



# Hovering Missiles: New Tools for Target ID, Interior Precision Strike, Friendly Fire Mitigation and Persistent Suppression

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

*44<sup>th</sup> Annual Gun and Missile Systems Conference & Exhibition  
Hyatt Regency Crown Center, Kansas City, MO  
8 April 2009*





# Purpose:



- *Expose the Munitions Community to the blurring line between missiles, munitions & UAVs.*
- *Describe advanced weapon systems which are technically feasible Today.*





# Outline:



***I. History of Underpinning Programs***

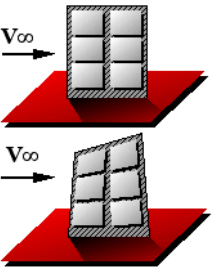
***II. Current Platform Configuration***

***III. New Missions...  
Revolutionary Capabilities***

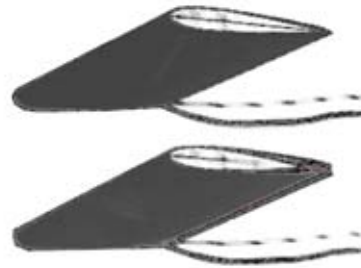
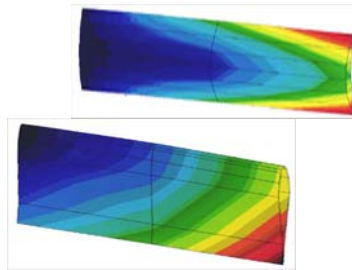




# Background in Flight Control

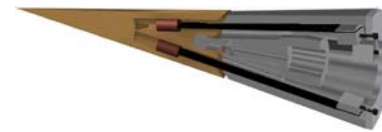


Twist & camber-active subsonic & supersonic wings



1st Pitch-Active Missile Fins

1st Adaptive Gun-Launched Munitions

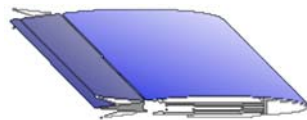


1st Adaptive Gravity Weapons

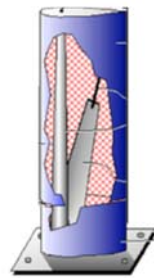
1985

1990

1995

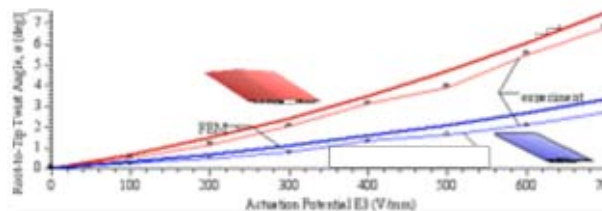


Twist-active plates & flaps

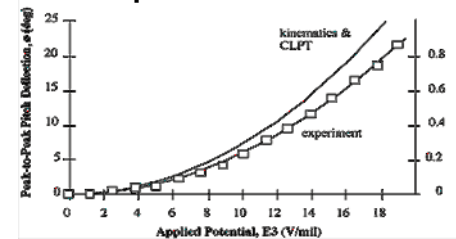


Crawley, Andersen, Spangler, Hall, Lazarus (MIT)

Good theory-experiment correlation



Flexspar Stabilizers



1st Flying Adaptive UAV





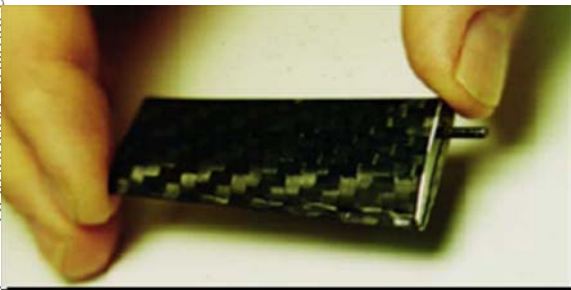
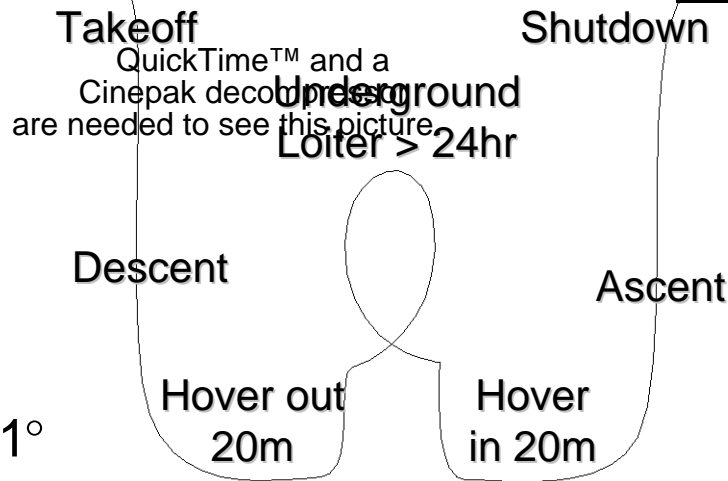
# VTOL Approach to Urban UAV Flight: 1994 - 1997 The First MAV, Kolibri

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

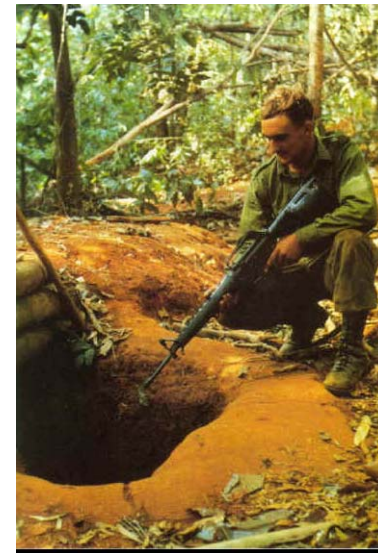
Enabled by Flexspar Piezoceramic Stabilators



