WHITE PAPER

UAVs – New Surveillance and Reconnaissance Options for the Battlefield, Homeland Defense, Law Enforcement, and Disaster Response

By: PICS, Inc.

7620 Slater

Overland Park, KS 66204

Contact: Mike Everhart, President

Telephone: 800-398-9037

Fax: 913-642-4204

E-mail: **meverhart@p-ics.com**

John Carnal, Chief Designer, Missouri

Phil Buckley, Consulting Engineer, MSME, SME, PMI, Missouri

Stanley Demster, Consulting Engineer, BSME, ASHRAE

Mike Krough, Consulting Engineer, Missouri

Ron Renoe, Design Consultant and Prototyping

Submitted By:

____ Date:_____________

Mike Everhart, President PICS, Inc.

EXECUTIVE SUMMARY

This paper presents a preliminary design and prototyping of two utilitarian demonstrator lifting bodies, which will provide proof of concept for reconnaissance and surveillance missions. The design is uniquely suited for surveillance, reconnaissance, search and rescue, and cinematography missions, but with a great variety of other possible uses. Designed performance characteristics are ideal for operations in "maneuver-restricted environments" such as urban locations, and impromptu field locations. The prototype vehicles have *very* short take-off and landing capability. In comparison with previous lifting body designs, these UAVs fill a unique niche position. Included is a plan to develop two sizes of autonomous prototype to demonstrate their capabilities. It will also be shown that the cost of this lifting body design can be greatly reduced from that of UAVs currently in use.

PROBLEM

In conflict zones like Iraq and Afghanistan, military commanders are constantly searching for new ways to improve situational awareness with reconnaissance and surveillance capabilities that minimize the danger to personnel. In the last decade, UAVs like the Predator and the RQ-7 Shadow have come to fill that role, but the cost and logistic requirements of those systems are significant. Furthermore, these designs use long-range optics and sensors that might be hampered in densely populated or constrained urban environments, where the eyes of a soldier on the ground are critical but under threat.

In the continental U.S. as well, threats from natural disaster and terrorist attack, as well as the needs of law enforcement entities, create an immediate, compelling need for aerial reconnaissance capabilities that most government agencies do not possess.

In the aerospace and defense industries, there has been an emphasis on developing large, long-range, highly sophisticated and expensive un-manned and remotely piloted vehicles. Further emphasis has been on developing "short take-off and landing" aircraft, as exemplified by extant aircraft designs, such as helicopter types, fixed-wing thrust diversion types, and assisted takeoff/landing types. However, other aircraft types that offer short take-off and landing capability seem to have been overlooked. Our lifting body has advantages over current extant designs, without some of the drawbacks. This lifting body offers a **simpler**, **safer**, **more stable**, and **less expensive** alternative to extant VTOLs, STOLs, and most extant UAVs while having similar performance characteristics.

The objective is to produce a UAV that is are uniquely suited for medium and close-range surveillance, reconnaissance, search and rescue, and cinematography missions, but with a great variety of other possible uses in the military and civilian sector. The cost of this UAV will be significantly reduced from extant designs, with greater mission flexibility, easy deployment, and minimal logistical support requirements.

PRODUCTS

This paper presents a concept for two advanced unmanned lifting body aircraft technology demonstrators. The primary mission of the aircraft is to carry photographic, infra-red/thermal, radar sensors, chemical/biological/radiological/nuclear/explosive (CBRNE) as well as telemetry, all to be used for day or night reconnaissance, photographic and other surveillance missions, along with data transmission. Furthermore, the UAV can be employed in maneuver-restricted urban areas. Operational requirements to perform these missions include the following:

- Type I: Carry 12 pound payload
- Type II: Carry 25 pound payload
- Very short take-off and landing in restricted space
- Flight in adverse weather that would ground most other airframes
- Autonomous operation

This lifting body has several unique capabilities that are ideal for restricted field operations and employment in maneuver-restricted urban zones. These capabilities include:

a. **Extremely** short take-off
b. Inherent autonomous near-vertical landing
c. Spectacular maneuvering capability
d. Operation in restricted quarters
e. Simple, quiet operation

The proposed Type 1 and Type 2 UAVs will have the following design criteria.

