



UAV ENGINES PLANT (UEP)

UAV Engines in the next decade - Turbine Engines, Piston Engines and the newly Combat Proven Rotary Engine

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A Lecture at the 6th Symposium on Jet Engines and Gas Turbines

Haifa, Nov. 16, 2006

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The Hermes 450 UAV, powered by R802



Engines for UAV's

| UAV Type | Engine Type | Power Range (HP) |
|-------------------|------------------------|-------------------------|
| Micro | Electrical | 1 |
| Mini | Piston (2X2) | 1 – 20 |
| TAC, CR/LE | Rotary (WANKEL) | 20 - 90 |
| MALE | Piston (4X4) | 90 - 250 |
| MALE | Turbo-Prop | 250 - 500 |
| HALE/ TCUAV | Turbo-Jet/Fan | above 500 |

UAV Models & Engines (e.g.)

| UAV Model | Engine Type | Engine Model | Engine Power (HP) |
|------------|-------------|--------------------|-------------------|
| Skylark | Electric | B40-19L | 1 |
| Neptune | Piston, 2X2 | 150D2 | 15 |
| Aerostar | Piston, 2X2 | 490IA | 38 |
| Harpy | Rotary | 731 | 38 |
| Hermes 180 | Rotary | 741 | 38 |
| Shadow 200 | Rotary | 741 | 38 |
| Hermes 450 | Rotary | 802 | 52 |
| Searcher | Rotary | 681 | 80 |
| Predator | Piston 4X4 | Rotax 914 | 100 |
| Heron | Piston 4X4 | Rotax 914 | 100 |
| Heron 1 | Turboprop | PT6 | 600 |
| Predator B | Turboprop | Honeywell TP331-10 | 950 |
| UCAV | Turbofan | F404 | 22,000 lb |

UAV Engines Special Requirements

- Long Endurance
 - Mission Length of 20-50 hours!
- Duty Cycle
 - Heavy weight/ High Altitude (completely different than light aviation)
- Compactness
 - High Power/weight ratio, Low Volume
- Simple Maintainability
 - Robustness, lower skills ground crews

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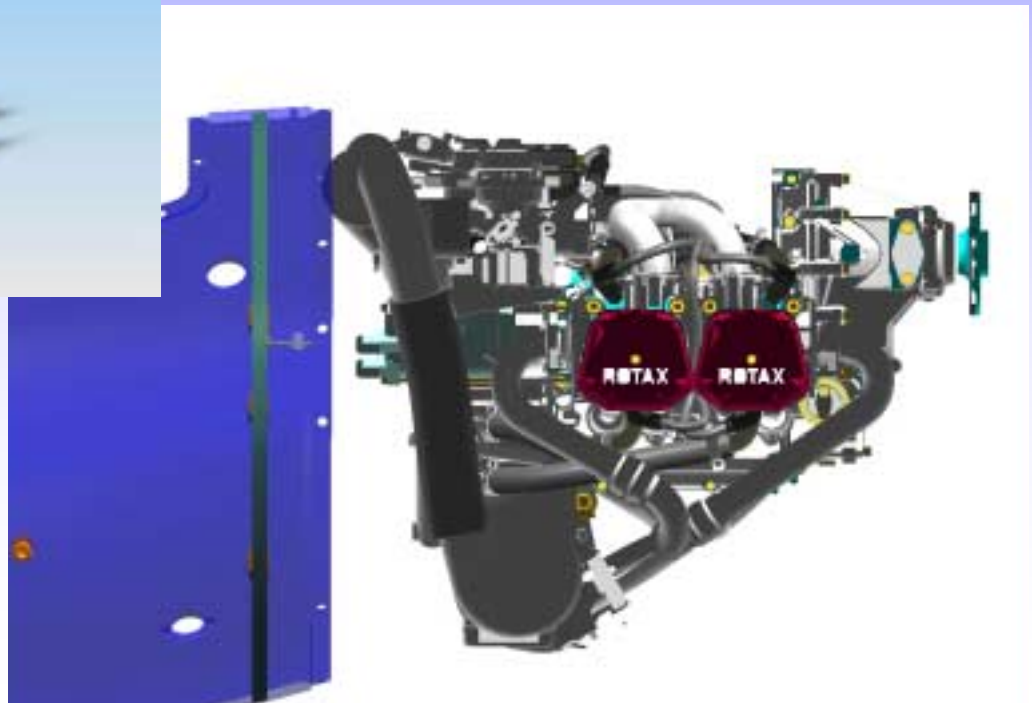
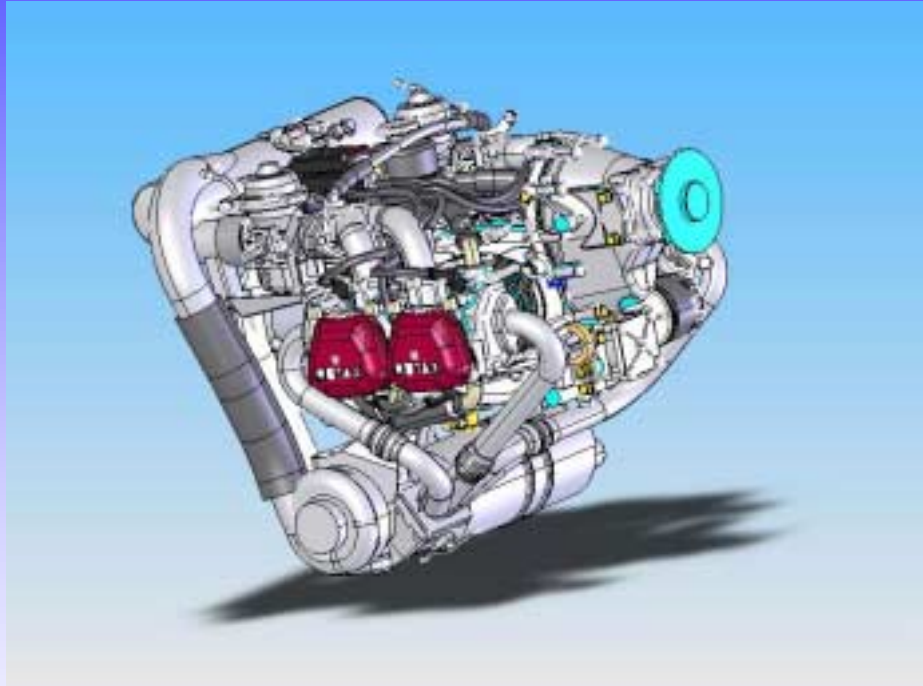
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Rotax 914



