GREATER THINGS ARE POSSIBLE

By Galen J. Suppes, Ability Prime, Exhibit #1003
April 30 - May 1, 2020; agilityprime.com

- Safer, Faster, More Efficient (than all others).
- Electric Motors at > 2X power density.
- Transformer Aircraft, Hybrid Jet Engines ...

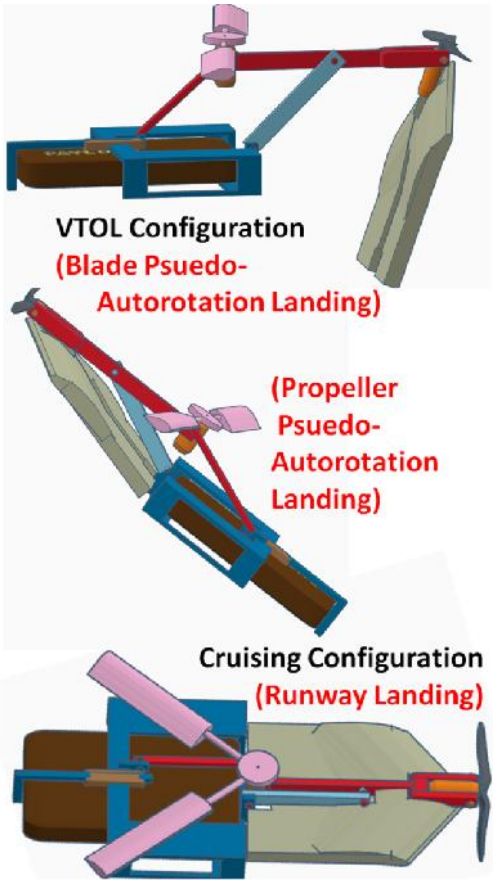
PART I: Transformer Aircraft

The Paradigm - The industry has overlooked the potential of lifting body technology and did not identify the upside of front tiltwing technology.

Serial Innovation Epoch - The front tiltwing identified as a passive transition method from VTOL to cruising*, and subsequently identified as a breakthrough failsafe.

The Front Tiltwing Showing Cruising & Failsafes:

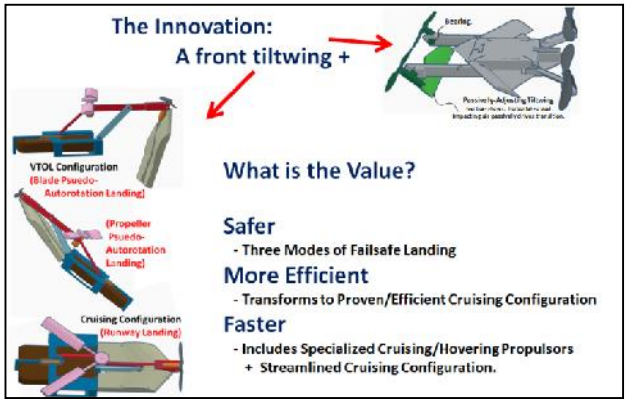
This vehicle can be made safer than any alternative



aircraft with as few as six motors/actuators. Passive stability is inherent and key to unveiling the potential.

*** Cruising uses body and fixed wings for lift (not rotor).**

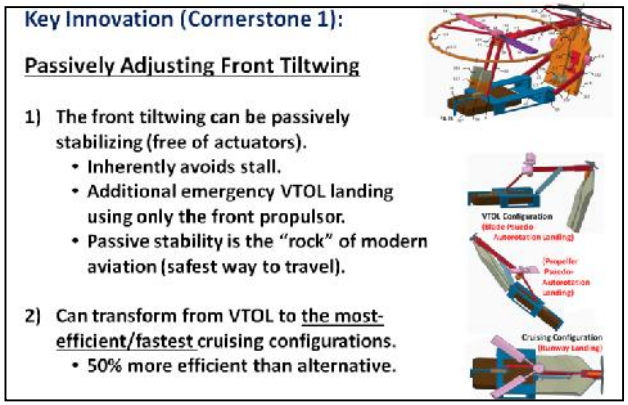
A Walk Through the Slides:



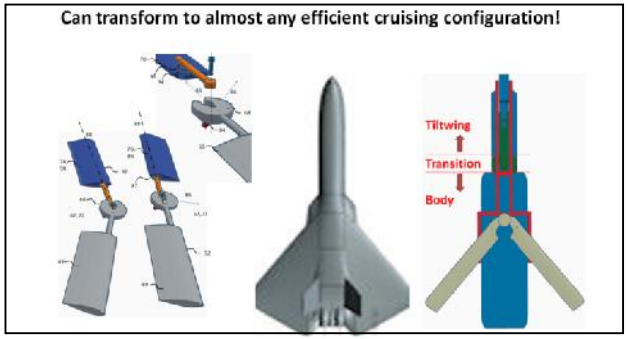
Three failsafes (two being VTOL) make the mature design of this aircraft safer than any other aircraft.

