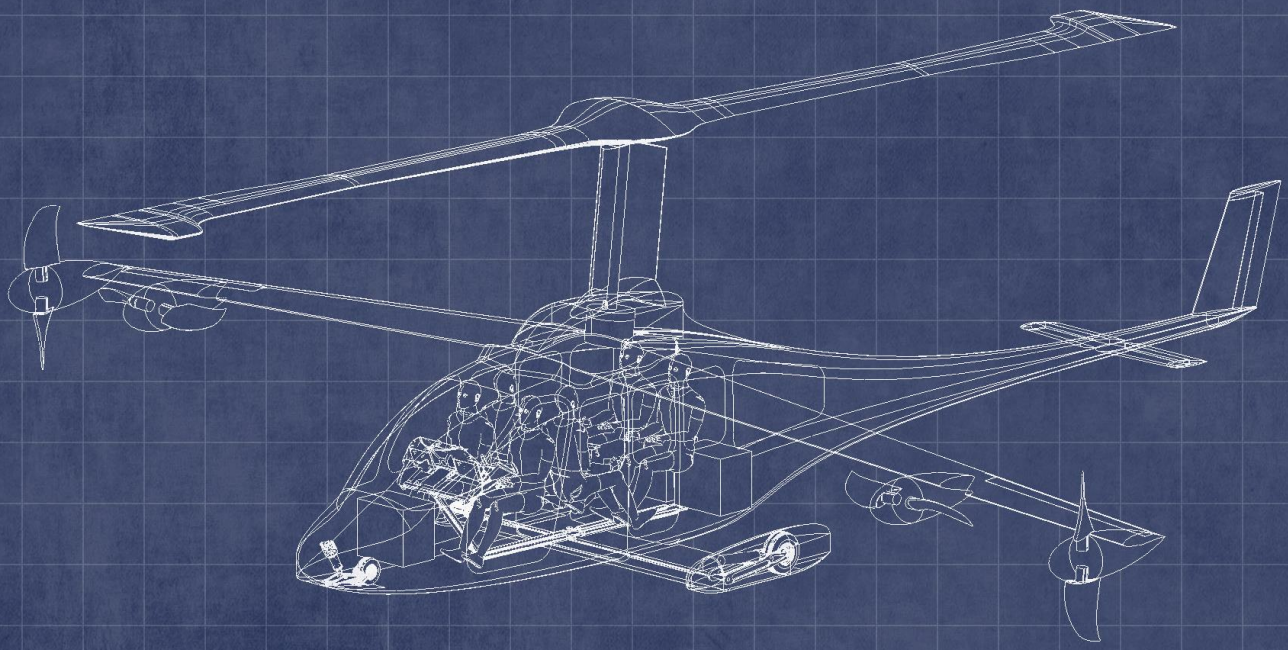
SAFE, FAST, EFFICIENT

A PRIMER ON CARTER SLOWED ROTOR COMPOUND (SRC) TECHNOLOGY



CARTER AVIATION TECHNOLOGIES
An Aerospace Research & Development Company

www.CarterCopters.com

SRC Benefits and Features

Carter has accomplished what no one else had been able to do before. Carter controllably, safely and *stably* slowed the rotor in flight to the point that the retreating blade experienced entirely reverse flow (technically known as a rotor advance ratio greater than one – or **Mu > 1** – the engineering term for a ratio of forward airspeed to blade tip velocity). The result of slowing the rotor so dramatically is reducing the rotor profile drag (by the cubic root of RPM) such that it almost disappears relative to the rest of the aircraft. Since the rotor provides the predominant lift for hover and low speeds, the wing can be sized for cruise instead of for takeoff and landing like conventional aircraft, allowing the wing area (and proportional drag) to be reduced by a factor of up to 5. This combination of low rotor/wing drag means that the overall efficiency can be the same as fixed-wing aircraft. The high aspect ratio wing doesn't need flaps or other high lift/drag devices, allowing for a simple, lightweight design.

Speed – A slowed rotor allows the aircraft to fly up to 450 kts without the advancing rotor tip speed exceeding Mach 0.95.

Cruise Efficiency – The slowed rotor at reduced pitch reduces the rotational drag so dramatically that its drag becomes only about 10% of the total aircraft drag profile – basically a function the rotor wetted area.

Vertical Takeoff and Landing – Both jump takeoff and hovering versions have the ability to operate without runways at low cost, which will revolutionize regional civil, commercial, or military air transportation.