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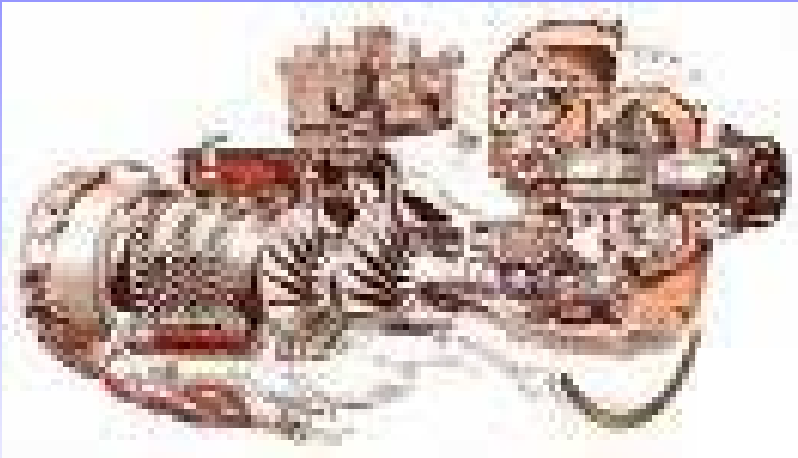
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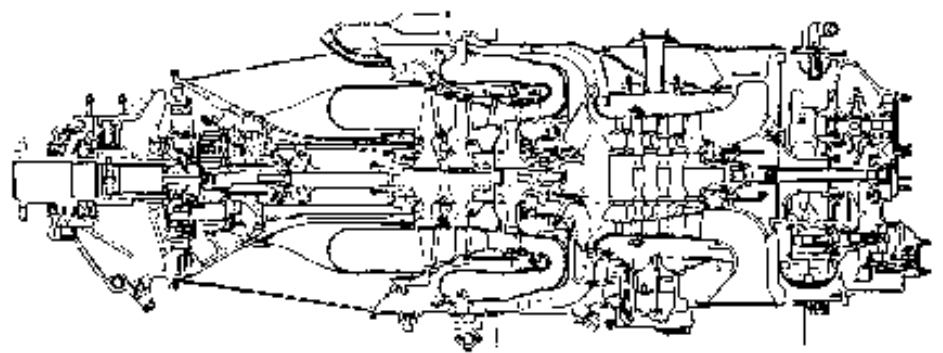
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UAV Turboprops (e.g.)