Efficiency is extremely important for electric vehicles and is a weakness of most current Flying Car designs.

Faster requires blades that handle most of hovering lift to be separate from cruising propellers.



The cabin may be connected to tiltwing.



It is possible to transform to a range of configurations.

Mounting Evidence Indicates:

HS-Drone Transformer can transform to:

- cruising configurations that can out-perform any bomber, fighter aircraft, passenger airline, or current VTOL;
- in scalable designs from toys to 20+ passenger;
- at greater origin-to-destination fuel economy than any other transit alternative;
- will make airfields obsolete; and
- with less COVID-19 contacts than any alternative.

Pie-in-the Sky or What?

These designs are:

- Scalable from toy to passenger service.
- Able to be 3D-printed.
- Are simple (6 actuators + motors).

They are not only possible, but potentially can be produced and in service before the majority of other flying car options that are primarily tweaked versions of the quadcopter or highly dependent on actuators to change the orientation of propulsors.

More on Efficiency

Airliner transit is documented by Oak Ridge as second only to intercity rail on passenger-mile efficiency. This is with aircraft at lift-to-drag ratios (L:D) near 15:1. VTOL aircraft can provide superior efficiency to all alternatives when: a) they attain L:D near 15:1, b) through non-stop direct origin-to-destination service outside land-based grids or "connecting" flights. Quadcopters, and other aircraft cruising with rotor-based lift have L:D near 4:1; and will never be efficient enough. Other aircraft (e.g. Osprey) have high drag profiles, resulting in an upper limit of about 10:1. HS-Drone can transform to efficient cruising bodies having L:D matching/exceeding the best alternatives.

COVID19 Statement

Drone delivery that is more-efficient than car/truck deliver (and driving to the store) will not only be less costly, but minimizes virus-spreading contacts.

Web Site & Patent Status

The web site **HS-Drone.com** provides further details and updates. This technology has a patented or patent-pending status as based on dozens of patent claims. The technology is disclosed to strengthen the patent position by making changes/tweaks of this technology not viable for patent protection. World-wide patent protection is being pursued.

GREATER THINGS ARE POSSIBLE

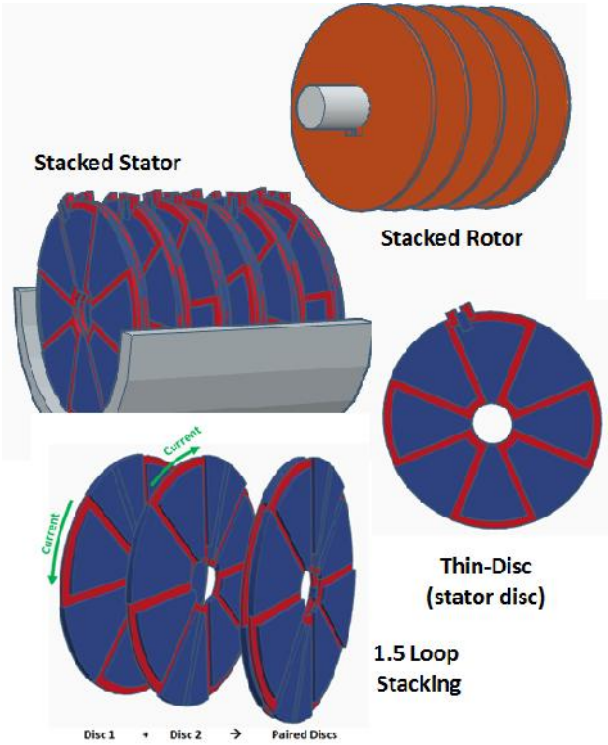
- Safer, Faster, More Efficient (than all others).
- Electric Motors at > 2X power density.
- Transformer Aircraft, Hybrid Jet Engines ...

PART II: Electric Motor Revolt

The Paradigm - The industry has overlooked the importance of two motor design heuristics: 1) heat transfer design is a high priority and 2) the specific stator-rotor gap surface area limits power density.

Serial Innovation Epoch - A thin-disc rotor design that most-efficiently used conductor surface and provided for improved heat transfer and subsequently-identified method to reduce current and induction mode setup.

