



MAV with Thermoelectric Integration



Fixed-wing MAV



AeroVironment airframe

+

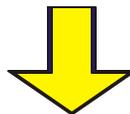
D-Star Engineering micro-diesel engine



Waste Heat from Engine

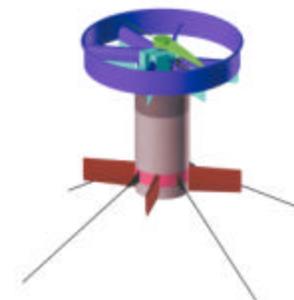
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Advanced Thermoelectric Modules



**Up to 3 Watts Continuous
On-Board Electrical Power**

Rotary-wing MAV



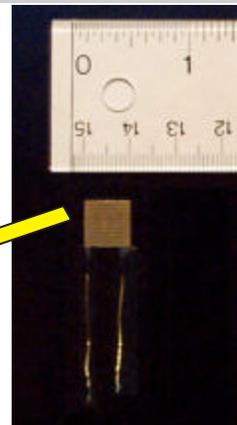
Successful miniaturization of modules and heat exchangers

- VHHFM-2 micro-module dimensions: 1 x 1 x 0.2 cm
- Constructed using Bismuth Telluride
- Manufacturing of miniature heat exchangers weighing < 0.5g



Thermoelectric modules integrated with engine and exhaust system

- Direct and indirect conversion of heat to electricity
- No moving parts – long life
- High power density



Program Goals

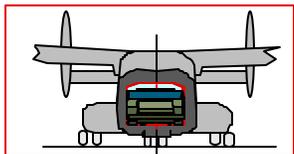
- Flight time > 3 hours
- Power density > 0.25 W/g
- Efficiency > 6%

Program Status 6/00

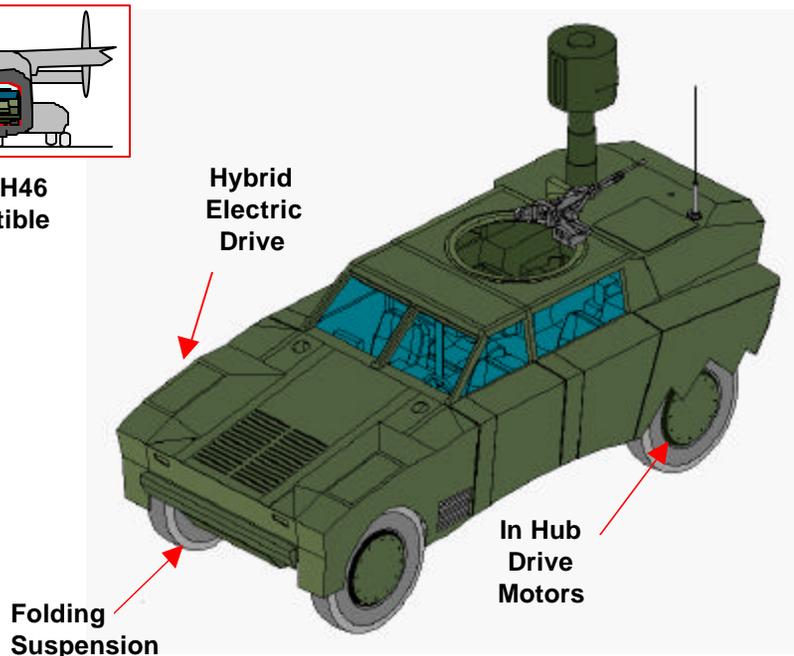
- Power density = 0.18 W/g
- Outperforms batteries for mission times > 40 minutes
- Projected module efficiency increase of 20% by end of 3rd quarter



Reconnaissance, Surveillance & Targeting Vehicle (RST-V)



