



**AC
PROPULSION**

AC Propulsion's Solar Electric Powered SoLong UAV June 5, 2005



Alan Cocconi with SoLong at El Mirage Dry Lake in California



Steve Neu

SoLong landing at the end of its 48 hour flight at Desert Center

Background

AC Propulsion is a small R&D and manufacturing company specializing in high performance electric drives and vehicles. Since 1991 most of the projects have been automotive, and AC Propulsion has established itself as an industry leader in the field of high performance AC drives and integrated battery-charging systems. The self funded SoLong UAV project builds on this electric propulsion expertise and has produced a small, inexpensive and rugged UAV that has demonstrated multi-day solar powered flight on June 1-3, 2005.

Applications

The long endurance electric powered SoLong is a unique platform that can be adapted to a variety of remote sensing applications. Its moderate size, the quiet and clean electric propulsion and GPS navigation make it a practical alternative to other available UAVs.

The airframe and propulsion system can be easily scaled up or down to accommodate various missions and the R&D effort is continuing towards a fully autonomous UAV data gathering “appliance” with automated launch and recovery.

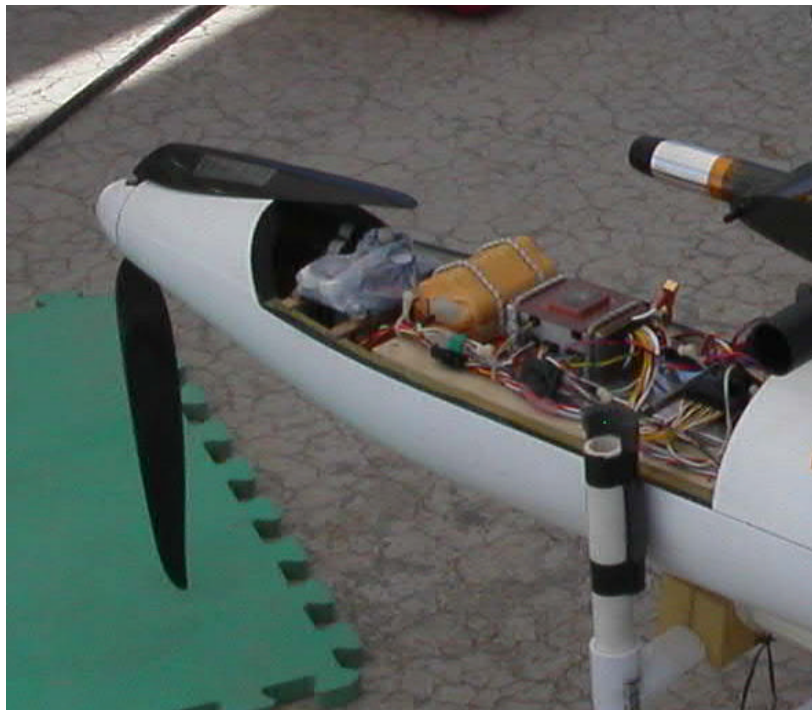
AC Propulsion is eager to find partners and or customers for non-military applications.

SoLong specifications

Wingspan	4.75m
Wing area	1.50 m ²
Mass	12.8 kg
Power sources	120 Sanyo 18650 LI-Ion cells and 76 Sunpower A300 solar cells
Solar panel nom. power	225 W
Battery mass	5.6 kg
Max motor power	800W
Min electrical power for level flight	95W
Stored energy	1200Wh
Speed range	27 to 50 mph
Max. climb rate	2.5 m/s
Control and telemetry range	8,000 m



SoLong takes off from a simple wheeled dolly, lands on its belly skid



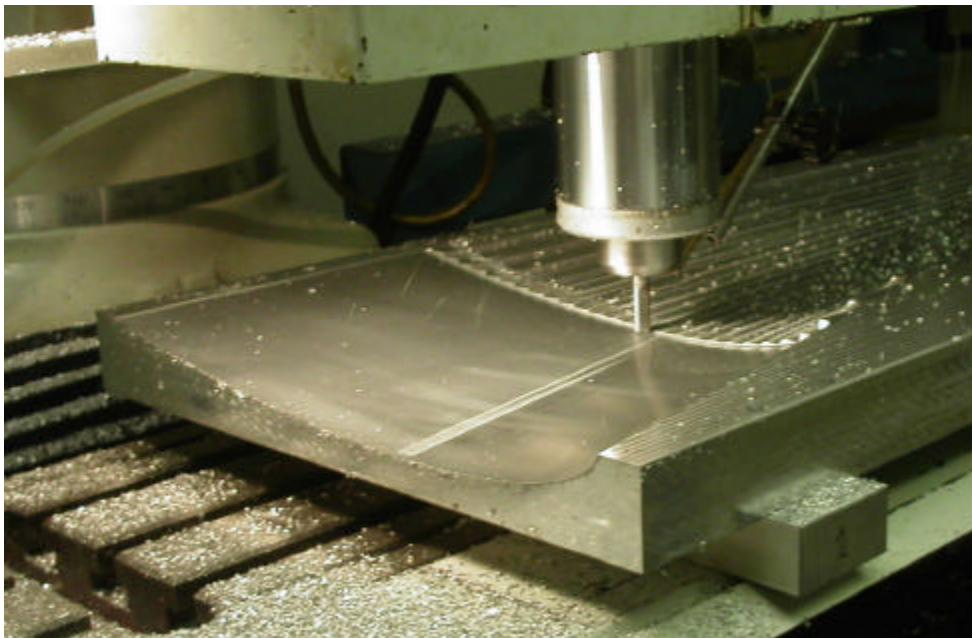
**Avionics (above) and propulsion battery (below) fit within 15 cm diameter fuselage.
Propeller folds during non-powered flight**

Construction

Fuselage	Kevlar epoxy monocoque with carbon boom.
Wings	Carbon, Kevlar and glass epoxy composite sandwich with molded in place solar cells using CNC machined aluminum molds.
Propeller	Molded carbon epoxy with an in-flight adjustable pitch hub and a load cell for in-flight thrust measurement.



