EPIPHANY™
Transporter

Development Report

EPIPHANY™ Transporter

- Two passengers, luggage and golf clubs
- 300+ mile normal range; 140 mile MRR*
- Triple-redundant computer autopilot
- Economy cruise 130 mph; max cruise 160 mph
- About the size of a Tesla Model S sedan
- Neighbor-friendly, ultra-quiet operation

**Mission Radius Range (Point A to point B, land, takeoff, return to point A, without recharging)*

NO AIRPORTS - NO VERTIPORTS - NO HELIPORTS - NO ROADS REQUIRED

DEVELOPMENT OVERVIEW

Coming out of stealth development, the personal *Epiphany Transporter* delivers fast, efficient, door-to-door transportation for two people seated side-by-side, with luggage. And golf clubs! Having true VTOL (Vertical Take-Off and Landing) capability, it can hover like a helicopter and achieve very long range, high-speed, efficient cruise flight like a conventional airplane.

Designed for UAM (Urban Air Mobility), the vehicle can legally operate essentially anywhere outside of controlled airspace, below 700 feet AGL (Above Ground Level), and away from airports. Its neighbor-friendly, very low sound is incomparable to *any other* eVTOL, VTOL, or conventional aircraft when taking off or landing, and is virtually silent and undetectable to people on the ground when flying overhead at low cruising altitudes. The vehicle is easily ground maneuverable and garage-able by one person, and can be fully-recharged in about 30 minutes.

In lieu of long, cumbersome, draggy wings, the craft employs six, small, uniquely designed, dual-mode ducted thrusters. The *fixed-pitch* fan blades work in concert with the ducts and internal components to produce powerful, yet quiet, static thrust during hover, and seamless ultra-efficient thrust and aerodynamic lift when tilted for cruise flight. With small footprint only slightly larger than an automobile, the vehicle can take off and land from almost any small, confined, nearly-level area.

Operation is easy and intuitive. The pilot sends commands via a “fly-by-wire” centered hand-joystick (no pedals needed) to the triple-redundant autopilot, which in turn manages power to the six thrusters achieving stable, comfortable, and safe flight in accordance to the pilot’s wishes and commands.

The *Epiphany Transporter* is expected to experience no troublesome “transition” issues between hover and cruise flight, typical of winged eVTOL aircraft, because the thrusters *continuously* produce powered-lift and aerodynamic lift throughout the flight envelope. On deck, the thruster’s ducts afford protection from the spinning fan blades; in the air, protection from nearby branches when hovering, and from birds during forward flight. The machine fits easily into a standard two-car garage, or a one-car garage with folded thrusters. For transport or shipping, with folded thrusters, it fits into a standard 8’ X 8’ X 20’ container.

Originally developed under a $5.1 million DARPA grant, the NASA-Ames proven thrusters have undergone over a quarter-century of continued refinement and full-scale flight testing in both wind tunnels and numerous prototype manned vehicles. The highly proprietary CFD (Computational Fluid Dynamics) computer model used to design the thrusters has also evolved, currently able to accurately predict static and high-speed thruster performance *within* 2% of actual real-world testing.

Each of the vehicle’s six thrusters are powered by state-of-the-art electric motors, earning it the moniker “eVTOL”. Six separate, super-powerful dedicated battery systems, with single-point charging, provide impressive cruise speed and range.

‘Normal’ range in eVTOL aircraft usually means flight from point A to point B. However, point B must have an accommodating charging station to power the return trip home. Much more important for UAM operations is MRR (Mission Radius Range). This is the effective range, with reserves, from point A to point B, land, then return home to point A, *without needing to recharge along the way*!

Part of the splendor of flying the personal *Epiphany Transporter* eVTOL aircraft for UAM is having no need (nor desire) for airports or vertiports. The lack of available recharging infrastructure creates "range anxiety" with other eVTOL aircraft, which have MRR measured in only *tens* of miles.

At its predicted best economy cruise speed of 130-mph, and with *15% battery reserve*, and using new (just becoming commercially available) Silicon-Lithium-ion batteries, the *Epiphany Transporter* has a predicted normal range of over 300 miles, and a MRR of 145 miles! At 160-mph fast cruise, normal range is an impressive 240 miles, with MRR of 114 miles. With current "standard" Lithium-ion batteries, and cruising at 130 mph, the normal range and MRR are 150 miles and 70 miles, respectively. For context, the *Epiphany Transporter* is predicted to economically cruise *2X faster*, and with greater range, than most EV automobiles!

Another way of visualizing the craft's striking performance and utility, is by drawing a circle with a radius of 145 miles from home base on a map. It will show the maximum outbound range achievable at best economy cruise, while still being able to return back home, *without recharging*!