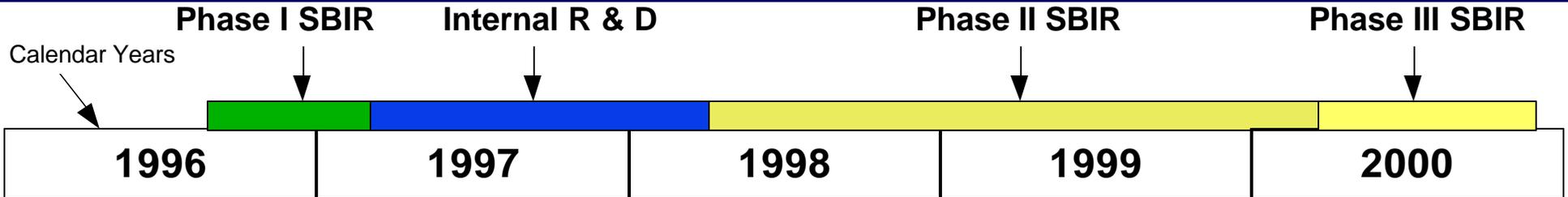
V-22, CH46
Compatible



- ✈ Automotive FRR completed
- ✈ RST/C4I FRR completed
- ✈ RST/C4I video transfer CID completed
- ✈ ATD 1 & 2 rolled out
- ✈ Demonstrated propulsion by engine & battery
- ✈ Demonstrated three ride heights & V-22 transport mode



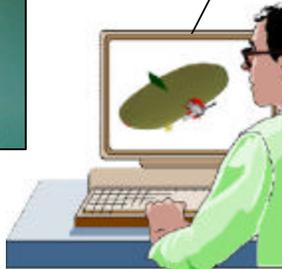
MAV Development Timeline



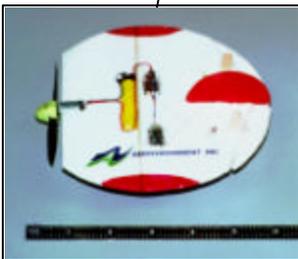
Configuration Selection



16-minute flight
No payload



Multidisciplinary
Design Optimization



2-minute flight
No payload

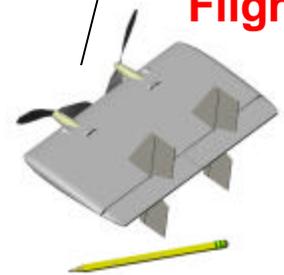


22-minute flight with
live video downlink



First color
video flight

Flight Demos at
Fort Benning, GA and
Camp Pendleton, CA



Hoverfly
Development

Stereo Vision UAV

**30
minute,
1.8 km
Flight**





Universal MAV GCU



- **Self-Contained System**
- **Weight: 19 lbs**
- **Tracking Antenna**
- **Collapsible Mast**