- Low-altitude capability
- GPS guidance for autopilot
- Stable flight platform
- Slow-speed loiter capability
- High rate of climb
- High resolution camera/video, thermal, radar, CBRNE, or other detection packages
- Data and control link to control ground station
- Autonomous flight capability
- Reliable power plant
- Rugged, lightweight airframe
- Easy to repair and maintain
- Readily available fuel worldwide
- Stable fuel stable in low temperatures
- Manual take-off and landing as standard
- In-flight route and mission modification option
- Inclement weather operation, including ice and snow
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Table 1 - Initial Design Specifications for Type 1 and Type 2 UAV

Specification	Type 1	Type 2
Transport	Car, van, or pickup truck	Van or pickup truck
Endurance	2-4 hours	6 hours
Service Ceiling	10,000 ft.	12,000-16,000 ft.
Range	10+ miles	150+ miles
Cruising speed	45 mph	70 mph
Max speed	70 mph	120 mph
Payload	12 lb.	25 lb.

Follow-up work would incorporate micro-miniature guidance, navigation, and flight control systems for autonomous operation, and incorporate terrain avoidance equipment for maneuvering in close-quarter urban environs.

Development would involve the following technical, business, manufacturing and managerial capabilities: aeronautical, mechanical, electrical, and control systems engineering, model design and construction management, flight dynamics and control simulation, pilot training management and liaison, manufacturing, financial management and cost accounting.

The University of Missouri Aeronautical Laboratory in Rolla would be the ideal facility for the aerodynamic testing, for example. A proposed business development organization is available.

PROCESS

A preliminary design UAV concept is viewable on request. The operating design has several unique features. The aerodynamic configuration and the mass distribution produce an inherently statically stable vehicle, able to fly "hands-off" for protracted periods. An aerodynamic fuselage encloses all necessary equipment. This includes the payload, engine, fuel, control system, guidance, and communications. The vehicle would be constructed around a lightweight, rugged frame, and arranged to provide balanced, aerodynamically stable, and dynamically well-behaved performance.

We propose to design, build, and test a radio-controlled prototype model to demonstrate feasibility, operability, performance, and maneuverability. In addition, it is proposed to use an established flight-dynamics and control simulation facility, first, to corroborate and predict actual operational flight dynamics and control performance, and second, as a training tool for pilots.

Once a vehicle design is established, the following effort would develop an autonomous guidance and navigation system.

This system consists of a hybrid of inertial and GPS navigation. Accelerometer measurements are fed to a computer, then converted to an inertial coordinate system and then integrated to obtain velocity and position. The coordinates are periodically corrected with GPS fixes and altitude information from an onboard altimeter. Also stored in the computer are pre-programmed time-correlated position data defining the aircraft's ground path and altitude profile. The difference between the computed position and the pre-programmed position is used to self-correct the aircraft's flight path.

A final development would be the addition of proximity sensing devices and terrain-avoidance radar for use in conjunction with the flight control system to facilitate maneuvering restrictions in an urban area.

The complete development plan is outlined below in Figure 1. Note that PICS, Inc. has its corporate headquarters in the greater Kansas City area, and nearly all phases of research and development of this project, including fabrication and testing, will take place in Missouri, using Missouri-based engineers, companies, facilities, and subcontractors.

