHS Student Design Competition this year. The Boeing Company will provide the funds for the awards through AHS International. All award monies will be provided in US Dollars. Submittals are judged in three (3) categories:

Undergraduate category:

- 1st place: $2,000
- 2nd place: $1,000
- 3rd place: $500
- Best New Entrant: $500

Graduate category:

- 1st place: $2,500
- 2nd place: $1,250
- 3rd place: $750
- Best New Entrant: $500

Hardware validation bonus (optional): $500 (one undergraduate and one graduate team winner) awarded independent of the paper design portion of the competition.

Certificates of achievement will be presented to each member of the winning teams and to their faculty advisors for display at their school. The first place winner or a team representative each for the graduate and undergraduate categories is expected to present a technical summary of their design at AHS International's 72nd Annual Forum & Technology Display during May 17-19, 2016 in West Palm Beach, Florida, USA. AHS will provide the presenters with complimentary registration and payment of up to $1000 in travel expenses for each 1st place team to help defray the cost of attendance.

1.3 Schedule

Schedule milestones and deadline dates for submission are as follows:

Milestone	**Date**
AHS issues Request For Proposal	August 25, 2014
Submit Letter of Intent to Participate	No Later Than (NLT) 9 February 2015
Submit Requests for Information/Clarification	Continuously, but NLT 27 February 2015
AHS issues Responses to Questions	NLT 26 March 2015
Teams submit Hardware Validation (optional) pre-test predictions	NLT 3 April 2015
Teams submit Final Submittal (Final Proposal and Executive Summary) and optional Hardware Validation addendum	NLT 29 May 2015
Student Design Steering Committee completes judging	6 August 2015
AHS announces winners	20 August 2015
Winning team presents at AHS Forum 72	17-19 May 2016

Again, if you intend to participate, your Letter of Intent – submitted electronically – must be received by AHS International no later than 9 February 2015. The signature page must include all of the information requested in section 1.1.7.

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/clarification (questions) will be answered as soon as possible. All of the questions and answers will also be distributed collectively to all entrants no later than 26 March 2015.

The Final Submittal files must be received by 29 May 2015.

1.4 Contacts

All correspondence should be directed to:

Ms. Kay Brackins, Deputy Director
AHS International
2701 Prosperity Ave., Suite 210
Fairfax, VA. 22031 USA
Phone: 1-703-684-6777 x103
Fax: 1-703-739-9279
E-mail: kbrackins@vtol.org

1.5 Evaluation Criteria

The competition has two complementary activities which will be evaluated separately. The primary activity is associated with the design of an air vehicle. An optional hardware validation activity, informed by the proposed air vehicle, may also be entered and will be judged separately.

1.5.1 Vehicle Design Activity

Vehicle design proposals shall be judged in four (4) primary categories with the weighting factors specified below (100 points total).

A. Technical Content (40 points)

The Technical Content of the proposal requires that:

- The design meets the RFP technical requirements (Undergraduate Only)
- The proposed system of systems and derived vehicle system requirements are consistent with the concept of operations (Graduate Only)
- The vehicle design meets the derived system requirements (Graduate Only)
- The assumptions are clearly stated and logical

- A thorough understanding of tools used is evident and their use is appropriate and sufficient for the application
- 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

B. Application & Feasibility (25 points)

The proposals will be judged on the appropriateness of the proposed aircraft to the mission requirements, how well current and anticipated technologies are applied to the problem, and the feasibility of the solution. The proposals must:

- Defend the choice of the aircraft based on the mission requirements (Undergraduate) or system-of-systems approach based on concept of operations (Graduate)
- Justify the choice of technologies and substantiate the technologies as being within the state of the art
- 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 (All) and provide results of operational simulation (Graduate Required)

C. Originality (20 points)

The originality of the proposal shall be judged on:

- The solution's level of innovation
- How much the solution demonstrates originality and 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
- 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 that demonstrates the technologies chosen are state-of-the-art
- Professional quality and presentation
- Proposal compliance with all format and content requirements

The RFP describes the contest and the requirements. Schedule, page count and other limits, and the basic rules are part of the RFP and will be judged under section 1.1.

1.5.2 Optional Hardware Validation Activity

This competition includes an optional hardware validation activity that will be judged independently of the vehicle design competition. The focus of this activity is on the approach to hardware validation and its completeness, not necessarily the end results of the testing. Detailed criteria for this portion of the competition are provided below (40 points total).

