ELECTRIC POWER TRAINS
THE KEY ENABLER FOR CONTRA
ROTATING PROPELLERS IN
GENERAL AVIATION
(& VICE VERSA)

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“THE EMERGENCE OF ELECTRIFICATION IN AEROSPACE”

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THE CONTEXT

• 85% of the world’s 410,000 civil fixed wing aircraft are propeller driven.

• 99.99% of these aircraft are driven by combustion engines.

• 99.99% of these aircraft have one propeller per engine.

• Electric drives offer the single biggest advance in aircraft propeller technology in it’s 100 year history – they allow the manufacture of simple, affordable, twin screw, contra rotating propeller systems.
Two contra rotating (CR) propellers give an aircraft a hugely improved performance over a single fixed or variable pitch propeller using the same total horsepower.

However, prior to the recent development of high torque, slow speed, electric motors by the automotive industry, CR has never been viable in light aviation.

This is because of the high cost and extreme complexity of constructing contra rotating systems using combustion engines. These types of engines must use propellers with variable pitch. Only the military have been able to afford them.

By contrast, using electric motors enables the use of fixed pitch propellers and the building of very simple, inexpensive contra rotating propulsion systems suitable for GA.

It’s all about torque delivery.
THE TECHNOLOGY STATUS

Until 2017 fixed pitch CR propellers suited to electric motor power delivery curves did not exist.

My company together with Hercules Propellers Ltd designed and manufactured sets of fixed pitch propellers following an 18 month, NATEP assisted R&D project, to formulate design rules and create the algorithms to allow the construction of CR propeller sets, for any light aircraft driven by electric motors.

Furthermore, the company has designed, built and ground tested a 225kW prototype twin motor contra rotating propulsion system (CRPS) to prove the format and record compelling data to verify the benefits.

The most important benefits are the yaw-free delivery of thrust, better acceleration, higher top speed and reversibility. There are many other important benefits.
CONTRA ROTATING PROPELLERS COUNTERACT YAW.

WHEN HIGH POWER ELECTRIC DRIVES WITH ALMOST “INSTANT POWER” BECOME AVAILABLE IT WILL BE ABSOLUTELY NECESSARY TO USE CONTRA ROTATING PROPELLERS TO PREVENT TORQUE ROLL ACCIDENTS.

Front Propeller - CCW Torque Reaction

Both Propellers – Contra-Rotating

Rear propeller - CW Torque Reaction

Nett Torque (yaw) = 0
FLIGHT TEST STRATEGY

To flight test systems and demonstrate the hugely significant advantages of the format, we propose to design, build and flight test two complete systems:

1. An “entry level” single motor, gearbox driven contra rotating unit for aircraft in the 75 – 150kW power range.

2. A “high performance”, twin motor contra rotating unit for aircraft in the 150–350kW power range.

The power density of electric motors is 2 to 3 times that of similar power combustion engines. Electric power trains are therefore much smaller and lighter.

However, as existing battery capacity only offers about 1/5 the range of combustion systems (system weight for system weight), aircraft benefiting most from improved performance and tolerant of short range will be adopt the format first.
OUR PITCH

The two illustrations you see here show the step change in fuselage profile going from combustion to electric propulsion offers. This change alone reduces drag by 7%.

The aircraft on the right has two “engines” on the fuselage. Almost all other twin engine aircraft have an engine on each wing.

We are looking for partners who recognise the opportunity to establish a new aircraft propulsion industry in the UK and revolutionise GA propulsion. At present there are no known competitors.

The existing market for combustion engine propulsion systems in GA is about 10,000 units per year. Value exceeding $2 billion.

Single Piston 180 HP with 1xVariable Pitch Propeller

Twin Electric Motor 300 HP 2 Fixed Pitch Propellers (CR)
STATIC TEST AT 140KW TOTAL POWER GIVING 500KGS THRUST. VEHICLE MASS 1200KGS.
1200kg Vehicle accelerates to 55kts in 200m simulating take-off speed (Vr) of typical GA aircraft. An equivalent piston powered single propeller aircraft takes 300 – 400m.
THE MAJOR BENEFITS OF ELECTRIC CONTRA ROTATING PROPULSION
(COMPARED TO SINGLE PROPELLER SAME POWER COMBUSTION SYSTEM)

• No aircraft yaw during power changes, dramatically improving safety.
• Much improved performance and handling. Speed increase by 0.1MACH (75mph).
• Reverse thrust, greatly expanding aircraft operability.
• Twin “engine” safety & classification, with no asymmetry on single engine failure.
• No engine warming, shock cooling or spool up time.
• No weight change during flight.
• Almost instant throttle response.
• Smaller overall propeller disc diameter.
• Extremely simple construction.
• No exhaust or pollution.
• Virtually silent motor operation.
• High energy efficiency.
• Recharge using ground power, wind or solar sources.
• No change in power output at sea level or high altitude.
• No liquid fuel or lubrication system.
• Offers aerobatic a/c unique manoeuvring capabilities.
• Negligible vibration.
• Very low maintenance
• TBO extended to 5,000hrs
COMMERCIAL DEVELOPMENT

1. ENTRY LEVEL SYSTEM

The contra rotating format is particular appropriate for aircraft operating from snow, ice, water & in mountainous terrain.

The ability to accelerate, climb faster and apply full forward and reverse power almost instantly and without yaw, has been described as the “holy grail” for these environments.
In contrast to piston or gas turbine engines, electric motors can be mounted in series and therefore offer a “twin engine” capability in the form factor of a normal single piston or turbine installation.

Aircraft fitted with twin engines have enhanced safety and greater access to controlled airspace than single engine aircraft.

Uniquely, an engine failure does not cause asymmetric flight.

The yaw free power, higher top speed and increased climb rate together with full reverse capability, low operating and maintenance costs make this system extremely attractive.

The system can be retrofitted to many types of aircraft.
Demonstrating all forward and reverse propeller operations
Reverse thrust demonstration