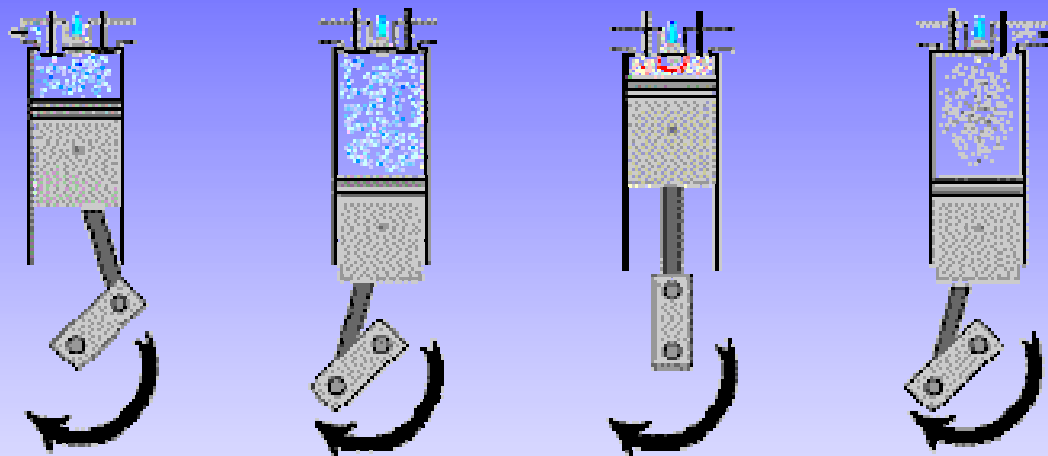
TP331-10



PT6



Wankel – Vs – Piston Principle

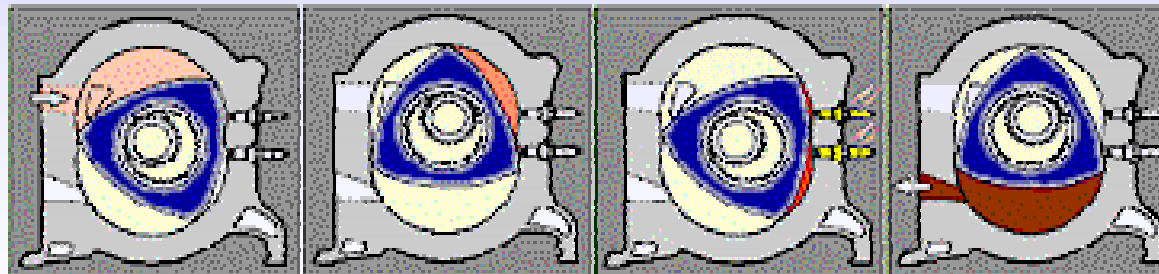


Intake

Compression

Power

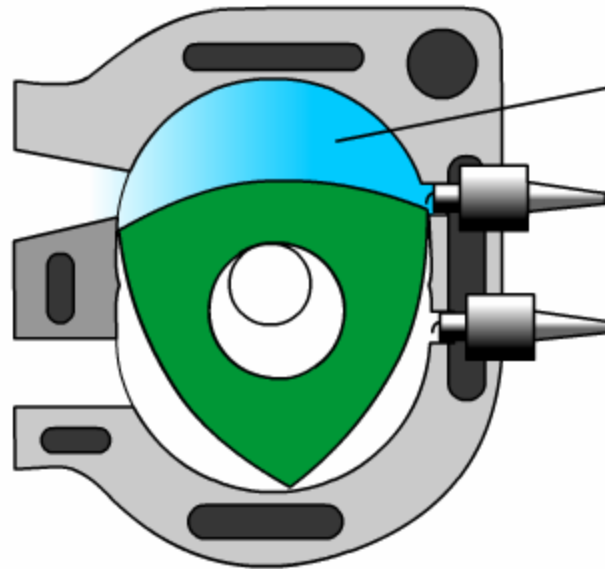
Exhaust



How Rotary Engines Work

Intake

Exhaust



Intake Stroke



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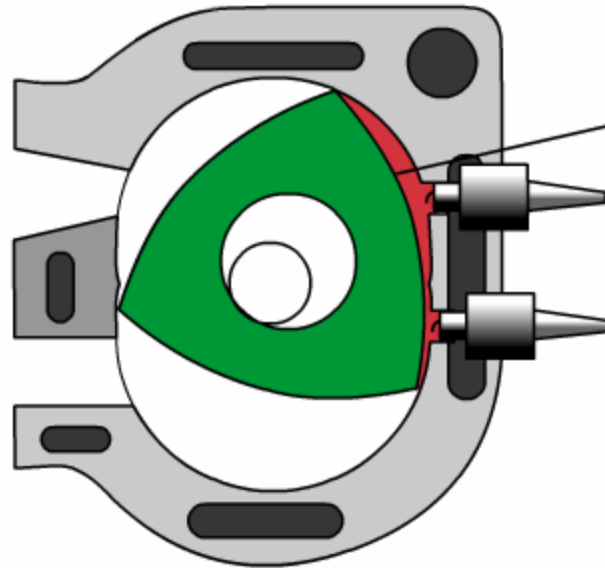
click here for
full animation



How Rotary Engines Work

Intake

Exhaust



Compression Stroke



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Mazda RX8 Wankel powered Car



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The new NRV 588 Norton Motorcycle unveiled on October 2006



Rotary (Wankel) Engines in Israeli UAVs

| Engine Model | Power (BHP) | Application |
|--------------|-------------|--------------------------------|
| 681 | 80 | IAI, MLT, Searcher |
| 802 | 52 | Elbit/ Silver Arrow, Hermes450 |
| 741 | 38 | Elbit/ Silver Arrow, Hermes180 |
| 731 | 38 | IAI, MLT, Harpy |

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AR741 Wankel (Rotary) Engine



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Rotor



Rotor Housing (trochoide)



Eccentric Shaft



Enhanced Performance 802 Engine (802W)

- Design-
 - Longer Chamber, displacement increase from 294 cc to 350 cc.
 - EFI
 - Starternator
- Outcome-
 - Higher Power (70+ -vs- 52)
 - Better SFC (0.45 –vs- 0.55)
 - Outstanding Power/Weight(*) Ratio (~1.6 -vs- 1.3)