A. Test Plan Preparation (10 points)

- Clearly identified test objective that adds to the substantiation of the proposed vehicle concept
- Identified parameters requiring measurement and necessary measurement accuracy and precision
- Clearly identified resources necessary to complete test program

B. Pre-test Predictions (15 points)

- Appropriate analysis identified for necessary performance predictions
- Clearly identified assumptions
- Estimate of prediction accuracy

C. Data Reduction and Results Reporting (15 points)

- Tares and instrumentation calibration information reported
- Measurement accuracy and repeatability reported
- Clearly labeled figures and data tables
- Raw data reduced to meaningful engineering quantities of interest to demonstrate validation of hardware performance

- Summarized impacts to the proposed design based on test results

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 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. An explanation of the choice of the type of aircraft being offered is expected. 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 any 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 and an explanation of why you chose the particular tools and methods.

E. (Optional) Include the addendum documenting hardware validation activity, including pre-test predictions. Note: Pre-test predictions, not to exceed five (5) pages, shall be e-mailed to the AHS contact no later than 3 April 2015. These pre-test predictions are part of the page count for the 15-page optional Hardware Validation addendum.

F. 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 two files. 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 judges should select your design concept as the winner. The Executive Summary should highlight critical requirements and the trade studies you conducted, and summarize the aircraft concept design and capabilities. Note that the optional Hardware Validation video file is a third file.

2.0 System Objectives

2.1 Operating Concept

Continuing advances in microprocessors, microelectronic sensors, electric motors and batteries point to emerging opportunities to provide rapid aerial delivery of small cargos over the "last-mile," directly to the point of need. These small UAS logistics vehicles, when working together with larger cargo air vehicles, can form a complete aerial shipping system that rapidly takes goods from factory/warehouse all the way to the individual consumer. Such a system of vehicles has been seen as having positive impacts in both the commercial marketplace, where on-demand delivery is a premium service, and the military where getting supplies to the *point-of-the-spear* quickly and efficiently by air has been shown to improve military effectiveness and reduce soldier exposure to enemy forces. This RFP explores the design of such a small, distributed logistics, delivery vehicle and its role in a large logistics system concept.

2.2 Specific Objectives

The competition is divided into three tasks. **Undergraduate student teams are required to complete Task 1: Undergraduate Vehicle Design. Graduate student teams will complete Task 2: Graduate System of Systems Design**. Task 3: Hardware Validation is an optional task for both undergraduate and graduate teams and will be scored separately from the main competition. Teams should consider state-of-the-art technology in their designs. For the purposes of this RFP, state-of-the-art technology is any technology that can be justified as being at least technology readiness level (TRL) 3 as of end of calendar year 2014.[1]

2.2.1 Task 1: Undergraduate Vehicle Design

2.2.1.1 Primary Mission. The vehicle shall be capable of carrying a logistics payload of 13 lb an unrefueled distance of 10 statute miles (mi) from a central supply location to the point-of-need and then returning to the central supply location without a payload. The mission shall include a 1 min hover at the start the mission and an additional 1 min hover at the point-of-need followed by landing and unloading the payload. Hover shall be assumed to occur 10 ft above the ground, measured from the lowest point of the combined vehicle and payload. As a margin on maneuver performance, the propulsion system shall be designed to generate a sustained vertical lift force of at least 110% of the max take-off gross weight in hover. Hover and forward flight performance shall be calculated in a 6000 ft / 95°F atmosphere (ISA + 57.4°F). Flight shall be limited to 500 ft AGL with ground level of 6000 ft.

2.2.1.2 Logistics Payload. The vehicle shall accommodate a logistics payload of 13 lb and 12 in x 8 in x 12 in in dimension in an enclosed, weather-proof payload container or fairing. The

[1] See DOD Deskbook 5000.2-R, Appendix 6, "Technology Readiness Levels And Their Definitions" https://acc.dau.mil/adl/en-US/23170/file/2350/TRL50002R.doc

payload container or fairing shall include provisions to allow for the rapid (<1 minute) loading and unloading of the payload. Unloading of the payload shall be automated. Additionally, the vehicle shall be capable of carrying oversized payloads of up to 13 lb externally, using a cargo carrying net (or similar) attached via a single point to the vehicle. When carrying an external load, the payload container or fairing may be removed from the vehicle.