## Mission Profile:



- 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

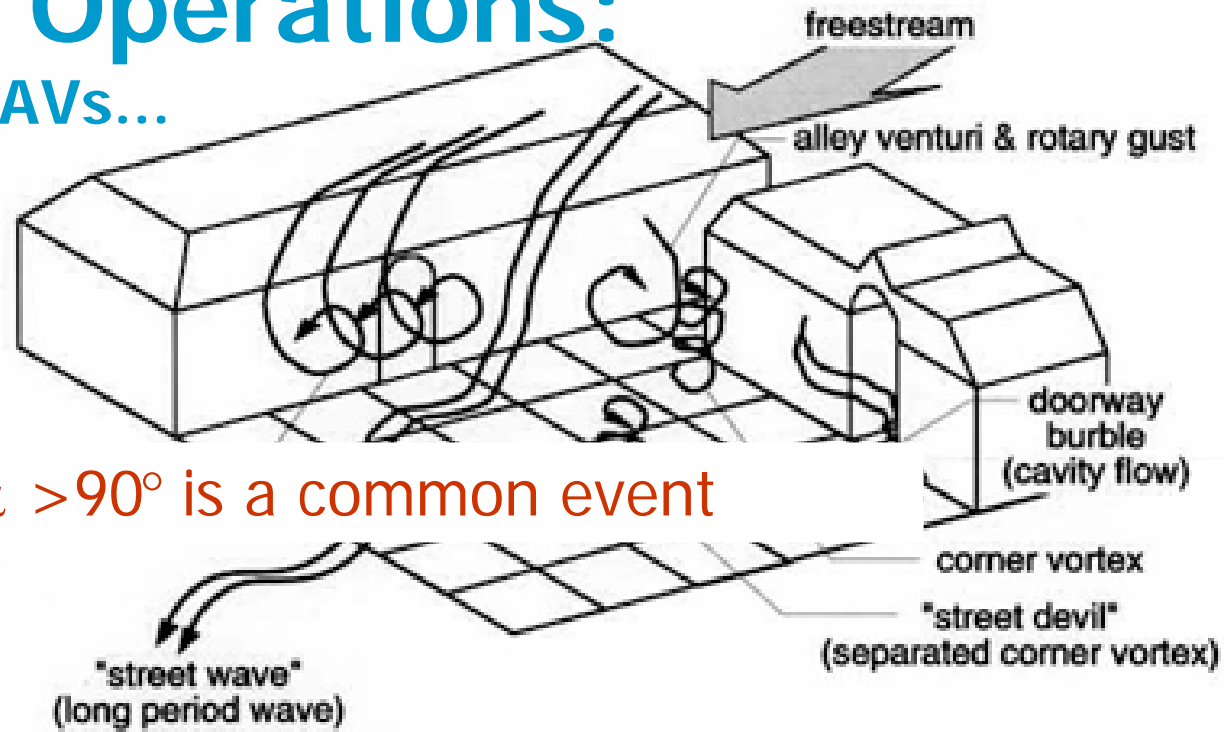




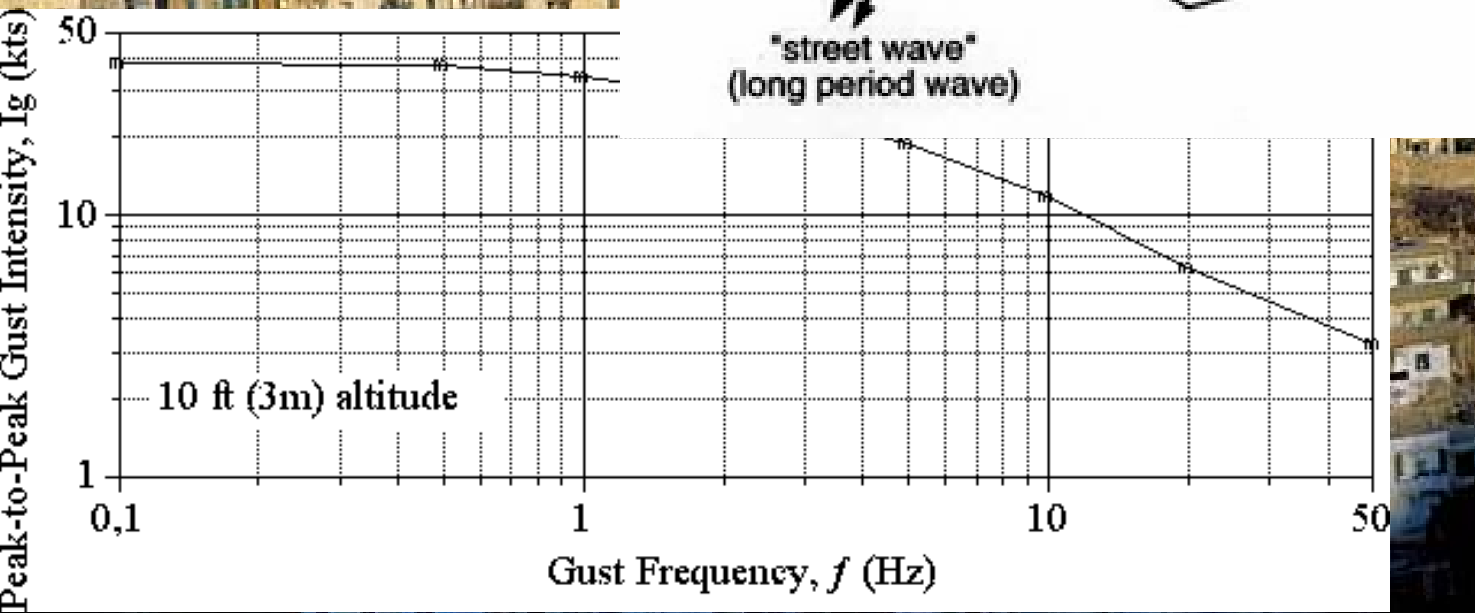
# Low-Level Operations:

## Serious trouble for UAVs...

DARPA Urban & Sub-Canopy  
Atmospherics Survey 1998



$\alpha > 90^\circ$  is a common event

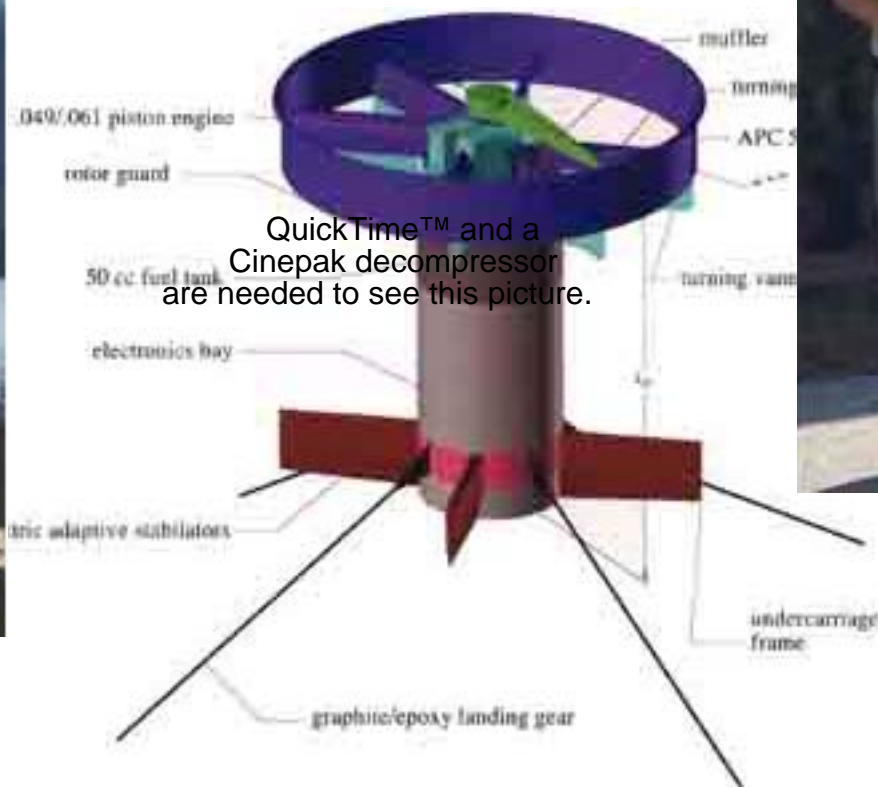






# First Free-Flight VTOL MAVs

## 6" (15cm) VTOL Coleopter



DARPA  
1999 - 2000  
Flyoffs @  
MacDill &  
Quantico





## More 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)







# Advanced/Hypermaneuverable UAVs: Why?? ... & the Role of Adaptive Aerostructures

*"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*





# Low-Level UAV Ops Challenge:

*New UAVs*

*New Tactics*

**All overhead surveillance gives the same view**



**Current UAVs offer monocular situational awareness with only one general view -- from above.**



**Panocular situational awareness is necessary in the modern battlefield.**



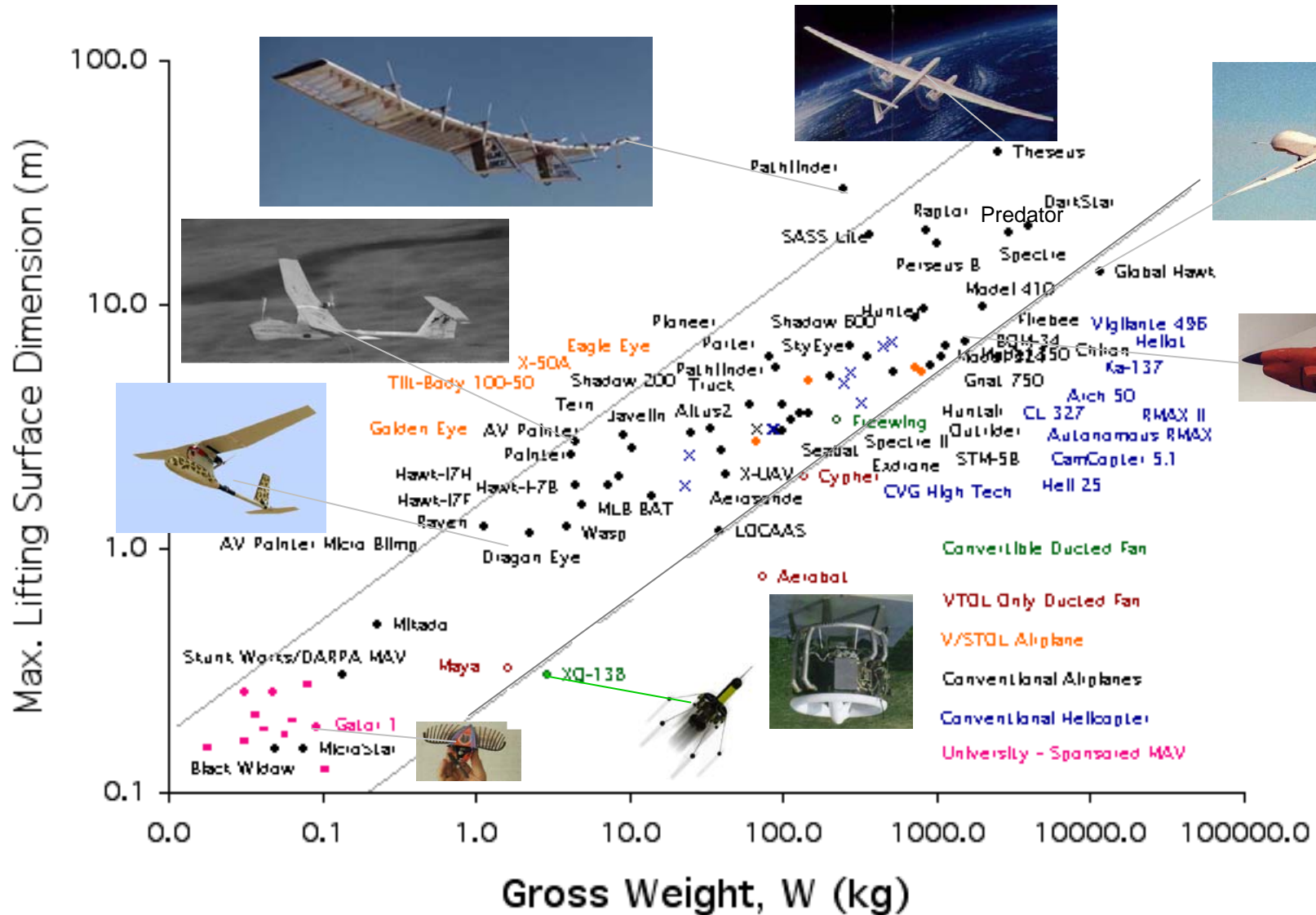


# Changing UAV Operations

*Sharing Airspace -- the fight at altitude*



# Current UAV Market







# Honeywell's "Micro Aerial Vehicle" (MAV) or "Organic Aerial Vehicle" (OAV)

QuickTime™ and a  
MPEG-4 Video decompressor  
are needed to see this picture.