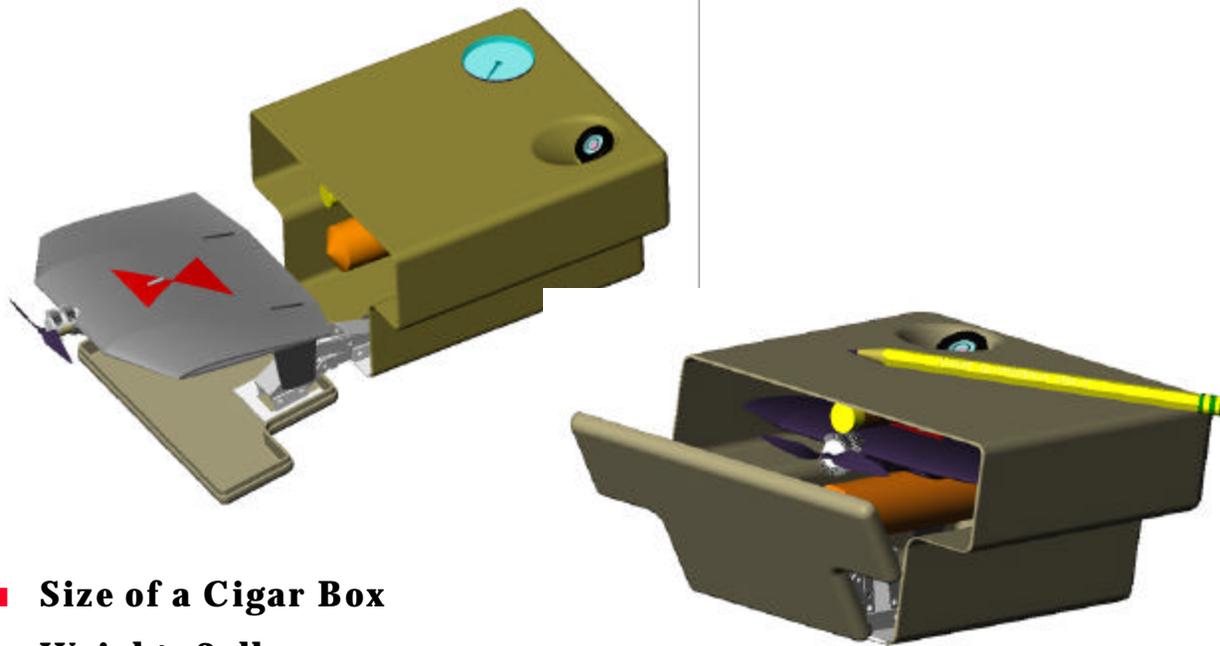
Operator's Console



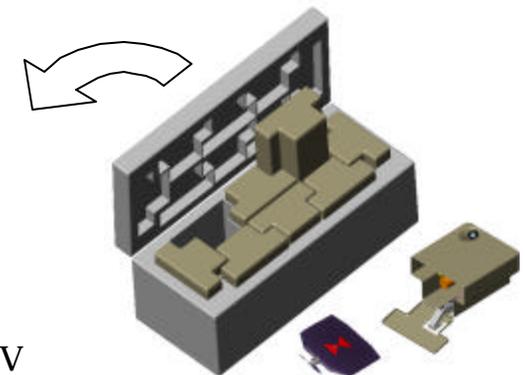
- **Color Video LCD**
- **Guidance Controls**
- **Light Weight**
- **Comfortable to Hold**
- **Rugged Construction**
- **Daylight Viewable**
- **Data Display over Video**



MAV Cassette Launcher



- **Size of a Cigar Box**
- **Weight: 2 lbs**
- **Ruggedized Container**
- **User Does not Handle MAV**
- **Includes Pneumatic Launcher**
- **Connects to Ground Control Unit**
- **Used Cassette Can be Discarded**
- **8 Cassettes Pack Easily in HMMWV**