(*) Weight includes Buildup and propeller

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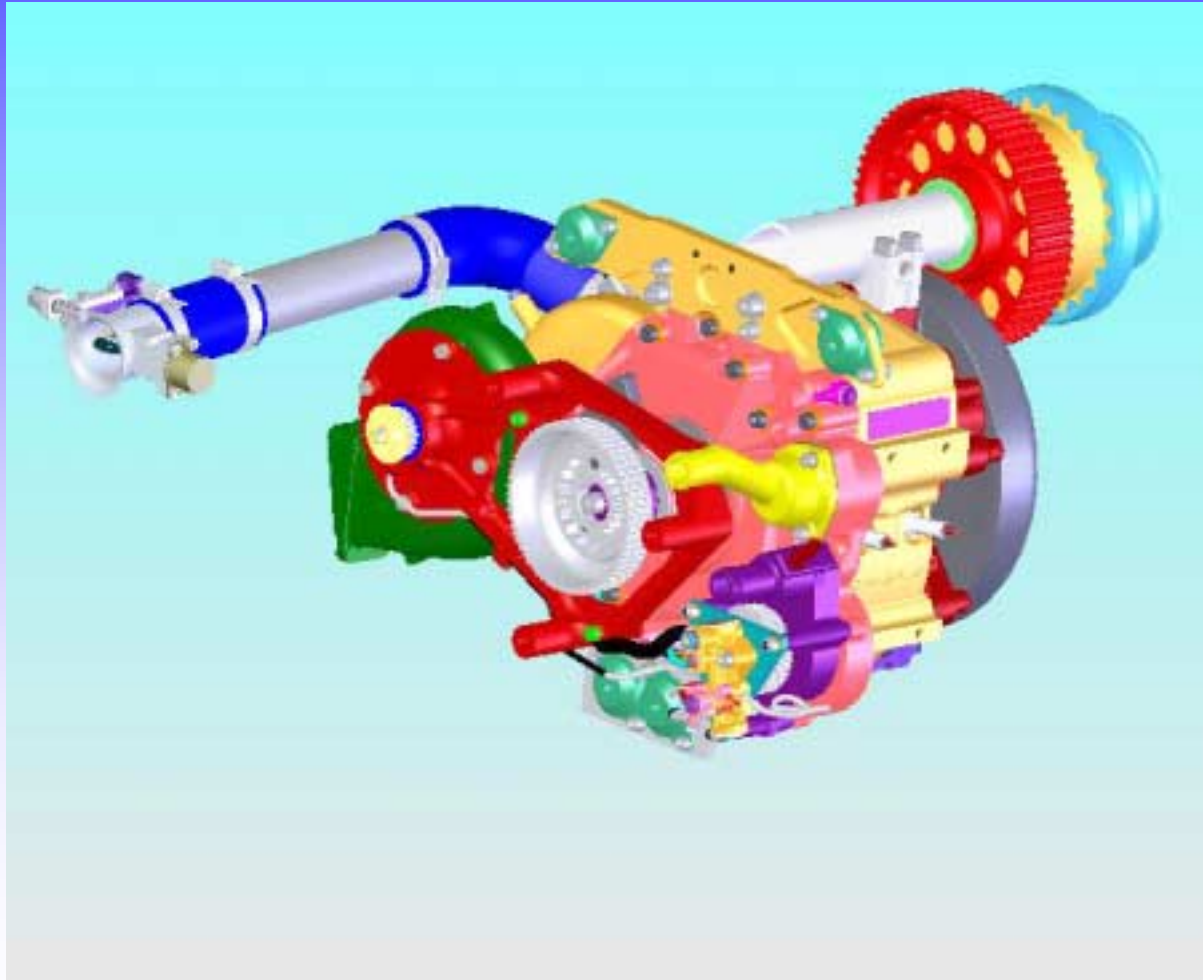
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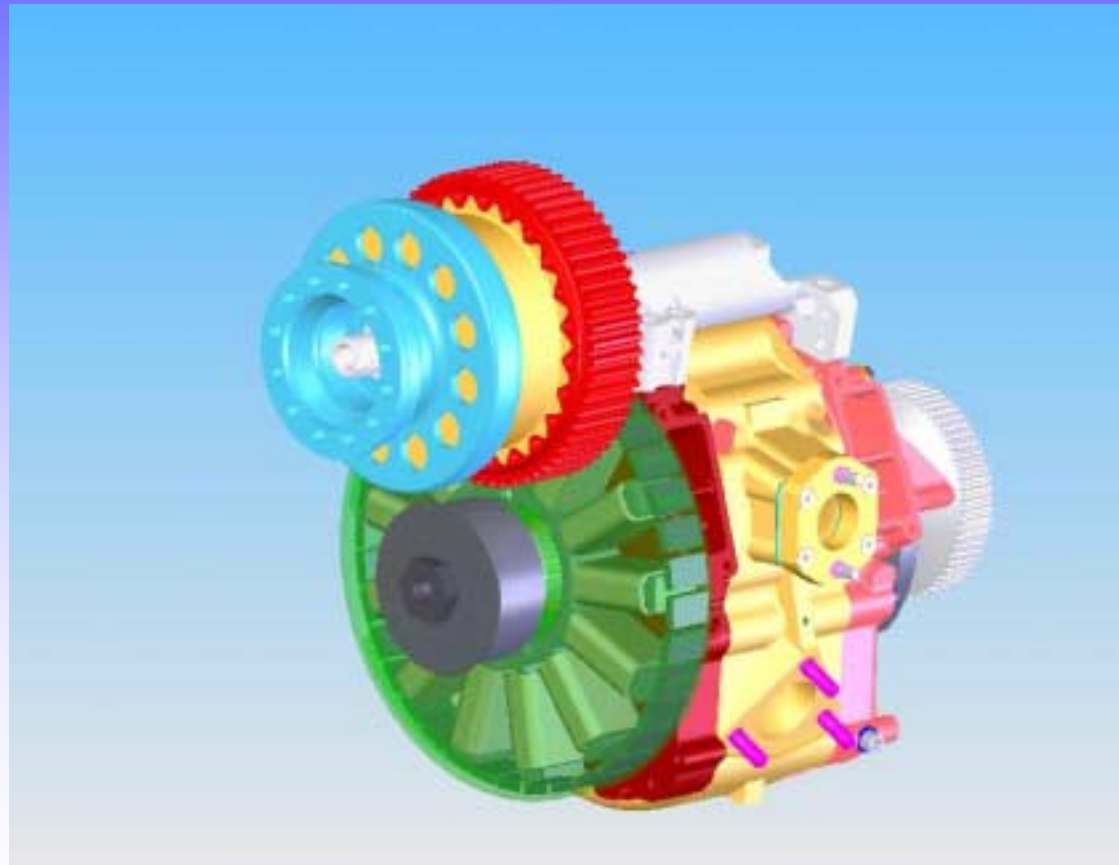