# Paradigm Shift...

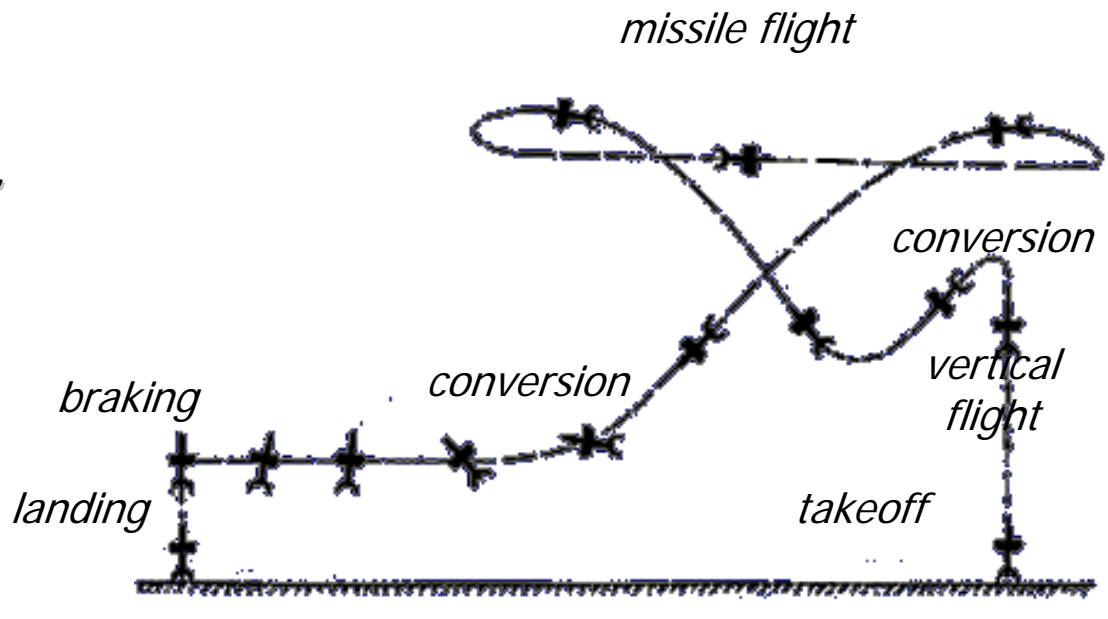
## Hypermaneuverable UAVs

***Hover in more places than a helicopter***

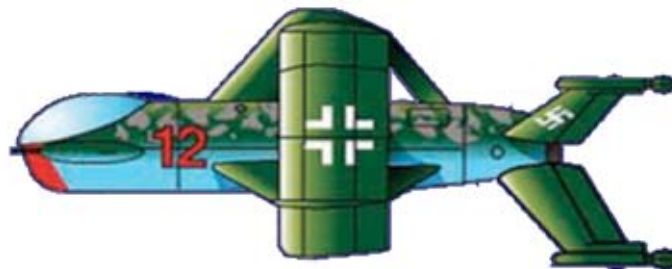
***Fly as fast as a missile***

### **Convertible Coleopter Configurations**

**Heinkel Wespe 1944  
(concept only, never built)**



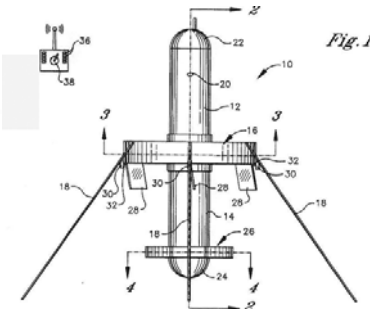
**Heinkel Lerche 1944 (concept only, never built)**





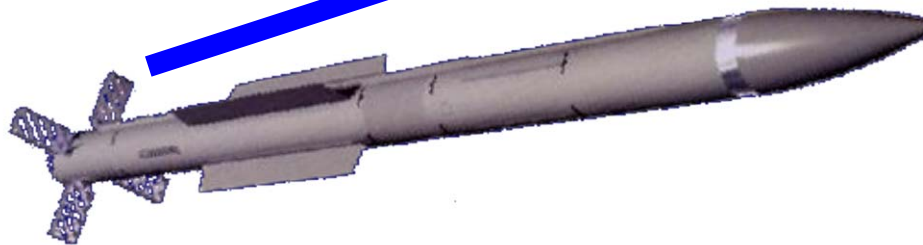
# Hypermaneuverable UAVs

XQ-138 Program 2001 -  
Heinkel Wespe 1944

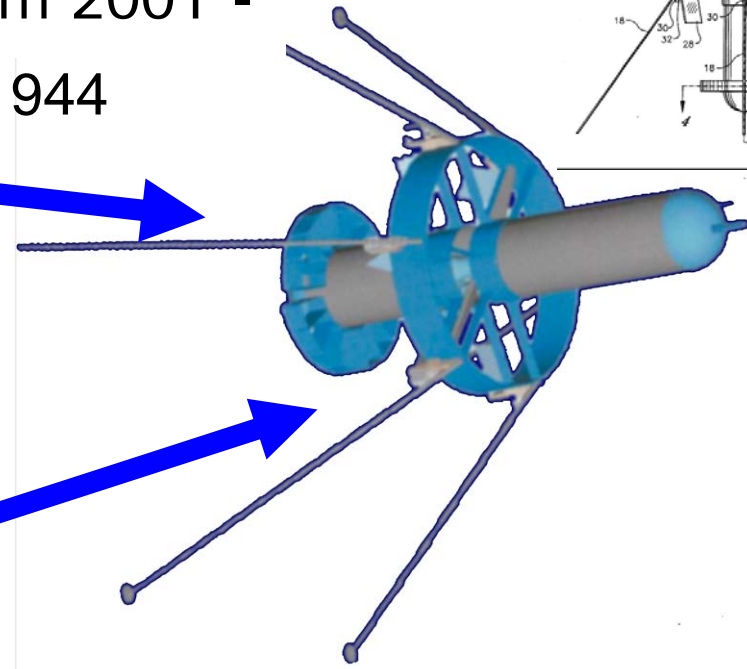


*more control authority  
needed for MOUT environment*

AA-12 (R-77)  
(Aamraamski)



