Hovering Precision Weapons: Enabling Precise Surgical Strike and Collocated Close Air Support from Tactical to Strategic Distances

Professor Ron Barrett
Director of the Adaptive Aerostructures Laboratory (AAL)
Aerospace Engineering Department
The University of Kansas, Lawrence, Kansas USA

AAL ...Backroom for the Innovation-Driven Aerospace Organizations of the world...

Joint Armaments Conference, Exhibition and Firing Demonstration
Dallas, Texas 19 May 2010
Motivation:

- Current tactics and weapon systems often induce unacceptable levels of collateral damage and Coalition casualties.

Costly collateral damage in Afghanistan

"a US bomb flattened a flimsy mud-brick home in Kabul on Sunday blowing apart seven children as they ate breakfast with their father. The blast shattered a neighbour's house killing another two children …..the houses were in a residential area called Qalaye Khafir near a hill where the hard-line Taliban militia had placed an anti-aircraft gun."\textsuperscript{18}
Paradigm Shift:

Now...

Hmmm...
Outline:

I. Hovering Precision Weapon History

II. Current Platform Configuration & Performance

III. The Paradigm Shift... New Systems with New Capabilities
Conventional UAV “Challenges”

Operation Allied Force
Kosovo 1999
(source: Yugoslav armed forces)

UAVs Lost in Kosovo:

Britain: 14 (14 Phoenix)

United States: 17 (3 Predators, 9 Hunters, 4 Pioneers, 1 UAV of undetermined type)

Germany: 7 (presumably all CL-289 turbojet drones)

France: 5 (3 Crecerelle, 2 CL-289)

By Jan. 2003, 30 of 70 RQ-1 Predators crashed or were shot down
(source: Mike Mount CNN Washington Bureau)

4 UAVs of undetermined origin (possibly U.S., German, or Italian)

$122k ea.
Advanced Convertible UAVs: Why??

“2/3 of eligible targets went undetected, let alone unengaged because of our reconnaissance deficiencies.”

“Folks... it’s going to take something new to fix this problem.”

-Lt. Gen. Bruce Knutson, USMC
VTOL Approach to Urban UAV Flight: 1994 - 1997 The First MAV, Kolibri

The 1st Micro Aerial Vehicle -- by the DoD CounterDrug Technology Office

Mission Profile:
- Takeoff
- Descent
- Hover out 20m
- Hover in 20m
- Ascent
- Underground Loiter > 24hr
- Shutdown

Enabled by Flexspar Piezoceramic Stabilators

- total mass 5.2g
- actuator mass: 380 mg
- max. static deflections: $\pm 11^\circ$
- max power consumption: 14 mW
- pitch corner frequency: 47 Hz
- first natural frequency in pitch: 23 Hz
Low-Level Operations:

Serious trouble for UAVs...

DARPA Urban & Sub-Canopy Atmospherics Survey 1998

$\alpha > 90^\circ$ is a common event
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First Free-Flight VTOL MAVs

DARPA

1999 - 2000

Flyoffs @ MacDill & Quantico

6" (15cm) VTOL Coleopter

History and Background    Current Platform     Revolutionary Missions
Paradigm Shift...

Hypermantueurable UAVs

Hover in more places than a helicopter
Fly as fast as a missile

Convertible Coleopter Configurations

Heinkel Wespe 1944 (concept only, never built)
Heinkel Lerche 1944 (concept only, never built)
Hypermaneuverable UAVs

XQ-138 Program 2001 - Heinkel Wespe 1944

more control authority needed for MOUT environment

AA-12 (R-77) (Aamraamski)

high control authority grid/lattice fins
XQ-138 Hypermaneuverable UAV

Mission Specification:
- Max. gross weight: 6.8lb (3.1kg)
- Max. payload weight: 2.2 lb (1kg)
- Sandstorm capable to 100kts
- All weather capable
- Vmax 140kts for 1hr (blue sky)
- 12″/hr (31cm/hr) rain
- -40/100° F (38° C), 100% humidity
- 25+ kt gust penetration
- Combat shotgun resistant @5m
- 15g MOUT wall strike
- Sensors: B/W 0.001 lux, Color 0.1 lux, FLIR
- Land + autostart
- Flight modes: 1st, 3rd person, fully autonomous w/ waypoint nav.
**XQ-138**

MDO using best currently available technology

- Ballistic graphite & boron structure
- Titanium powerplant housing
- Magnesium motor mount/fuselage coupler
- Graphite racking grid fins
- Kevlar turning vane flaps
- Piezoceramic turning vane flap actuators
- Piezoceramic grid fin actuators
- Piezoceramic gyros
- Sensor
- Transmitter
- Receiver
- GPS navigator
- SAS system
- Fuel tank
- 1.3hp (970W) powerplant
- Muffler ass’y

**History and Background Current Platform Revolutionary Missions**
### Adaptive FCS

#### XQ-138 Weight Fraction Trends...

<table>
<thead>
<tr>
<th>Component</th>
<th>% MGWTO</th>
<th>Useful Load</th>
<th>SAS/Coms/Power</th>
<th>Propulsion</th>
<th>Flight Controls</th>
<th>Structure</th>
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<tbody>
<tr>
<td>11&quot; (28cm) Ø</td>
<td>2.0%</td>
<td>31.4%</td>
<td>14.5%</td>
<td>18.9%</td>
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<td>(T/W)min = 1.2</td>
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<td>6&quot; (15cm) Ø</td>
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<td>22.2%</td>
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<td>4&quot; (10cm) Ø</td>
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New Mission Testing...