225 W solar array is molded into the wing surface



**CNC-machined wing molds provide accurate profile
For construction of wing and bonding of solar cells**

Avionics

2.4 GHz video and data downlink with 23 channels of telemetry plus GPS nav. data (position, velocity, waypoints etc.)

AC Propulsion developed autopilot with differential pressure for wing leveling, 3 axis gyros, accelerometers, and barometric pressure for stability augmentation and pitot pressure for airspeed hold.

Ublox OEM GPS module for position information

Microchip 8 bit processor running assembly language code for all control and navigation processing.

High efficiency AC Propulsion developed digital amplifiers for the 6 control surface servos

Propulsion

AC Propulsion 9 phase motor drive with 88% minimum DC to motor shaft efficiency over the 60 to 800W range.

Kontronik Tango 45-06 3 phase brushless ironless motor with 4.2:1 planetary gear reduction turning a 23 inch folding, variable pitch propeller.

30 volt Li-Ion battery pack of 120 Sanyo 18650 cells

76 Sunpower A300 solar cells.

AC Propulsion 300W 4 phase peak power tracker weighing 100g and operating at 98% efficiency.

Ground Station

A 5ft by 8ft utility trailer with GPS aimed tracking downlink antenna and 3 computer screens display live video feed and flight instruments, GPS waypoints and altitude coded flight path overlaid on a moving topo map or satellite imagery, and the third is multi function backup. The UAV flight and navigation is controlled using a modified RC model transmitter. The flight and landing is controlled from inside the trailer.

Navigation waypoints can be downloaded before flight or set and moved while airborne.

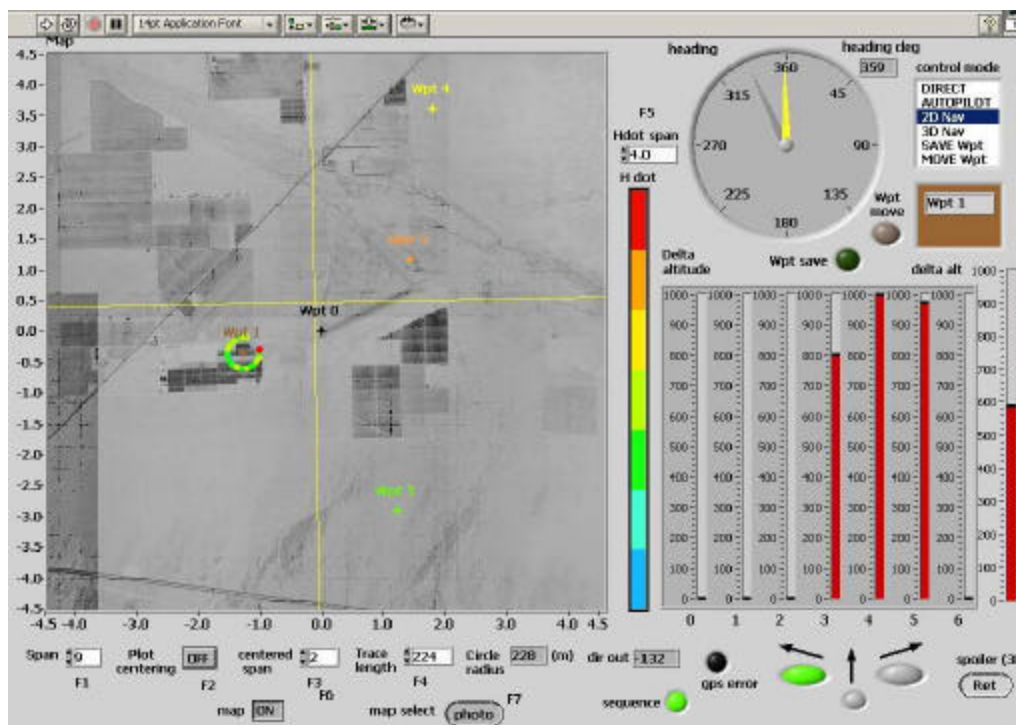
Telemetry allows display and monitoring of solar power capture, energy use, battery state of charge and real-time propulsion efficiency.



Ground station trailer with 2 axis tracking antenna



Flight screen with live video feed, instrumentation and telemetry



**Navigation screen displays waypoints and flight path.
Trace color indicates rate of climb.**

Flight Tests

The present prototype has had over 60 flights and 250 hours since July 2004 and is the latest of a series of UAVs designed and flown since 1983 by Alan Cocconi, chairman of AC Propulsion.

The SoLong has been operated safely in winds of up to 30 mph and has been flown for many hours at night and has landed in full darkness with only runway marker lights.

SoLong flew continuously for 48 hours and 11 minutes on June 1-3, 2005, demonstrating sustainable solar electric flight.



48 hour flight pilots.

From left to right:, David Fee, Jerry Bridgeman, Alan Cocconi, Chuck Grim, “RCDave” Freund and Steve Neu

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