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The 802W CAD View



802 Starterator, schematic



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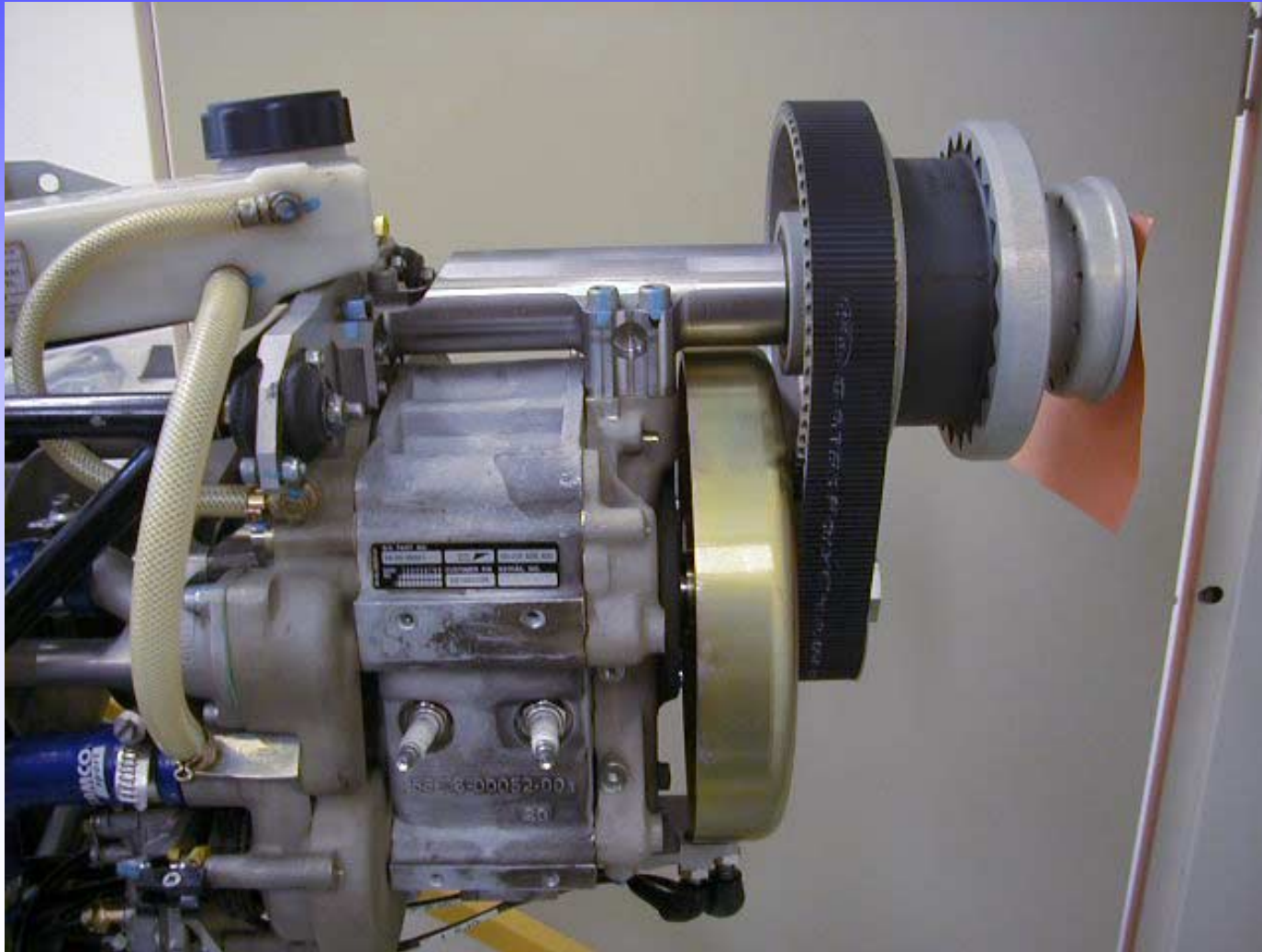
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UAV ENGINES PLANT (UEP)