The *Epiphany Transporter* has been carefully designed to safely accommodate the loss of a thruster, motor, motor controller, or battery. During normal flight, it is able to take-off and hover using less than 50% of its installed power, providing a very large margin of excess power for non-standard day, high-altitude, and emergency operations. It also has built-in redundancy for all potential single-point-of-failure components and systems, including its triple-redundant autopilot.

The *Epiphany Transporter's* design and engineering have been tailored to comply with known and anticipated rules and regulations for the FAA's (Federal Aviation Administration's) new MOSAIC (Modernization of Special Airworthiness Certificates) program which recently received preliminary approval, subject to formal industry ratification expected soon.

MOSAIC contains very favorable changes to LSA (Light-Sport Aircraft) certification and pilot rules. Crucially, the *Epiphany Transporter's* design meets the new LSA certification standards as they relate to powered-lift aircraft.

It is anticipated that FAA certification for the *Epiphany Transporter* under the new and more favorable LSA rules would be greatly simplified, in terms of cost and time, even when compared to other winged and wingless eVTOL aircraft, for the following essential ten reasons:

1) The *Epiphany Transporter* would be certified for personal, non-commercial use.
2) The *Epiphany Transporter* is limited to two occupants.
3) The *Epiphany Transporter* will not have the same hover-to-cruise-to-hover transition issues faced by other eVTOL aircraft.
4) The *Epiphany Transporter* would be certified only for flight operations in Class G airspace, i.e., between ground-level and 700 feet AGL, and clear of controlled or restricted airspace.
5) The *Epiphany Transporter* would be certified *initially* only for daytime, VFR (Visual Flight Rules) operations.
6) The *Epiphany Transporter* is being designed to meet or exceed the same level of safety standards and protocols being applied to the manufacturing and operation of other eVTOL aircraft currently pursuing FAA *normal* certification under the more rigorous FAR Part 23.
7) The *Epiphany Transporter's* fuselage and overall design are greatly simplified, and have a much lower part count, when compared with other eVTOL aircraft pursuing LSA or Part 23 certification.
8) The *Epiphany Transporter's* thrusters are designed to meet or exceed known international safety and noise mandates.
9) The *Epiphany Transporter's* triple-redundant autopilot and distributed propulsion are compliant with DO178C, DO254, DAL-A, and DO160 standards for eVTOL UAM certification.
10) The *Epiphany Transporter's* operation is intuitive and easy, with redundant controls.

Although a few other *personal* eVTOL aircraft are in various stages of development, compared to the *Epiphany Transporter* they have incredibly loud noise, disappointingly low airspeeds, dismal normal range, insignificant (if any) MRR, long cumbersome wings, minimal cargo space, and serious airspeed transition concerns.

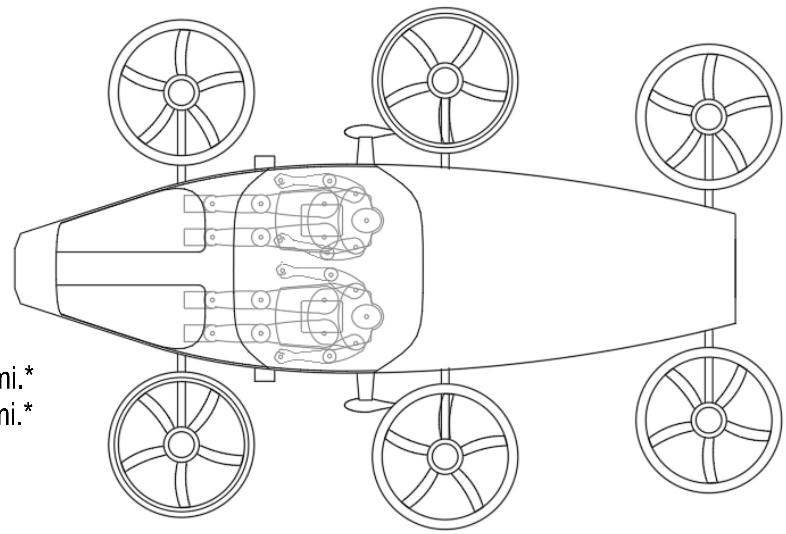
Several other eVTOL aircraft in development are targeting the commercial "e-taxi" market, and are well along their way to achieving normal FAA Part 23 (non-LSA) certification. However, as a commercial air carrier, they must also comply with onerous FAA part 135 rules and regulations established for this industry which pertain to carrying passengers for hire. These aircraft would typically cruise along burgeoning "highways-in-the-sky" between 2,000 and 4,500 feet AGL and be relegated to operate only out of designated regional "vertiports", while the normal domain for the *Epiphany Transporter* will be ground level to 700 feet AGL.