2.2.1.3 Environmental Impact. The vehicle shall be designed to minimize impact on the environment with respect to energy consumption, emissions and acoustic signature.

2.2.1.4 Precision Departure, Approach and Hover. The vehicle shall be capable of operating to and from a landing spot by transiting an unimpeded airspace region defined by a cylinder 10 ft radius and 50 ft in height as depicted in Figure 1. The vehicle shall also be capable of hovering for 1 minute, while remaining within that cylinder, and placing the payload within 95% circular error probable of not more than 2 ft radius of the designated delivery point, with winds at 10 knots gusting to 15 knots.

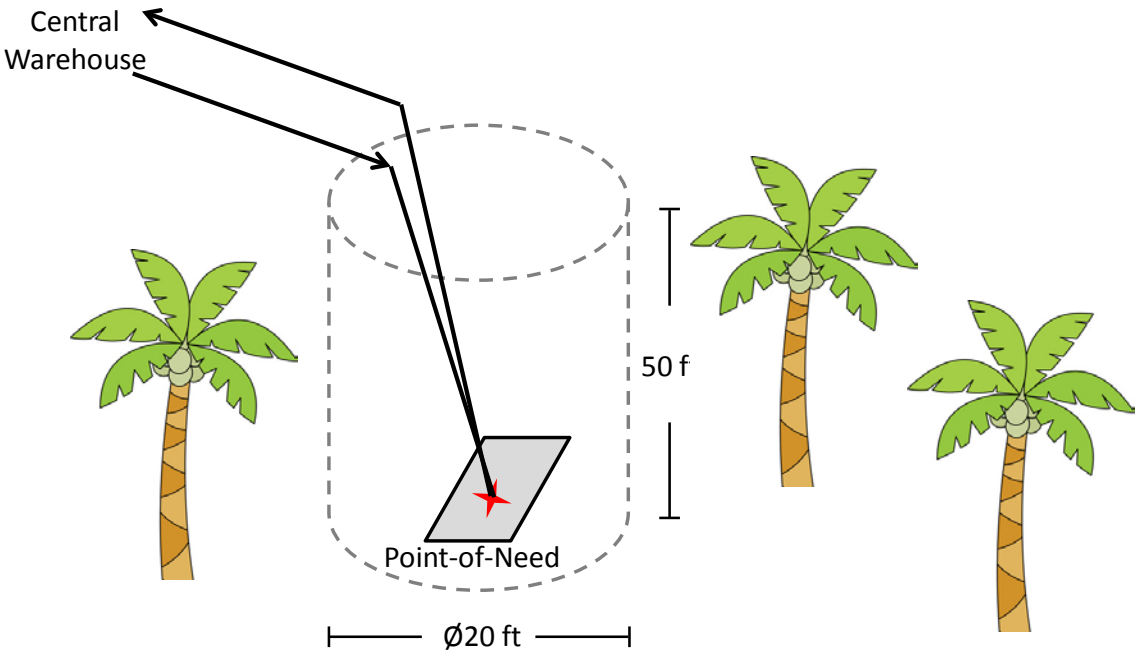

Figure 1: Safe approach/departure corridor near point-of need

2.2.1.5 Avionics. The vehicle shall be capable of autonomous flight operations using the customer-furnished avionics package specified in

Table **1**. Continuous contact with a central ground control center shall be maintained, providing aircraft telemetry data and ability to dynamically re-task the vehicle.

Table 1: Summary of customer supplied avionics equipment

Function	Component	Continuous Power (W)	Peak Power (W)	Weight, (lb)	Dimension (L x W x H), (in)
Mission Manager	CPU	0.2	0.4	0.1	4.0 x 1.0 x 0.2
Flight Controller	CPU	0.1	0.2	0.1	3.0 x 2.0 x 0.5
Telemetry	Processor, 3G antenna	0.5	1.0	0.1	3.0 x 2.0 x 0.2
Visual Sensor	Camera	0.05	0.05	0.1	0.5 x 0.5 x 0.5
GPS/INU	Antenna/ controller	0.2	0.2	0.1	1.0 x 1.0 x 0.5

2.2.1.6 Maintainability. A modular system design shall be utilized such that the time to replace any component shall not require more than 1 person-hour of labor to accomplish.