high control authority grid/lattice fins

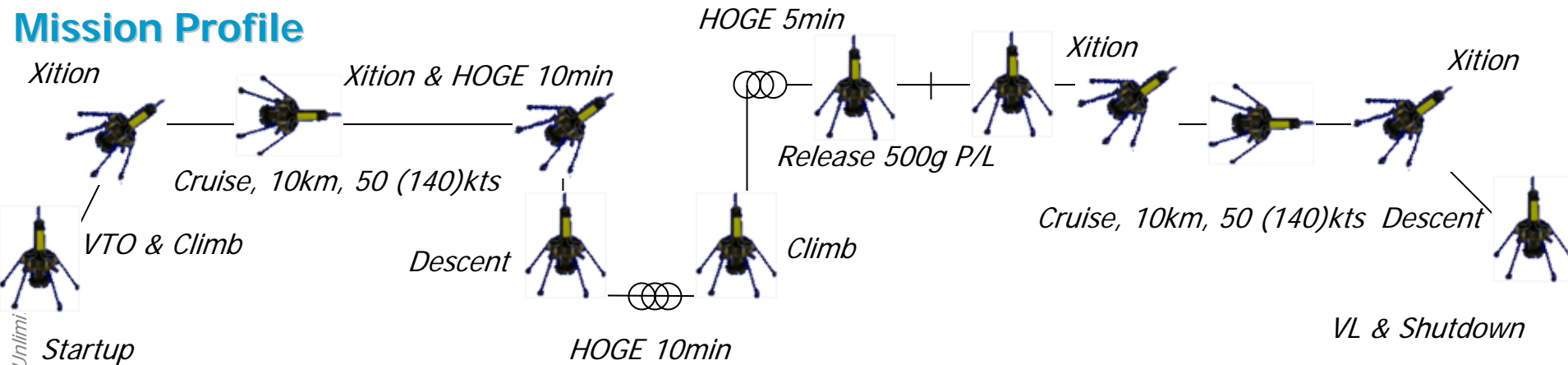


R. M. Barrett 11 February 2009  
Unclassified  
Distribution Un



# XQ-138 Hypermaneuverable UAV

## Mission Profile



## Mission Specification:

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

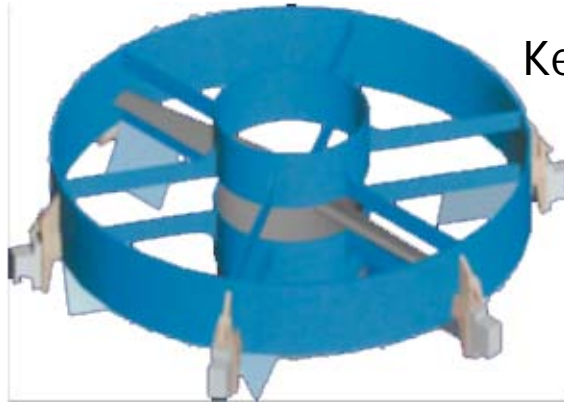




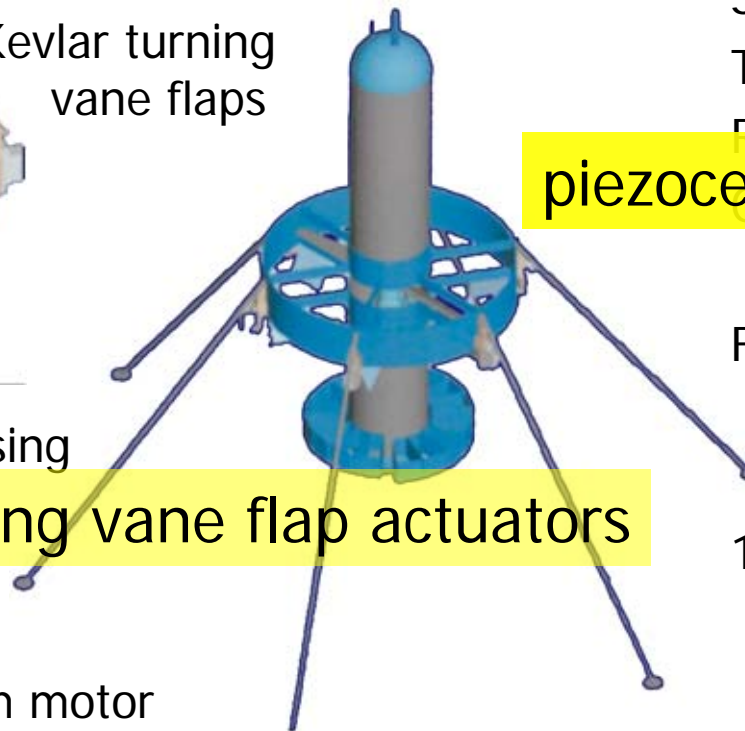
# XQ-138

MDO using best currently available technology

ballistic graphite & boron structure



Kevlar turning  
vane flaps



titanium powerplant housing

piezoceramic turning vane flap actuators

piezoceramic gyros

Sensor

Transmitter

Receiver

SAS system

Fuel tank

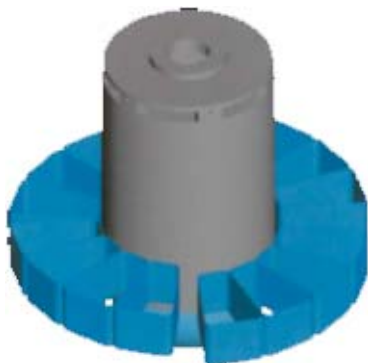
1.3hp (970W)  
powerplant

Muffler ass'y

magnesium motor  
mount/fuselage coupler  
flight control actuators

graphite racking grid fins

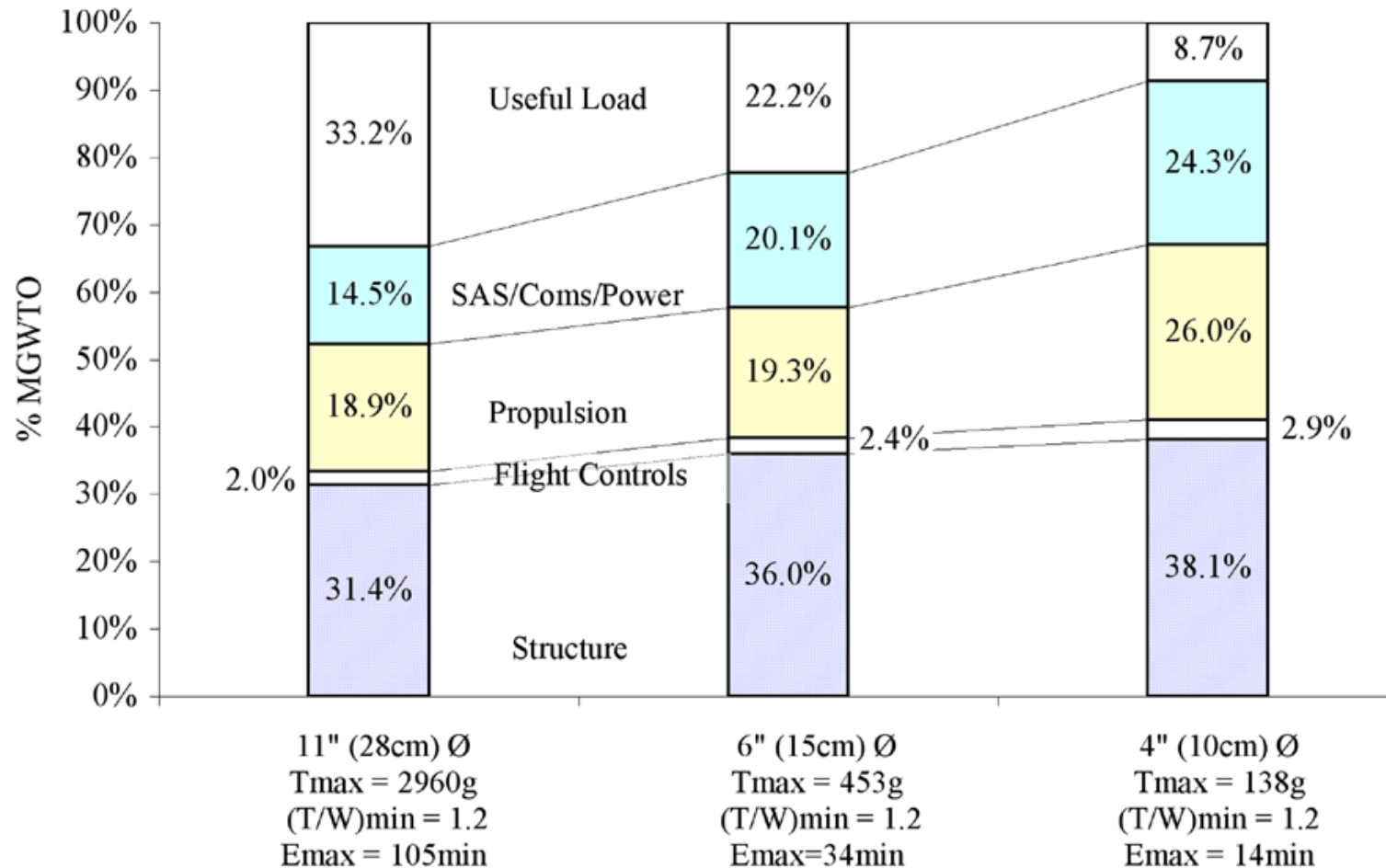
piezoceramic grid fin actuators





# XQ-138 Weight Fraction Trends...

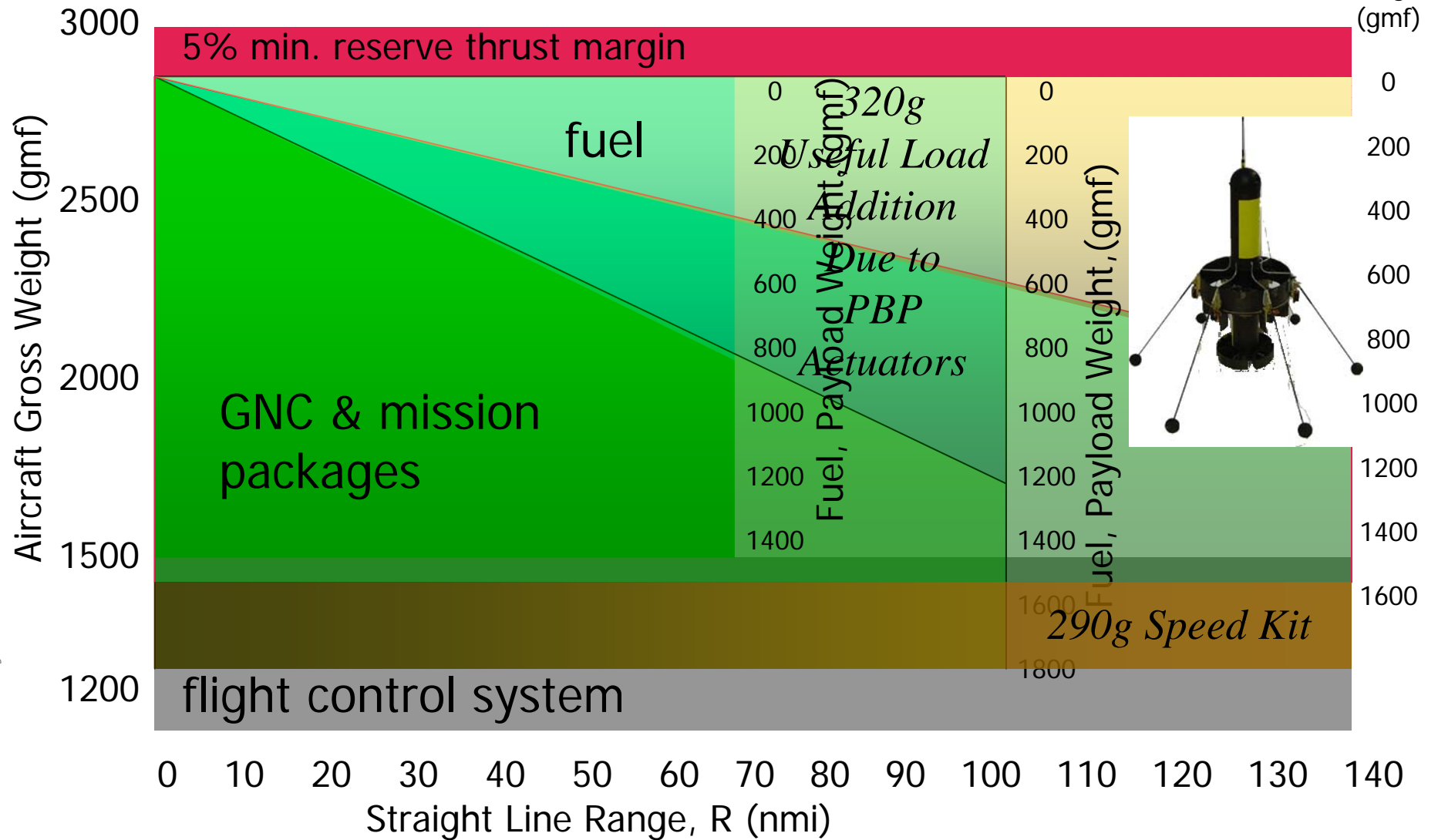
