2003 American Helicopter Society Student Design Competition

VTOL Urban Disaster Response Vehicle

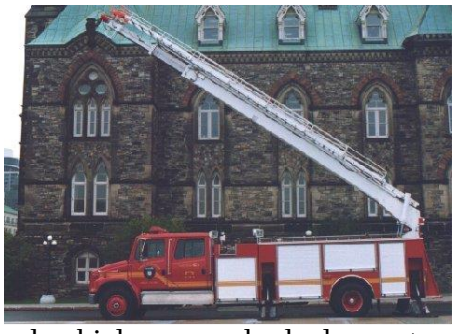
Sponsored by Sikorsky Aircraft and NASA

Introduction:
On the anniversary of the destruction of the World Trade Center, emerging rotorcraft design students have the opportunity to help the rotorcraft industry explore how it can best help support disaster response in urban environments in the future. The 2003 AHS student design competition challenges rotorcraft designers to perform the concept design of a vertical takeoff and landing vehicle capable of savings lives and protecting property in demanding urban high rise environments.

The Problem:
Disaster response in urban environments is challenging due to the density of buildings, building heights, and access road congestion. Current response is provided largely by ground vehicles and systems installed within the buildings. Shortfalls of the current response system include:

Ground vehicle access to disasters is limited or delayed by road traffic
Firefighting personnel ingress crowds stairwells used for occupant egress

Occupants in upper floors can be trapped by fires on lower floors
Ground based ladder trucks can only reach up 10 stories



Ground based vehicles can only deploy water up to 10 stories
Building based fire fighting systems are often damaged
Command and control of response efforts is limited by difficult situational awareness due to distance of ground based decision makers from disaster

Helicopter usage in disaster response is currently limited in part due to the following issues:

Rooftops are often not suitable for landing due to antennas and other systems

Rotorcraft operation is dangerous in tight urban environments

Rotorcraft to not have the subsystems required to make them useful urban firefighting and rescue tools

Rotorcraft are expensive to procure and operate

VTOL Systems offer Great Potential

The ability of a system to hover offers great potential to address many of the shortfalls of current urban response systems. Several experiments have been conducted to explore new ways of firefighting with VTOL systems. These technologies integrated into platforms suitable for urban operations offer great promise to save lives and protect property in the future.

Sikorsky Firehawk

Erickson Skycrane

Precision Lift inc. has an interesting web site which discusses many aspects of the problem and some of the experiments that have been conducted

http://www.precision.rotor.com/trialpgs/hi-rise.shtml

VTOL Urban Disaster Response Vehicle Design Requirements:

1) The system shall be tasked to perform the following missions:

- High rise Firefighter deployment
- Rooftop Occupant extraction
- Building face penetration and occupant recovery
- Ground pump water cannon fire fighting
- Self contained tank water cannon fire fighting
- Disaster command and control

2) Safely transport a minimum of 1200 people per hour from high rise rooftops to either the ground or adjacent rooftops. High density packing of occupants is permissible.

3) Enable air vehicle or rescue subsystem "landing" on congested rooftops.

4) Enable delivery of teams of 15 firefighters weighing 300 lbs each with gear to rooftops up to 1500 ft in no more than 2 minute cycles.

5) Enable safe and prolonged hover operations within "urban canyons" … between high rise buildings

6) Perform precision hover, maintaining lateral separation from glass, steel, or concrete vertical surfaces within 1 ft of a pre-selected separation distance while maintaining altitude within 1 ft.

7) Ability to sustain position hold hover is zero visibility conditions.

8) Enable penetration of building windows at any floor

9) Enable extraction of not less than 800 occupants per hour from windows at any floor when equipped with a window extraction mission kit (to be defined as part of solution.

10) Provide lift for 5 inch diameter water hoses capable of pumping 1500 gallons per minute to a minimum of 100 stories using ground mounted pumps or pumps positioned on adjacent rooftops. Mixing of additional fire retardants may accomplished by ground systems.

11) Enable engagement of fires on any floor with a directed water cannon drawing from either the air to ground hose or by drawing from an optional (Mission equipped) onboard water tank of not less than 500 gallons.

12) The internal water tank when installed shall be refillable in under one minutes from standing water sources or water supplies in adjacent buildings.