2.2.1.7 Productivity. The vehicle's productivity shall be defined as the total lb-mi achieved in one day (number of missions in 10 hr x 10 mi x 13 lb). Turn-around time between two missions, for a single vehicle, shall be not more than 15 minutes. A single system shall be defined to include all the provisions necessary to achieve the number of missions used to in determining the system productivity as defined above.

2.2.1.8 Safety. The vehicle shall be designed such that given a loss of power, during any phase of flight and at 50 ft AGL or higher, the aircraft and payload shall be able to accomplish a safe landing on level terrain. Using the customer provided avionics package, the vehicle shall be capable of autonomously operating in an urban obstacle environment. Segments of the mission operated between 100 ft AGL and 500 ft AGL may be assumed to be free of stationary obstacles, below 100 ft AGL forward speed shall be limited such that the vehicle can come to a stationary hover in not more than 400 ft horizontal distance, with no change in vehicle altitude. The safety requirements apply to the vehicle when carrying either an internal or external payload.

2.2.1.9 Desired Data Deliverables. The following deliverables are required for the undergraduate teams and shall be provided in the format described in Section 1.1:

1. General description of the proposed vehicle which highlights how it meets the stated requirements.
2. Three-view drawings of the vehicle showing the placement of major components

3. Segment by segment summary of the mission performance including flight speed, energy consumed and power required for the entire vehicle system.
4. Performance data at the individual component level (rotor, transmission, etc) that substantiates the cruise and hover total power required used in the mission performance analysis.
5. A detailed weight statement with substantiating analysis.
6. Turn-around timeline showing steps necessary to prepare the vehicle for the next mission
7. An estimate of the cost to produce the vehicle based on assembly labor and bill of materials.
8. An estimate of the direct operating cost to operate the vehicle for 365 days, assuming 6 days per week at 10 hours per day of operation.
9. An estimate of the system dispatch reliability, and probability of mission abort due to mechanical malfunction.