## Adaptive FCS







# Payload-Range Diagram





# Flight Testing

QuickTime™ and a  
Cinepak decompressor  
are needed to see this picture.



# New Mission Testing... Redstone Arsenal, AL

***Demonstration of stable launch, transition,  
missile-mode flight, stable hover and recovery***

QuickTime™ and a  
H.264 video decoder are  
needed to see this picture.  
***Remote Launch from Remote Controlled  
Armored Vehicle***

***Redstone Arsenal***



# New Mission Testing... Eglin AFB, FL, Hellfire Range

***BDA following Javelin Missile  
Live Fire Shot against a T-60***

QuickTime™ and a  
Cinepak decompressor  
are needed to see this picture.  
***Launch and Target ID against Ground Target***

***Stalking Hovering Missile Flight Demonstration***





# XQ-381 Mission Profile & Spec. 40mm Weaponized Aircraft

## ***40mm Recoilless Munition Shots***

QuickTime™ and a  
Cinepak decompressor  
are needed to see this picture.







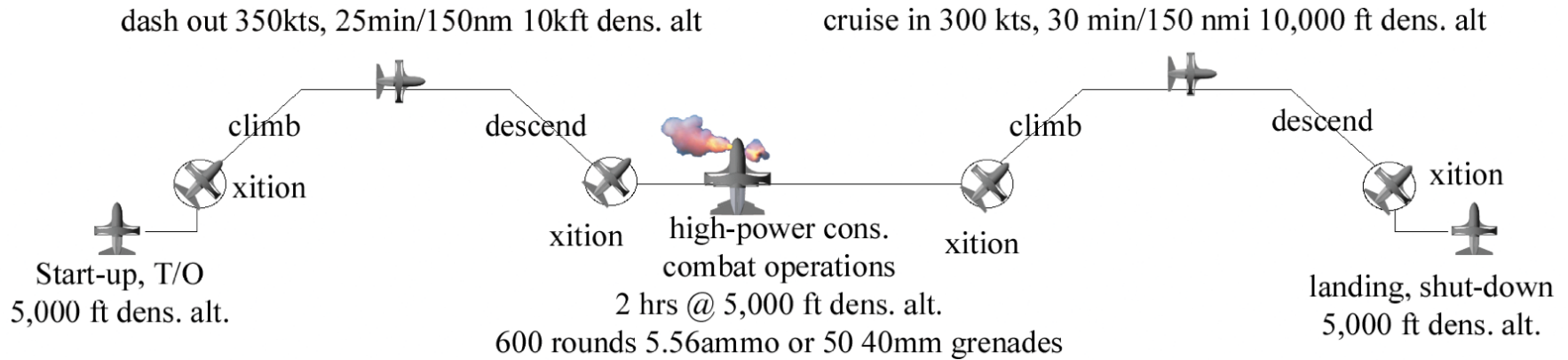
# Now where???