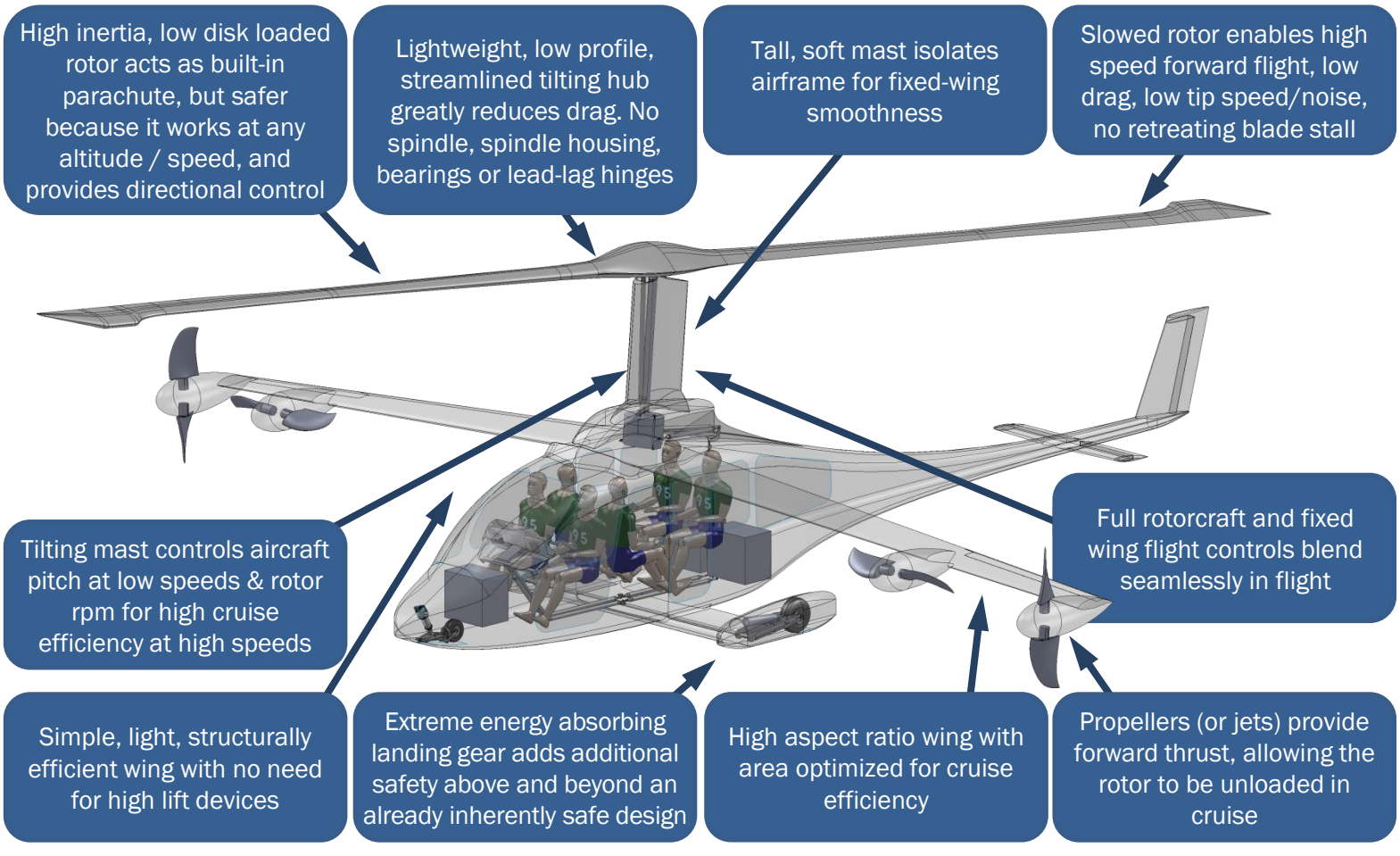
Impossible blade stall – Since the wing provides the lift at cruise, the rotor does not need to provide lift and therefore there are no retreating blade stall issues as with conventional helicopters at high speed.

No cruise rotor noise – The slowed rotor reduces the noise so significantly that during a flyover at 600' (200 m) above the ground, the rotor noise is insignificant compared to engine/prop noise – as quiet as a fixed wing aircraft, or even quieter using Carter propeller technology.

Hover and low speed efficiency – With the dramatic reduction in slowed rotor drag, SRC aircraft can operate with a large low disk loaded rotor, so hover and/or jump takeoff efficiencies are very high.

Fixed wing smoothness – A tall tilting mast mounted on flexible supports, essentially isolates the fuselage from rotor loads, even for 2-bladed rotors – no vibration. The mast also handles large CG variations.

Unparalleled safety – Since the rotor is always in autorotation and has heavy tip weights for stability at high speed SRC flight, it acts as a built-in parachute, but better because it can operate at *any* airspeed or altitude to provide a very soft zero roll landing for unparalleled safety.