802W Engine Demonstrator



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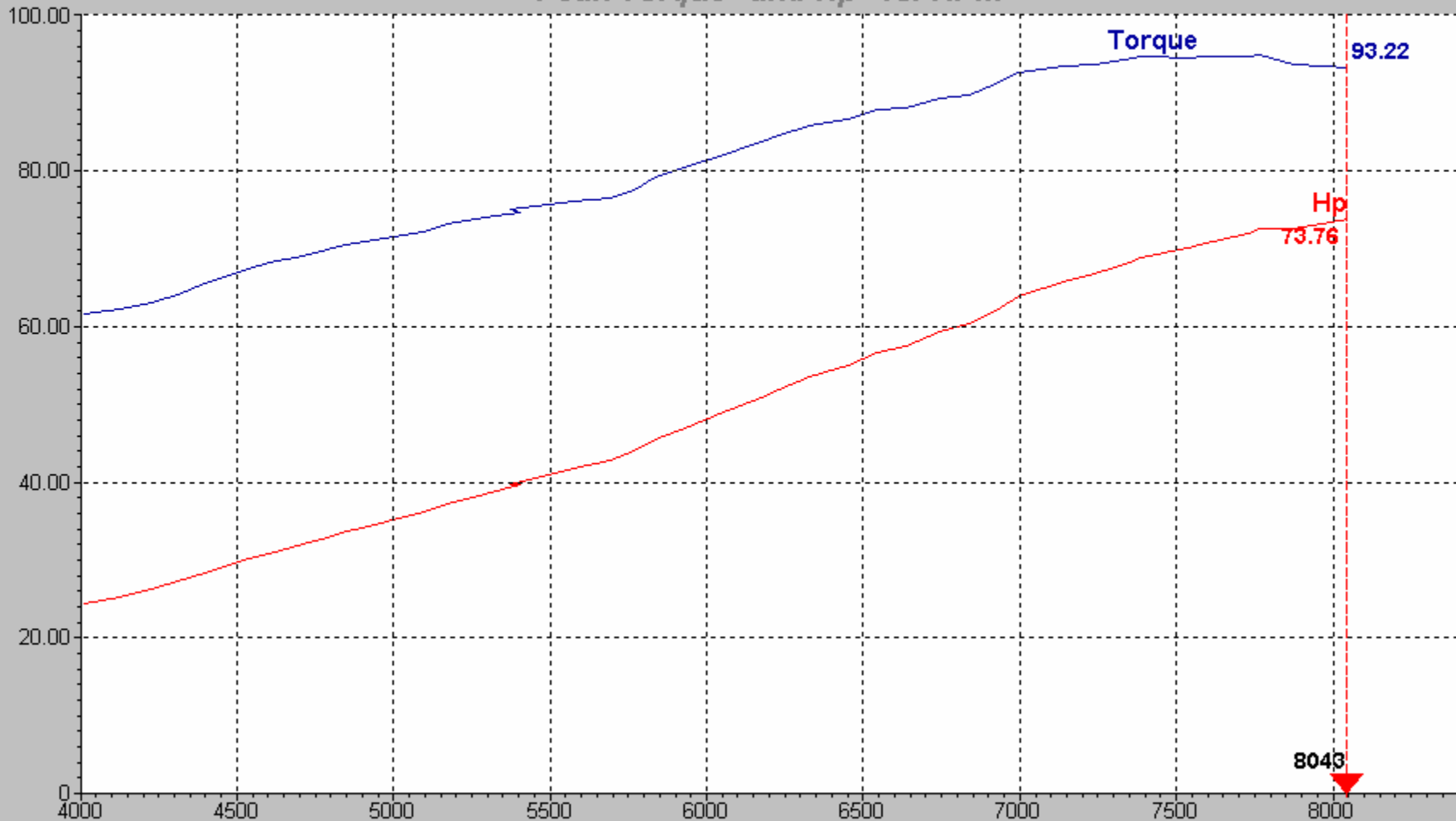
802W demonstrator in H450 UAV following maiden flight