## ***FAQ-381 Hypermaneuverable Collocated Close Air Support (CCAS) Hovering Missile***



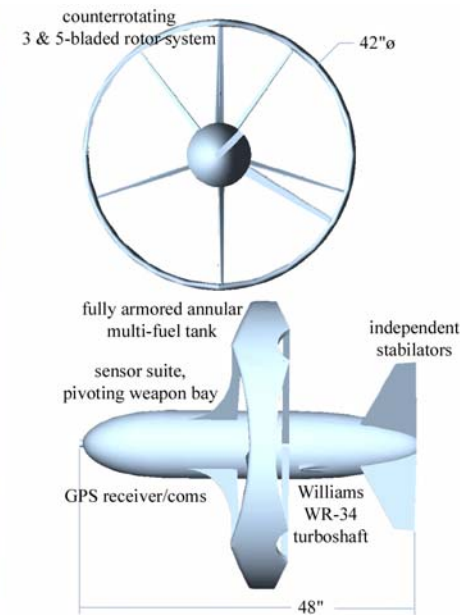


# The Next Generation: FAQ-381



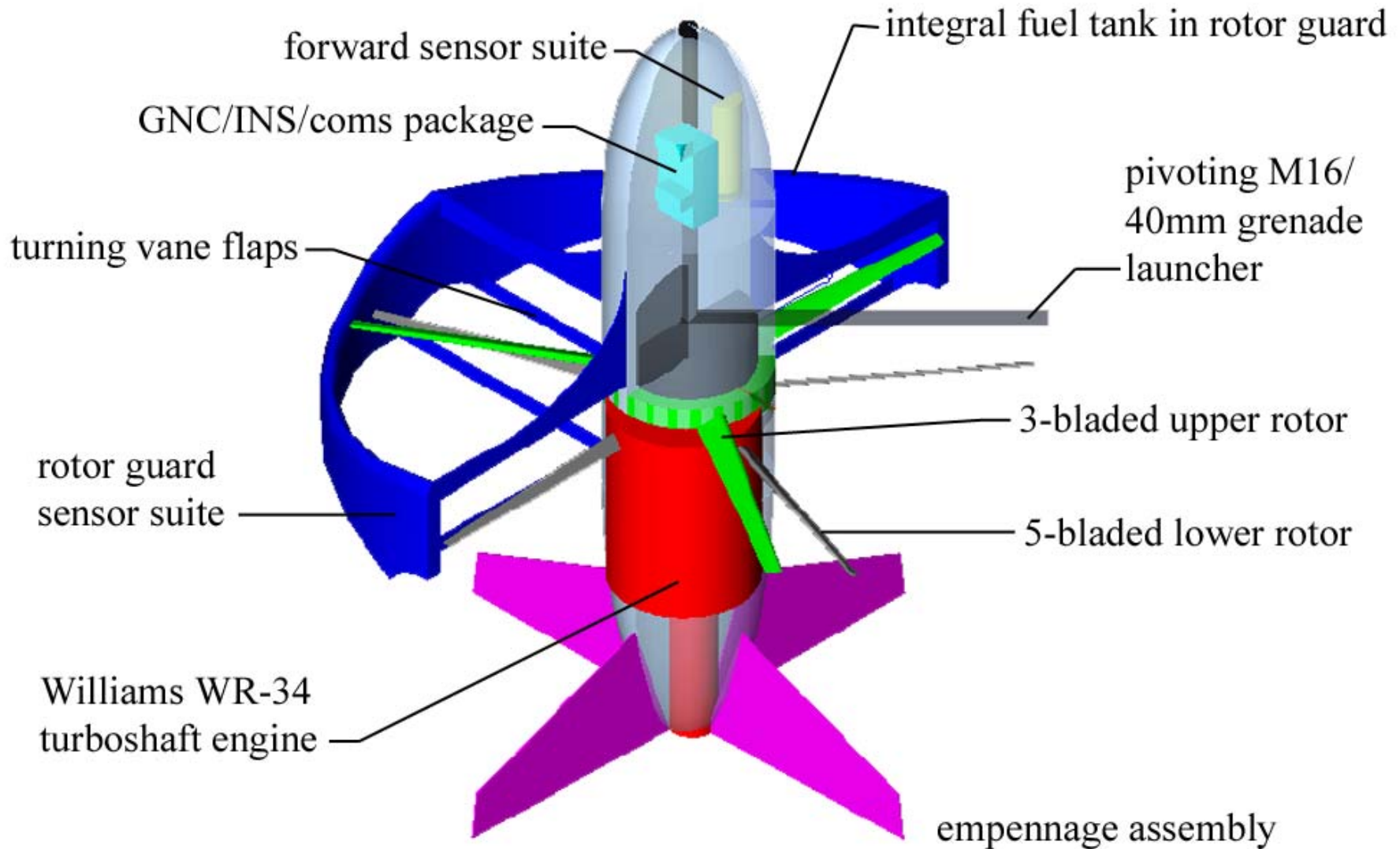
## Enhanced Mission Specs:

- MGWTO ~50 lb
- $V_{max} > 380\text{kts}$
- >3hr HOGE
- >5hr Vbr Loiter
- Large Sector Coverage
- Full sensor & coms suites
- Collocated Close Air Support
- Combat resistant