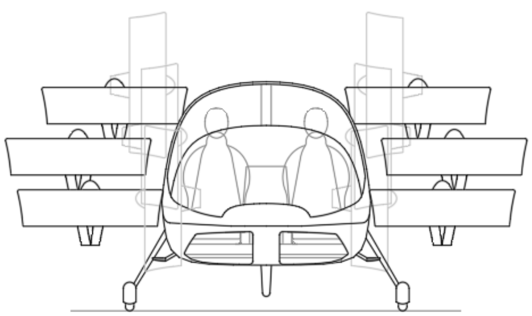
Epiphany Transporter

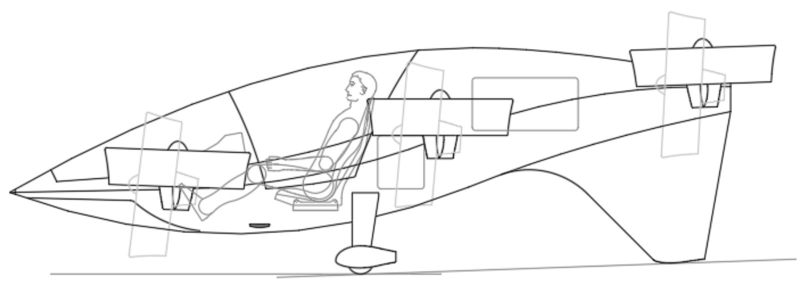
Specifications and Predicted Performance

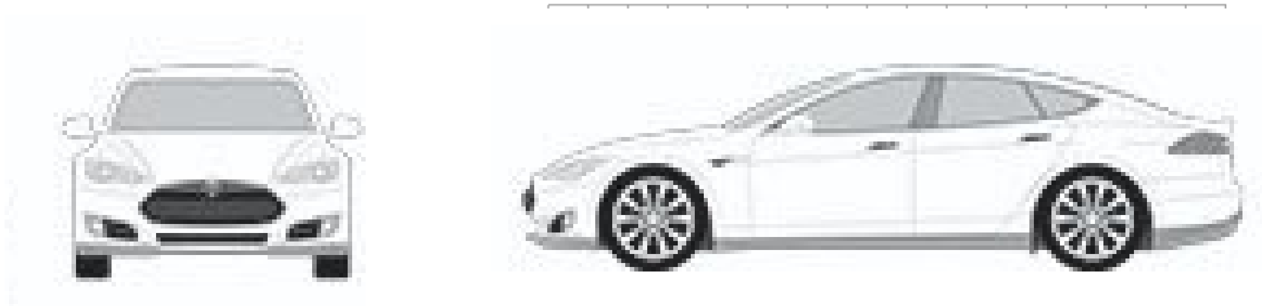
Length:	19.5 feet
Width:	13.2 feet
Width (ducts folded):	8.0 feet
Height:	6.7 feet
Height (ducts folded):	7.5 feet
Normal Takeoff Gross Weight:	1670 lbs.
Empty Weight:	1270 lbs.
Normal payload (people + cargo):	400 lbs.
Max. payload (people + cargo):	475 lbs.
Economy cruise / normal range:	130 mph / 305 mi.*
Economy cruise / MRR:	130 mph / 145 mi.*

** With Amprius (or equivalent) Silicon-Lithium-Ion batteries, and normal payload.*









Tesla Model S size comparison

CONTROL METHODOLOGY

INTRODUCTION

The *Epiphany Transporter* has a single, center-console-mounted, 3-axis, spring-loaded-to-neutral, joystick with integral thumb-switch, and thumb/finger-buttons, which together let the pilot send control inputs to the autopilot from either seat. The autopilot in turn sends the *processed* signals to the six thruster motor controllers which manage the thrusters both collectively and differentially. Absent any overriding control commands from the pilot, the autopilot automatically maintains stabilized hover, and straight and level cruise flight, i.e., the last pilot-selected airspeed, altitude, attitude, and direction of flight.

ATTITUDE CONTROL

PITCH- Momentary forward and rearward deflection of the joystick controls the ***rate*** of change in nose-up or nose-down aircraft pitch attitude. The greater the joystick deflection, the greater the rate of change - within programmed safe limits. Change in pitch attitude affects *airspeed* (not altitude), and provides longitudinal translation and maneuvering capability from/during hover.

When *forward* joystick pressure is released, the joystick returns to its neutral detent, the rate of pitch change returns to zero, and the last selected pitch attitude is *maintained*.