Remote Launch from Remote Controlled Armored Vehicle
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New Mission Testing...
Eglin AFB, FL, Hellfire Range

History and Background    Current Platform     Revolutionary Missions

BDA following Javelin Missile
Live Fire Shot against a T-60
Launch and Target ID against Ground Target
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XQ-381 Mission Profile & Spec.

40mm Weaponized Aircraft

History and Background    Current Platform     Revolutionary Missions
What's Next???

FAQ-381

Collocated Close Air Support (CCAS) Hovering Precision Weapon (HPW)
XQ-381 Rubber Design General Sketch

Growth, Range, Payload

Max Gross Weight, MGWTO (lb)

Useful Load, W_{use} (lb)

Range, R (nmi), Rounds on Target, n (~)

- 28" ø, 72" long, 500 rounds
- 22" ø, 56" long, 500 rounds
- 13" ø, 33" long, 50 rounds
- 6" ø, 15" long, 5 rounds

Range (nmi):
- 10000
- 5000
- 500
- 50
- 5

Rounds on Target (n~):
- 10000
- 5000
- 500
- 50
- 5

Diameter (inches):
- 22, 56
- 13, 33
- 6, 15

Length (inches):
- 72
- 56
- 33
- 15
- 28
- 13
- 11
- 5

XQ-381 Rubber Design General Sketch

History and Background  Current Platform  Revolutionary Missions
FAQ-381 Design Point 1

Enhanced Mission Specs:
- MGWTO \(\sim 50\) lb
- \(V_{\text{max}} > 380\) kts
- \(>3\) hr HOGE
- \(>5\) hr Vbr Loiter
- Large Sector Coverage
- Full sensor & coms suites
- Collocated Close Air Support
- Combat resistant

Start-up, T/O
5,000 ft dens. alt.

cruise in 300 kts, 30 min/150 nmi 10,000 ft dens. alt

dash out 350kts, 25min/150nm 10kft dens. alt

climb
descend
climb
descend

600 rounds 5.56ammo or 50 40mm grenades

landing, shut-down
5,000 ft dens. alt.

High-power cons. combat operations
2 hrs @ 5,000 ft dens. alt.

3 & 5-bladed rotor system

42\(^\circ\)
The Next Generation: FAQ-381_{DP1}

- forward sensor suite
- integral fuel tank in rotor guard
- GNC/INS/coms package
- pivoting M16/40mm grenade launcher
- turning vane flaps
- 3-bladed upper rotor
- rotor guard
- 5-bladed lower rotor
- sensor suite
- Williams WR-34 turboshaft engine
- empennage assembly
FAQ-381_{DP1} CCAS 20 min Response

Iraq:
4 Base Coverage for 20 min Response

Afghanistan:
5 Base Coverage for 20 min Response
FAQ-381_{DP1}  CCAS Refueling Concept

Tankers enable “indefinite” loiter/orbit
FAQ-381_{DP1} 5 min CCAS

9 Track Coverage for Iraq

10 Track Coverage for Afghanistan
The Next Generation: FAQ-381<sub>DP1</sub> Counterpiracy

**SH-60 Intercept Range**
- 15 min
- 30 min
- 1 hr

**FAQ-381 Intercept Range**
- 15 min
- 30 min
- 1 hr
XQ-381 Rubber Design General Sketch
Growth, Range, Payload

Max Gross Weight, MGWTO (lb)

Useful Load, W_{use} (lb)

Range, R (nmi), Rounds on Target, n (~)
FAQ-381 Design Point 2 - 100lb MGWTO

Enhanced Mission Specs:
- MGWTO ~100 lb
- Vmax >450kts
- >3hr HOGE
- >5hr Vbr Loiter
- 500nmi radius @ $V_{BR}$
- Large Sector Coverage
- Full sensor & coms suites
- Collocated Close Air Support
- Combat resistant

Startup, T/O
5,000ft dens. alt.

climb

dash out 450kts FL300+ 500nmi

2 hrs @ 5000ft dens. alt. 1200 rounds 5.56 ammo or 100 40mm grenades

2 hrs @ 5000ft dens. alt. 1200 rounds 5.56 ammo or 100 40mm grenades

hig cons.
cruise in 350kts FL300+ 500nmi

landing, shut-down
5000ft dens. alt
FAQ-381 Design Point 2 - 100lb MGWTO

History and Background    Current Platform    Revolutionary Missions
FAQ-381 Design Point 3 - 1000lb MGWTO

Enhanced Mission Specs:
- MGWTO \sim 1000\text{ lb}
- V_{\text{max}} > 450\text{ kts}
- >3\text{hr HOGC}
- >5\text{hr Vbr Loiter}
- 5000\text{nmi radius} @ V_{BR}
- Large Sector Coverage
- Full sensor & coms suites
- Collocated Close Air Support
- Combat resistant

History and Background   Current Platform   Revolutionary Missions
FAQ-381 Design Point 3 - 1000lb MGWTO
Now where...

• Battle Labs

• Brief Decision Makers

• Industry Consortium
Questions?
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