# The Next Generation: FAQ-381





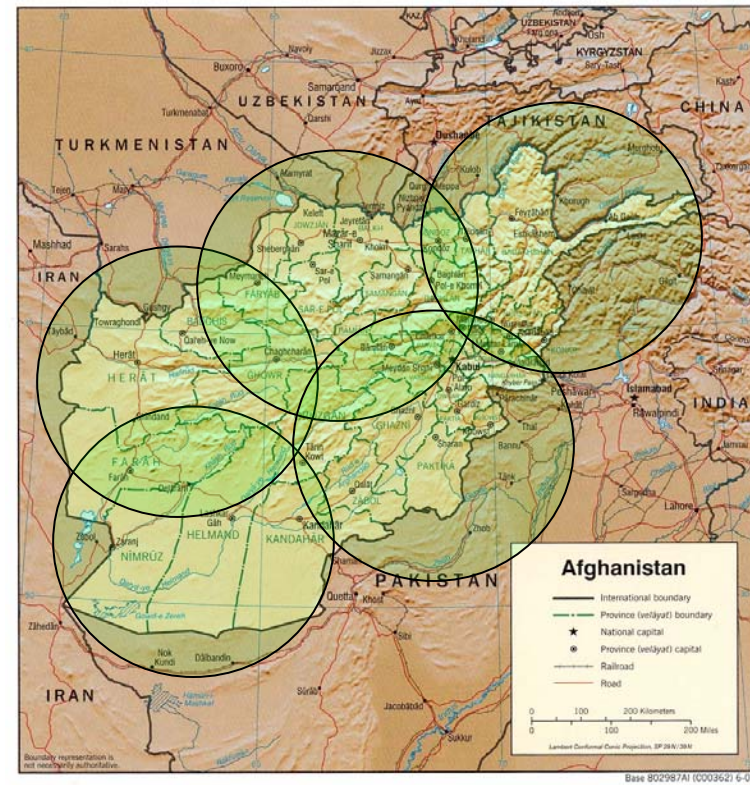


# The Next Generation: FAQ-381 CCAS

**Iraq:**  
**4 Base Coverage for**  
**20min Response**



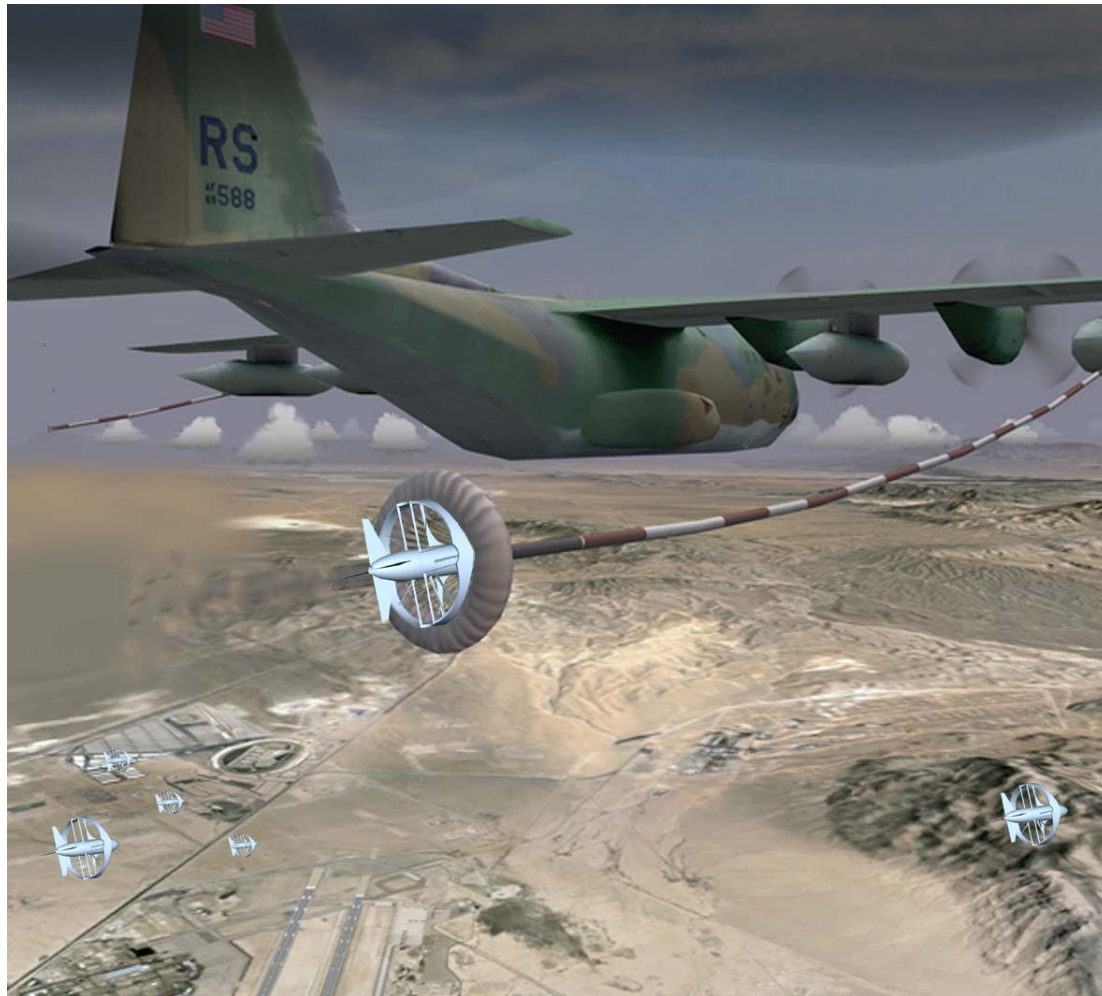
**Afghanistan:**  
**5 Base Coverage for 20 min Response**





# The Next Generation: FAQ-381 CCAS

Tankers enable "indefinite" loiter/orbit



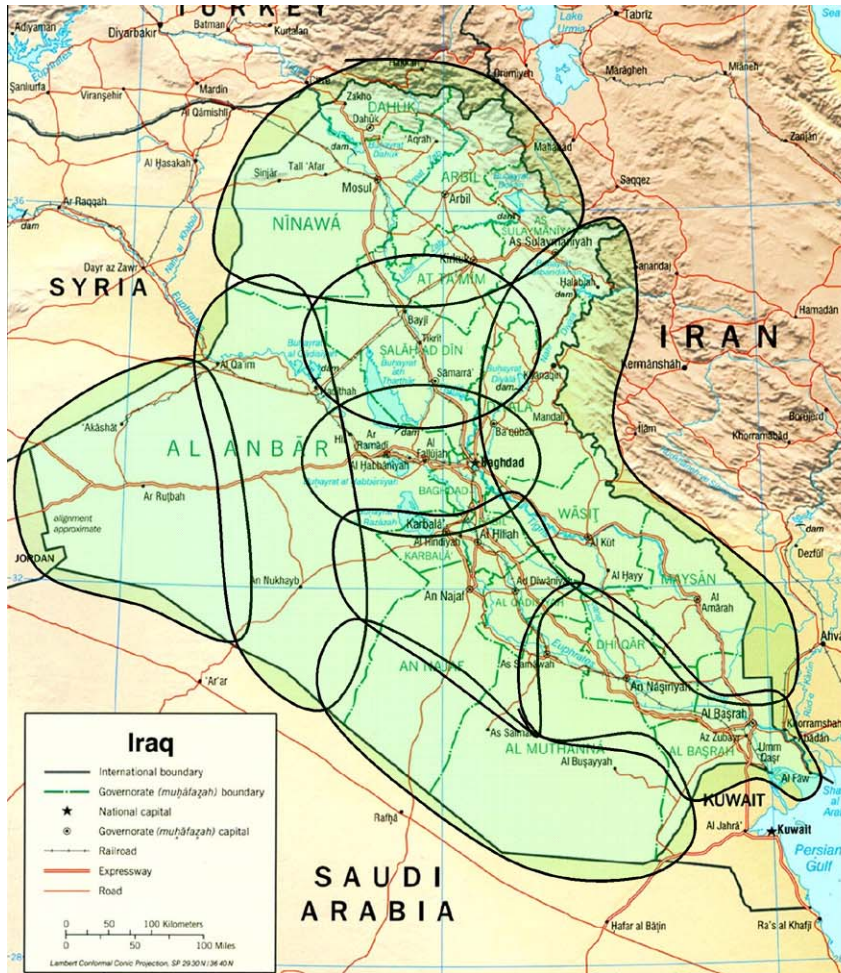




# The Next Generation: FAQ-381 5 min CCAS

9 Track Coverage for Iraq

10 Track Coverage for Afghanistan





# Precision Autorecovery

**Sub-millimeter navigation precision,  
exacting stabilization, gust insensitivity**

QuickTime™ and a  
Cinepak decompressor  
are needed to see this picture.





# Questions?