2.2.2 Task 2: Graduate System of Systems Design

2.2.2.1 Concept of Operations. On overall concept of operations (OV-1) is provided in Figure 2.

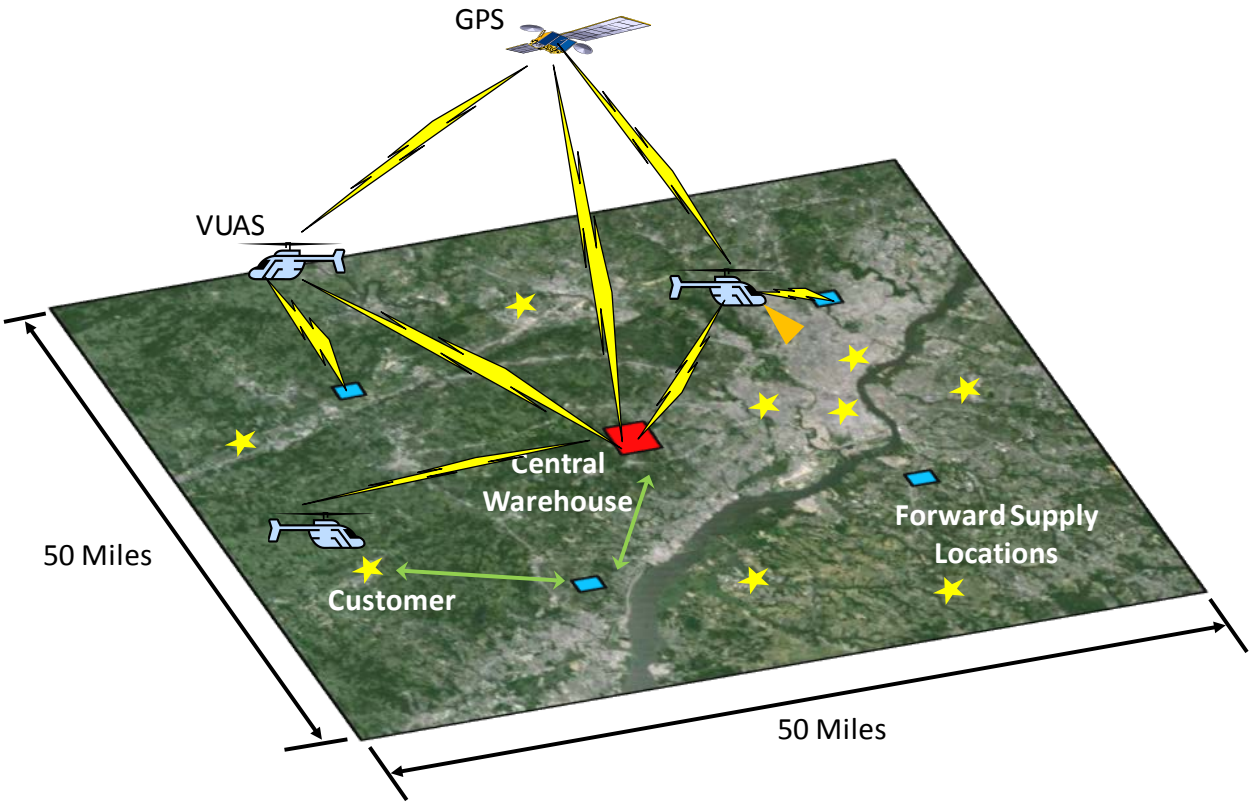

Figure 2: OV-1

A logistics company desires an aerial system of systems approach to deliver cargo to customers in a 50 mi x 50 mi area from one central storage/distribution warehouse. Additional forward supply locations are acceptable, but they are expected to only contain packages in the process of being shipped that day to/from customer locations. The company has provided the information regarding the distribution of cargo sizes that are shipped daily through their system (Figure). In addition, 90% of their shipments can be contained within a volume measuring 12 in x 12 in x 16 in. For larger shipments, external slung load delivery of the package is acceptable. The final destinations of the cargo can be assumed to be evenly distributed throughout the delivery area. The company expects to move 5,000 packages per 10 hr delivery day from the central distribution warehouse to customers. The company desires to deliver those packages within 2 hours from the time the delivery is requested by the customer. Customers request delivery of packages in uniformly random fashion within the first 8 hours of the delivery day.

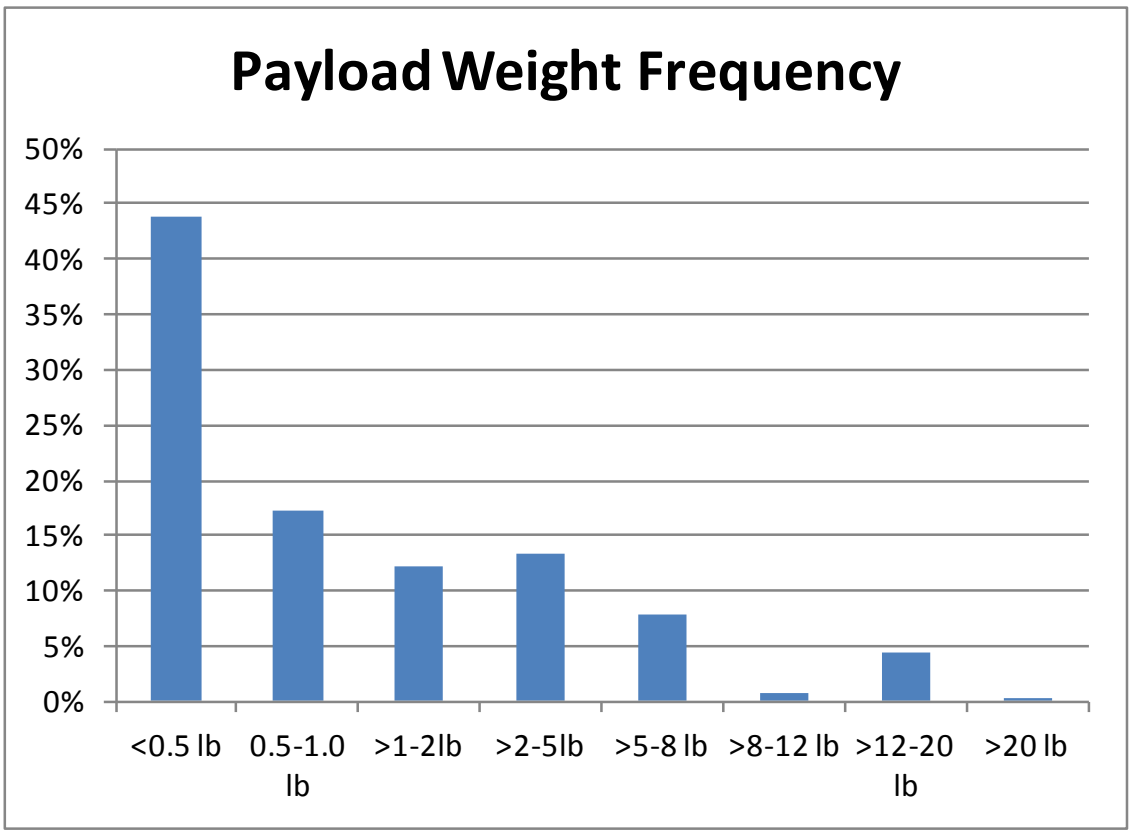

Figure 3: Frequency of delivery categorized by payload weight (lb)