HMMWV

8 Cassettes pack in
1.3 cu ft



Hoverfly VTOL MAV Prototype C

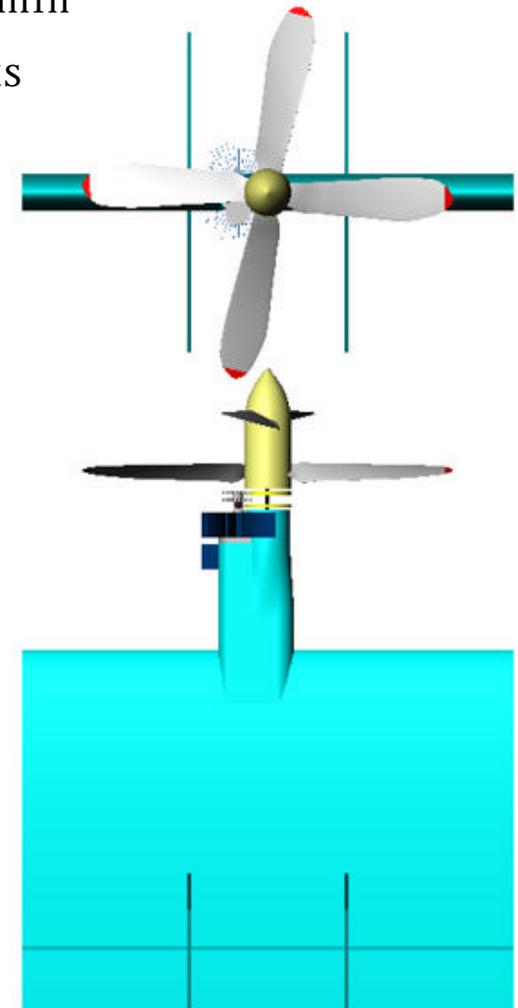
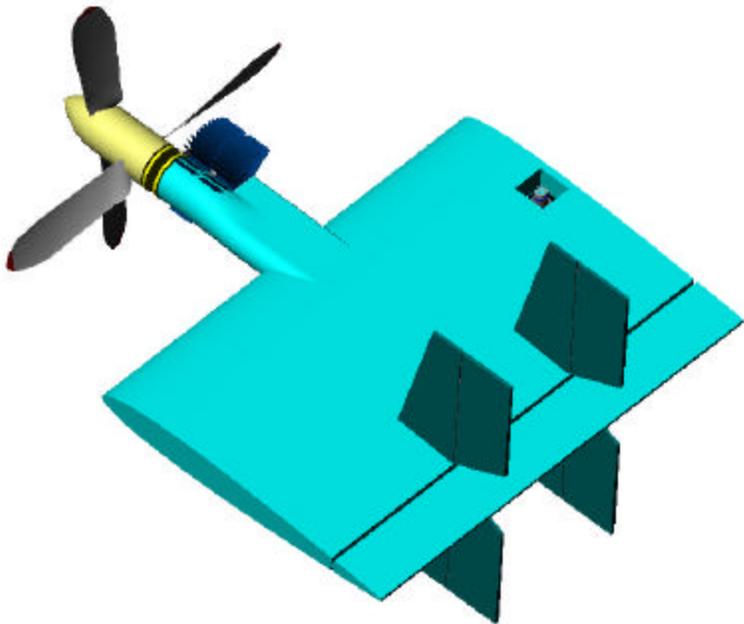


✈ Features

- All electric aircraft
- 3 Saft lithium batteries
- Single 32-gram motor
- 7.1" dia. coaxial rotors
- Gyros on all 3 axes
- Fixed-pitch props
- Mass: 180 grams

✈ Performance

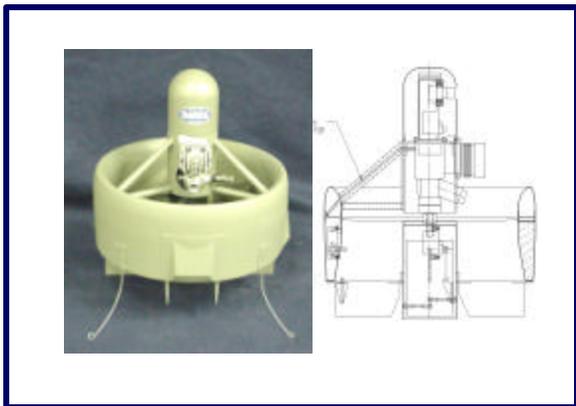
- Hover endurance: 7.3 min
- Cruise endurance: 13.2 min
- Hover power: 24.5 Watts