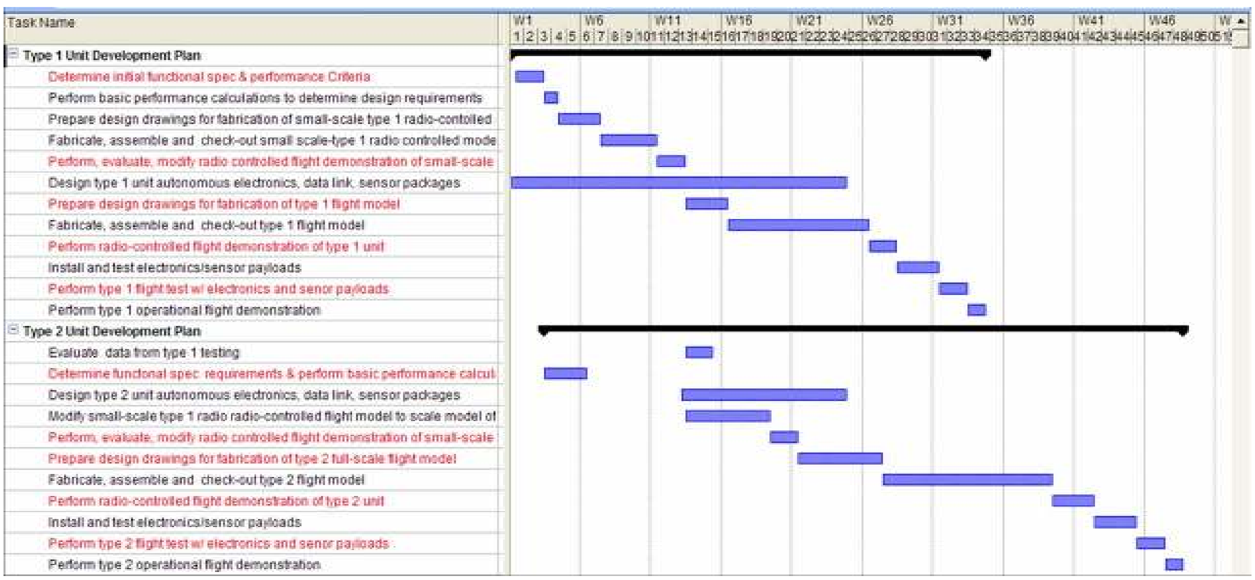

Figure 1 - Project Plan for UAV development

IMPORTANCE

The potential applications for Homeland Defense, disaster response, and conflict zone situational awareness are numerous. These UAVs would be perfectly suited for, but not limited to:

- Battlefield/conflict zone/reconnaissance and surveillance
    - Battlefield situational awareness
    - Population/insurgency surveillance
    - Military police operations
    - Counterterrorist/counter-drug operations

    - Perimeter/hot-zone security
    - Chemical/biological/radiological/nuclear/explosive (CBRNE) tracking and detection
    - Surveillance in hazardous CBRNE-affected areas
- Search and rescue situations, military and civilian
- Disaster response
    - Natural disasters
    - CBRNE tracking and detection
    - Wild fires
- Law enforcement
    - Criminal interdiction
    - Surveillance
    - Border security

These lifting bodies have unique, stable flight characteristics that make them a perfect but as yet unused asset on the 21st century urban battlefield. And the versatile, low-cost design that we propose means that they can be deployed easily and cheaply wherever they are needed.

PRICE

Table 2 outlines the projected costs of development of both lifting body prototypes. The aim is to develop a low-cost, reliable system that versatile enough for a variety of missions worldwide.

Table 2 - Cost Estimate of UAV project

Design, consulting, mgmt.	$123,200
Fabrication	$95,500
Lifting body materials and additional fabrication	$302,600
Fixtures and tooling	$64,320
Travel	$5,500
General office and administration	$29,950
Total	**$621,070**

SUMMARY

The development of these UAVs for hazardous and/or specialized environments could drastically reduce the need to put personnel in harm's way. From the battlefield to disaster response and law enforcement, a low-cost, reliable, autonomous, aerial surveillance package will fill a critical niche that cannot be filled by super-sophisticated, high-cost systems like the Predator and other UAVs. This proposal exemplifies the next generation of versatile, low-cost UAVs.