Thin-Disc Rotor and Stacked-Disc Axial-Flow Motor:

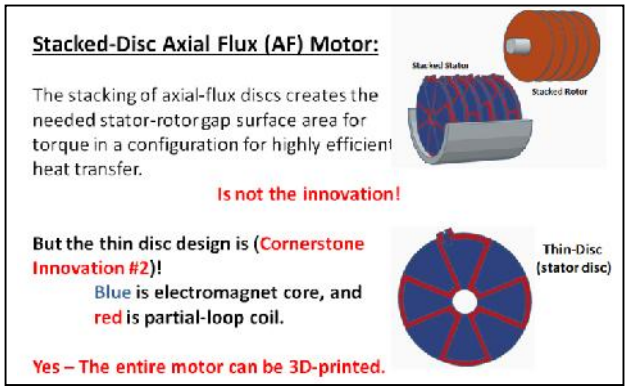


Features of design include:

- High specific rotor-disc gap surface area.
- Large conductor Surface:Volume ratio.
- Ability to 3D print (single loop).

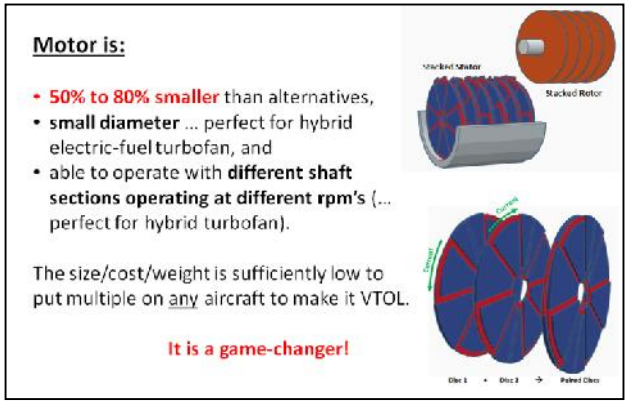
This image shows the stacked rotor as a series of Cu/Al plates designed for induction forces in a three-phase induction motor. Other designs are possible.

A Walk Through the Slides:



The innovations are the disc designs and arrangements of those discs. Early in the design process, a novel secondary coil was incorporated into the design; but concerns arose on the prospect that a built-in transformer would be the motor's power bottleneck.

It was then identified that to achieve a constant magnetic flux for a disc, the number of sections/"partial loops" (e.g. 8 for the above image) can be increased. A doubling of the sections per disc cuts the current needs in half. This approach can be used to reduce current needs to reasonable values for DC power delivery from nearby batteries on aircraft.



Will a partial (3/4^{ths}) loop provide an effective electromagnet? It can when supplemented with a core of the proper geometry. However, this problem can be alleviated by placing two thin discs next to each other in a continuous core and resulting 1.5 loops.

Compared to a single-gap pancake motor, the SD AF motor has a lower surface-area-to-volume ratio and is able to use thinner "discs". Preliminary calculations show an 80% reduction is size/weight.

Hybrid Electric-Fuel Jet Engine

The concept of a hybrid electric-fuel engine is not new, but a motor that has the: a) high power density, b) small diameter, and c) ability to have different sections of the rotor's shaft rotate at different velocities is new. A turbofan engine operates with the fan at a lower RPM than the high pressure compressor/expander.

Why the hybrid engine is important is because:

a) electric provides for quiet operation within cities,
b) electric is sufficient gain altitude,
c) electric can have a low-CO_2 footprint,
d) fuel is necessary for high speed thrust and
e) it enables VTOL to serve the major airliner market..

With SD AF motors, VTOL aircraft can be lighter-weight, less complex, and have smaller drag profiles than alternatives due to cost/weight of equipment and wingspans for runway landings.

Manufacturing Advantage

The US Military is interested in being able to repair/manufacture its resources on site. The SD AF motor (Stacked-Disc Axial-Flux motor) is perhaps the only motor that can be 3D printed. The key limiting factor in motors is the thin/perfect layer of insulation needed for wires. Because each stator has only one flat circuit, the insulation can be thicker without major deterioration in performance (it can also be dip-coated for thinner insulation coatings.

Albeit a motor only achieving a fraction of it's potential if 3D printed in entirety due to the low conductivity of printer filaments etc., this motor has an entry point in 3D printing manufacturing that is the starting point for evolution of on-site and local manufacturing. Those same methods reduce the cost of market entry for the SD AF motor.

COVID19 Statement

Providing a 4-20 passenger service that can out-perform today's major airline service with VTOL outside of TSA lines/areas is THE alternative to airports that will substantially reduce virus-spreading contacts. The hybrid jet engine is the key to that industry.

Web Site & Patent Status

The web site **HS-Drone.com** provides further details and updates. This technology has a patented or patent-pending status as based on dozens of patent claims. The technology is disclosed to strengthen the patent position by making changes/tweaks of this technology not viable for patent protection. World-wide patent protection is being pursued.