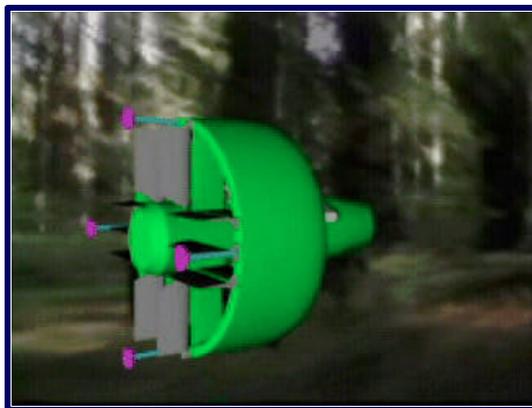


Hover and Transition

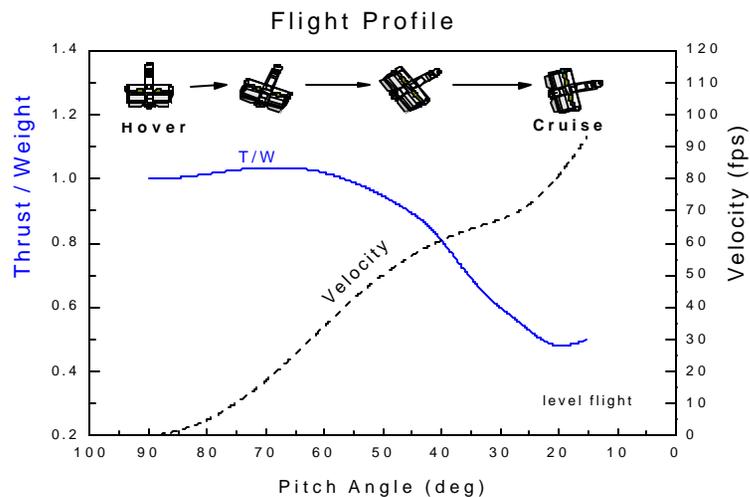
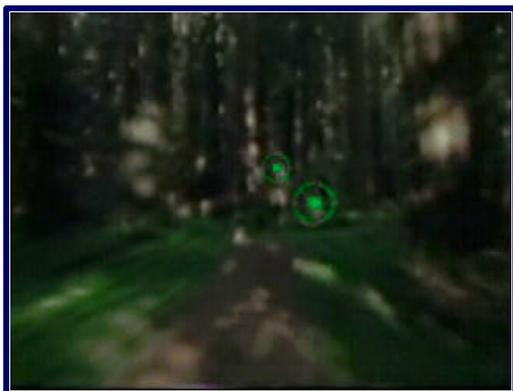
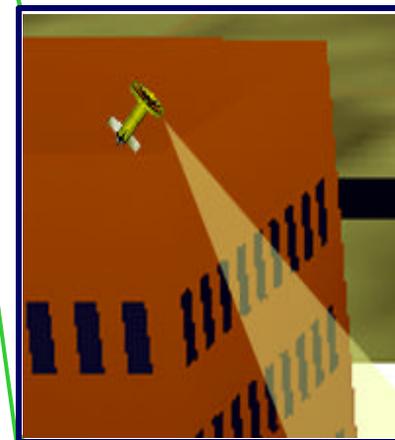
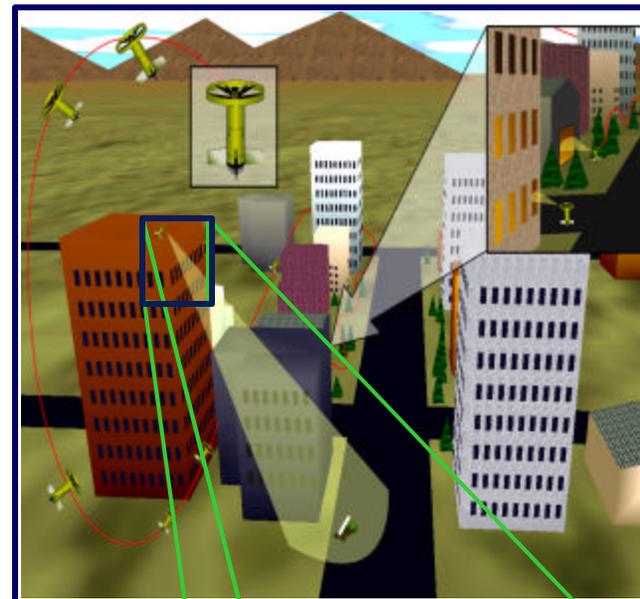
Micro Air Vehicle Concept



Ducted Fan



- High Speed Cruise
- Hover
- Vertical Landing



Micro Craft LADF Micro Air Vehicle Performance