13) Provide a command and control platform to disaster response decision makers to coordinate all aspects of disaster response. A minimum of 4 personnel is required with capability for simultaneous multiplexed communication on 6 different communication frequencies. The command and control variant shall be capable of developing horizontal and vertical tactical situation displays with overlays of data such as sensor information, maps, and building schematics.

14) When configured for command and control the vehicle must have an endurance of not less than 2 hours. 1 hour of which is in a hover and 1 hour of which is in cruise at 60 knots.

15) Navigation systems shall enable rapid and accurate response to street addresses.

16) Sensor systems shall have the ability to locate occupants in zero visibility conditions. Sensors shall be capable of developing thermal maps of building structures.

17) Sensor data shall be able to be transmitted to other disaster relief systems on the ground and in the air.

18) The system shall be easy to operate and mission manage. The system shall be flown by a specially trained "operator" , but not by a fully trained aviator. The operator shall be able to takeoff from a fire house, fly to a disaster site and precisely position the vehicle to accomplish mission tasks using simple commands.

19) The system must have the ability to carry external cargoes of at least 5000 lbs. to supply disaster relief materials or aid in the emergency removal of debris.

20) The system shall be capable of performing all mission at ambient conditions represented by Denver Colorado on a 95^{th} percentile summer day.

21) The system shall be transportable on a wide load flat bed truck on urban roadways.

22) The system shall be reconfigurable from one mission configuration to another in less than 20 minutes.

23) The system shall be capable of executing any of the defined missions following a 20 nm deployment from a home base. System endurance for firefighter deployment and occupant extraction missions shall not be less than 1 hour.

Response Requirements:

A written report limited to 100 pages shall provide the following:

Executive Summary (5 Page summary of entire report and key findings)

Description of operational environment and mission requirements (add critical requirements identified during concept exploration)

Detailed mission profiles shall be recommended for the following missions:

High rise Firefighter deployment
Rooftop Occupant extraction
Building face penetration and occupant recovery
Ground pump water cannon fire fighting
Self contained tank water cannon fire fighting
Disaster command and control

Concept evaluation and down-selection process and rationale
Selected Concept Preliminary Design

Overview including concepts sketches in each mission role
Day in the life of the system description
– timeline from 911 call to end of day
Vehicle Subsystem descriptions
(airframe, rotors, drive, controls, avionics, landing gear…)
Include rationale for recommended subsystem technical approach
Avionics system description including proposed operator interface
Mission kit descriptions as required for each mission
Weight empty derivation for primary vehicle
Mission Gross weight derivations for each mission
Performance estimates and plots for each mission
Such as time on station vs number of occupants recovered for building face extraction

Compliance matrix showing compliance with all technical / mission requirements
Non-recurring and recurring unit cost estimates
Development schedule
Risk identification and Risk Reduction plan
Recommendation of how many systems would be required per 1,000,000 person city population
Concept sketch of future urban fire station with mix of ground vehicles and proposed system(s)

Competition Judging Criteria:

Innovation: 40%

Study shows ability to depart from conventional thinking and paradigms to explore potentially high value solutions

Understanding of the Problem 10%

Study clearly demonstrates understanding of the real world mission problem and the associated technical challenges.

Technical content: 30%

Analysis and data is accurate and all methods used are well understand. Underlying principles are well understood

Clarity: 20%

Report is clear, concise, and develops compelling case for proposed solution. Emphasis is on clear graphics and diagrams to illustrate important points and concepts.

Milestones

Release of RFP:	October 21,2002
Notice of intent to compete:	October 28, 2002
Teleconference with Sikorsky on Problem statement:	October 30, 2002
Additional teleconferences	*as required*
2 Page emerging results summary:	February 15, 2003
Final report due:	June 15, 2003
Winners announced:	August 1, 2003

Awards:

First Place Graduate	$1500 plus brief at AHS Forum
Second Place Graduate	$500
Third Place Graduate	$250
First Place undergraduate	$1500 plus brief at AHS Forum
Second Place undergraduate	$500
Third Place undergraduate	$250

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Students are encouraged to discuss requirements and concepts with local urban fire fighting units. Sikorsky Aircraft will aid in establishing contacts if students have problems.

The rotorcraft industry looks forward to seeing your contributions to this important challenge!