The company has identified a number of Measures of Effectiveness (MoEs) for this system including:

- System acquisition and yearly system operating costs
- Number of packages delivered per vehicle per day
- Number of events where the time between customer's request for a package and the actual delivery exceeds 90 minutes

- Pounds of CO_2 emitted/delivery mile flown (based on daily average)
- Percentage of delivery missions successfully completed

The graduate teams' task is to design a system solution that includes the aerial vehicle that will provide the service to the customer's home from a node in the logistics' company infrastructure (final node is not necessarily the central warehouse, but depends on the proposed system solution). The team must describe how this vehicle fits into the systems of systems approach needed by the logistics company to meet the scenario described above; this may include additional vehicles and logistics nodes not specifically being designed in this task. Further, the customer requests a simulation of the system of systems for an average day to gain insight into how the system will operate, and a substantiation of the team's estimates for the MoEs identified above.

2.2.2.2 Potential Questions for Consideration. The following is a non-exhaustive list of questions the customer has raised about the potential vehicle:

- Do they need more than one vehicle design to accomplish the mission?
- What is the max payload each vehicle should be designed to carry?
- What is the design range of the vehicle?
- Do they need other operating locations inside the 50 mi x 50 mi area besides the central storage/distribution warehouse? What activities should occur at those locations?
- What does the operating flight profile look like?
- What flight control/vehicle automation technology is required to operate the vehicles such that they can deliver all the way to their customer's "door"?
- Can this be done with some form of hybrid or electric propulsion?
- What are the trade-offs between designing for repair vs. designing for inexpensive replacement of the vehicle or its components?
- How much is it going to cost to acquire these vehicles?
- How much is it going to cost to operate these vehicles for 3 years?

2.2.2.3 Cost and MoE Ground Rules. The following cost (in US Dollars) and MoE ground rules are provided:

- $15/sq-ft monthly rent for any location required outside the central distribution warehouse
- $5/gal for liquid fuel
- $0.18/kW-hr for electricity (only count electricity consumed by vehicles)
- 1.2lb of CO_2/kW for grid based charging (based on US average)
- $100/hr for vehicle repair labor and vehicle operators/monitors
- 3 year operating life of designed vehicle (operated 300 days a year)
- $200,000/lb of weight empty for development cost
- Life-cycle cost in constant year 2014 dollars

2.2.2.4 Desired Data Deliverables. The following deliverables are required for the graduate teams and shall be provided in the format described in Section 1.1:

1. Performance requirements to which the vehicle is designed.
2. General description of the proposed vehicle which highlights how it meets the stated requirements.
3. Three-view drawings of the vehicle showing the placement of major components
4. Segment by segment summary of the mission performance including flight speed, energy consumed and power required for the entire vehicle system.
5. Performance data at the individual component level (rotor, transmission, etc) that substantiates the cruise and hover total power required used in the mission performance analysis.
6. A detailed weight statement with substantiating analysis.
7. Turn-around timeline showing steps necessary to prepare vehicle for next mission.
8. Life-cycle cost estimate.
9. System simulation results, including probability of package delivery within 2 hour of delivery request.
10. Discussion of the proposed concept of operations, including regulatory and technical challenges.
11. A prediction of the acoustic signature of the vehicle(s) under the FAA flyover rules.

2.2.3 Hardware Validation (Optional)

Both the undergraduate and graduate design competitions teams are given the opportunity to develop a hardware validation test to help substantiate the validity of the claims made regarding their design. The details of the test activity are left to each team to determine, but should address the criteria set forth in the evaluation guidelines presented in section 1.5.2. Those teams choosing to participate in this task shall develop a test plan, identify pre-test predictions and submit them ahead of testing, perform data reduction, and report on the results.