CARTER SRC IS *FLIGHT PROVEN* TECHNOLOGY

CarterCopter Technology Demonstrator
First aircraft ever to achieve Mu-1
L/D of 7.0

CarterCopter Personal Air Vehicle
Second aircraft ever to achieve Mu-1
L/D of 11

11 key technical challenges overcome • 22 patents granted
multiple pending & provisional patents

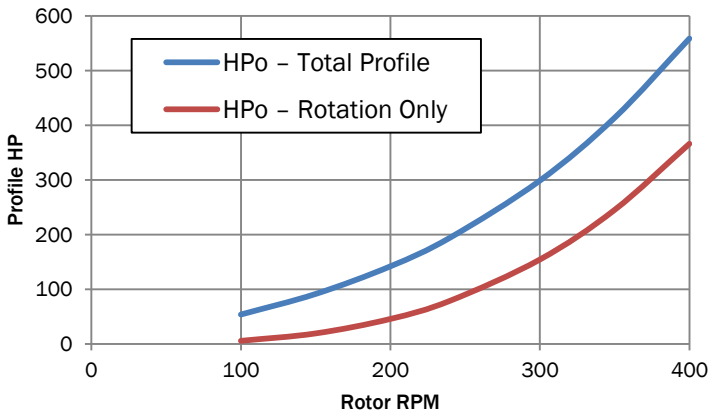
SRC – It's All About Reducing Drag

The benefits of slowing the rotor have been known for a long time. In the late 1950s the McDonnell XV-1 & Fairey Rotodyne both explored the SRC concept, but despite promising results, the programs were cancelled due to unresolved technical challenges. Carter has solved these challenges.

Flight Test Results

Carter's 2nd Generation Personal Air has completed 263 take-offs and landings, attained an 18,000 ft maximum flight altitude (VFR limited), and a 214 mph maximum true air speed. The aircraft routinely flies above Mu-1, having achieved a max advance ratio of 1.16.

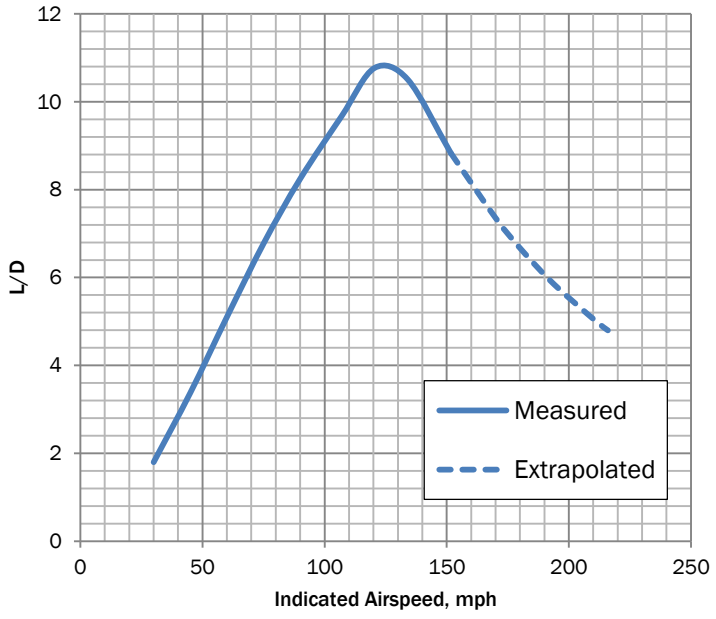
Rotor Profile HP vs. Rotor RPM, PAV Rotor @ 250 kts @ SL



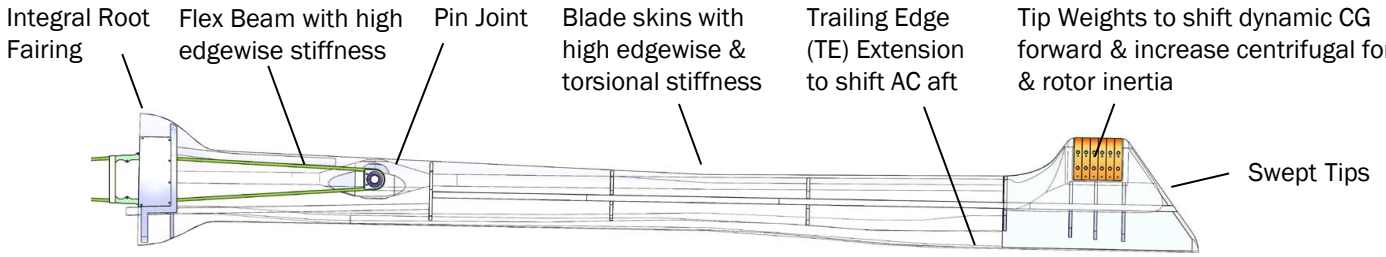
Drag per WADC TR 55-410:

$$HP_O = \frac{\rho_0/8 \; \sigma C_{D_b} A(\Omega R)^3 (1 + 4.6\mu^2) \rho/\rho_0}{550}$$