DYNomite test "My test name here on 2006-08-24 @ 17-44-43" by Silver Arrow

Peak Torque* and Hp* vs. RPM



* Correction Method: Standard

Notes: 802w 29.47, 57%, 30 deg c, 802 exhaust pipe, NO

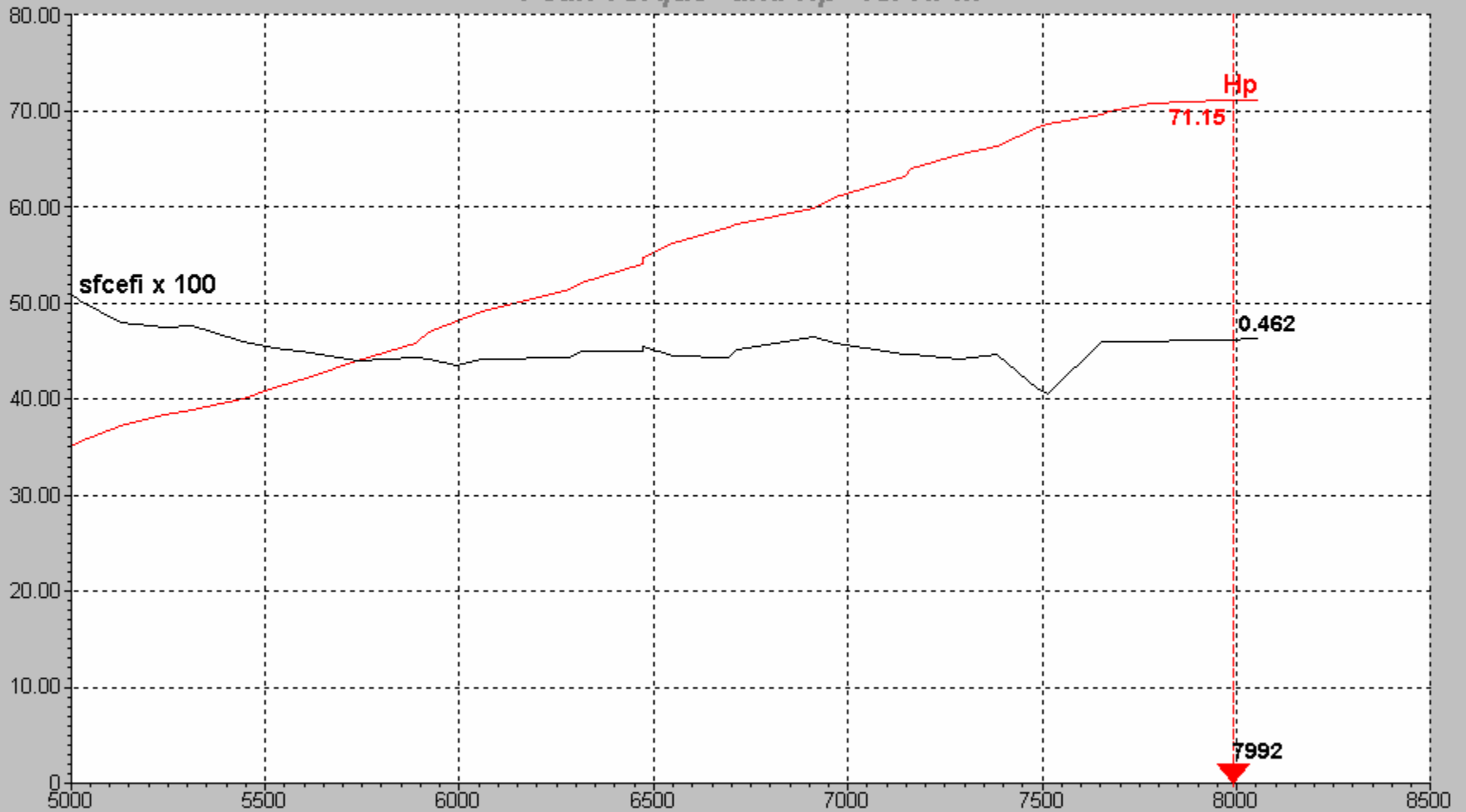
Reduction2engineRPM (engRPM)

Peak Power: 73.80 Hp @ 4200 RPM



DYNomite test "My test name here on 2006-09-27 @ 14-01-11" by Silver Arrow

Peak Torque* and Hp* vs. RPM



* Correction Method: Standard

Notes: \$02w, with screw, no alternator, KASAM, WOT,

Reduction2engineRPM (engRPM)

Peak Power: 71.19 Hp @ 4200 RPM

Summary

- UAV business volume in a dramatic increase
- The big players in the Engine world did not prepare engines for this market
- Wankel Engines are suitable and advantageous for TAC UAVs
- Academic Research covering Wankel Engines is almost nil