Carter PAV L/D vs. IAS



Carter Extreme Mu Rotor Technology

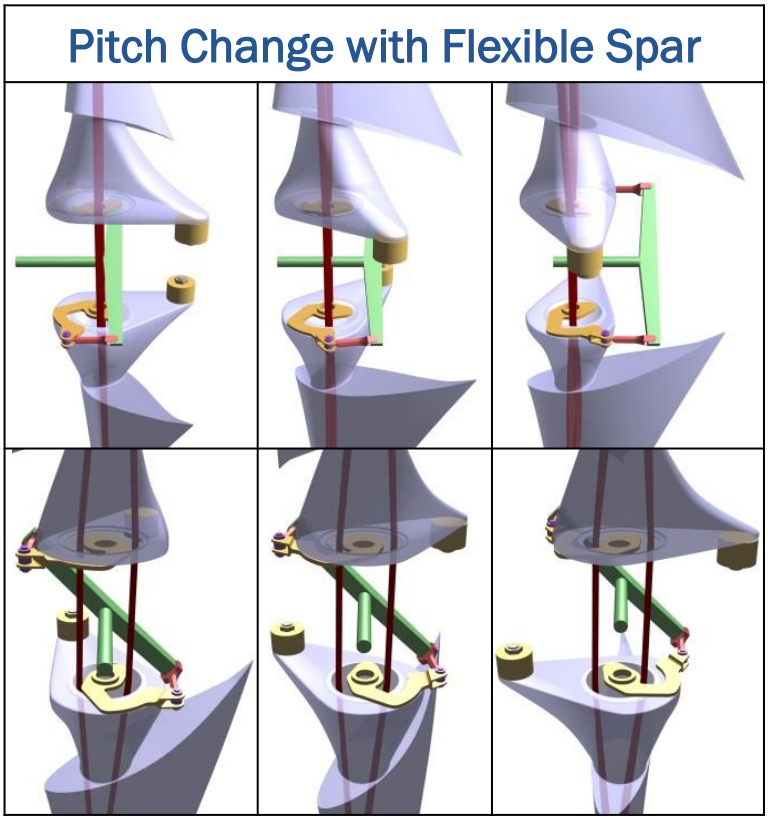


- TE Extensions move AC aft, Tip Weights in LE move CG forward
- Increasing stability on advancing blade outweighs decreasing stability on retreating blade
- Inherently stable up to Mu of ~1.5
- Inherent stability allows rotor to be slowed dramatically in cruise without boosted controls – boosted controls allow even higher Mu
- Integral root fairing with compact rotor head for low hub drag
- Swept tips for low noise
- Flex beam allows twist & flatwise bending, but very stiff edgewise – eliminates pitch change bearings & related hardware, lead/lag hinges, and coning hinges
- Total weight with rotor head ~1/2 that of a conventional rotor

Carter Scimitar Propeller Technology

Quiet, Efficient, Durable & Lightweight

- Highly swept - reduces apparent Mach number & reduces tip noise
- Twist a compromise between high speed cruise & static/climb
- Wide chord – uniform acceleration across blade, blade not stalled in static or low speed flight
  - Static/climb efficiencies on order of 30% better than conventional designs
  - Cruise efficiencies of 90+%
- Lightweight, hollow composite blades
- I-beam spar – soft flatwise – reduces coning & gyroscopic loads
  - Torsionally soft – ±25° pitch *without* hub, spindle, & bearings
  - Stiff edgewise – eliminates any edgewise natural frequencies
- Lightweight construction – 1/2 to 1/3 weight of conventional props (e.g. a 100” diameter prop shown above weighs only 42 lb)
- Ground tested at supersonic tip speeds > Mach 1 for 10 min



Carter Landing Gear Technology

Safe, Smooth, Long stroke - Trailing Arm, Energy Absorbing

- Carter invented and patented an ultra-high-energy-absorbing landing gear system
- Ground tested and flown in various configurations on all prototypes
- Greatly improves safety margins during landings and is scalable to fit any aircraft design
- Uses a special "Smart Strut," a hydraulic cylinder with a mechanical smart valve – provides a near constant deceleration during stroke
- Demonstrated at the extreme – One design for a 24” stroke gear absorbed 24 ft/s impact at 3000 lb in an instrumented test
- Extremely forgiving – No rebound – No bouncing
- Proven technology – used on all Carter prototypes
- Lightweight due to efficient energy absorption cylinder design