When *rearward* joystick pressure is released, the joystick likewise returns to its neutral detent, and the rate of pitch change returns to zero, but the last selected pitch attitude setting is *NOT maintained* and returns to zero pitch in hover, or to the previous pitch attitude setting in forward flight. This safety feature helps ensure that deceleration during cruise, and rearward acceleration and airspeed in hover, does not exceed the craft's, nor the pilot's, capabilities. In straight and level *forward* flight only, the pilot's hand pressure can be removed from the joystick while the aircraft maintains its current pitch attitude and airspeed.

ROLL- Side-to-side deflection of the joystick directly changes the craft's roll attitude ***position*** (not rate) providing lateral translation and maneuvering while in hover. In other words, roll attitude *follows* joystick deflection. With any amount of forward airspeed, side-to-side joystick deflection results in a fully-coordinated turn as the autopilot automatically dials in the correct amount of yaw – a function of airspeed. The greater the joystick deflection, the greater the turn rate - within programmed safe limits. When the joystick is recentered, roll attitude returns to “wings-level”.

YAW- Momentary twisting of the joystick while hovering controls the ***rate*** of change in yaw resulting in a change of direction. The greater the amount of twist, the faster the directional change. Anytime joystick twist is neutralized, the new direction is *maintained*. Out of hover, with any forward airspeed, twisting the joystick has no direct effect. But as noted above, the autopilot introduces the correct amount of yaw to sustain a fully-coordinated turn when the joystick is deflected left or right.

AIRSPEED CONTROL

A key feature of the *Epiphany Transporter* is the ability to tilt its ducted thrusters for high-speed flight. Without thruster tilting, the airspeed would be limited to about 40 mph with dismal range. The pilot does not *directly* control tilt. Rather, the autopilot automatically adjusts and optimizes thruster tilt based on the pilot’s commands, current airspeed and pitch attitude.

Airspeed is also a function of aircraft pitch. From hover, forward or rearward deflection of the joystick controls the rate of change in aircraft pitch attitude, and resulting airspeed. Small deflection changes pitch slowly; larger deflection changes pitch more rapidly. These changes in pitch attitude produce forward and rearward longitudinal thrust vectors without engaging thruster tilt in relation to the fuselage.

For a slow departure from hover (small amount of joystick deflection and nose-down pitch), thruster tilt remains fixed until around 30 mph when the autopilot starts tilting the thrusters forward relative to the airframe in conjunction with increasing airspeed. For a faster departure (more joystick deflection and greater nose-down pitch), thruster tilt starts occurring sooner. And for a maximum performance departure (maximum joystick deflection and maximum permitted nose-down pitch), thruster tilt begins as the nose starts to pitch downward.

As the craft accelerates toward cruise airspeed, the autopilot will increase thruster tilt, and optimize craft pitch for the current airspeed, resulting in the lowest profile drag and the best flight efficiency. The pilot need not hold the joystick forward any longer than it takes to reach the desired airspeed, at which time the joystick is returned to its neutral position. The autopilot will maintain that airspeed until the pilot decides to go faster or slower, again by moving the joystick in the preferred direction. The operation of the *Epiphany Transporter* is entirely intuitive and natural, i.e., push the joystick forward to go faster, pull it backwards to go slower; enter a fully-coordinated turn by applying side-to-side pressure against the joystick.

To slow the craft in forward flight, the joystick is pulled backwards from neutral signaling the autopilot to reduce the forward tilt of the thrusters and optimize pitch for the current airspeed. For more aggressive slowing (a function of how far the joystick is pulled backwards), the autopilot will further increase pitch attitude - within programmed safe limits, depending on airspeed. A small deflection of the joystick produces a slow ***rate*** of change in airspeed, while a larger deflection produces a greater ***rate*** of change.

ALTITUDE CONTROL

Altitude control is managed by the joystick's three-position, spring-loaded-to neutral, thumb-*switch*.

Pressing and holding the switch upward establishes a ***rate*** of climb, while pressing and holding it downward establishes a ***rate*** of descent. The further the switch is pressed in the desired direction, the greater the rate of change - within programmed safe limits, a function of distance from the ground. When the thumb-switch returns to its neutral position, rate of change is zeroed and altitude is automatically maintained by the autopilot.

Absent any overriding altitude commands by the pilot, the autopilot will maintain the last selected altitude regardless of changes in attitude, airspeed, thruster tilt, translation, or turns.

Preparing for takeoff, the pilot has the *option* of momentarily pressing the joystick's (auto-takeoff/land) thumb-*button* when the joystick is centered with no other joystick switches or buttons activated. When pressed, the autopilot takes over automatically increasing thruster power from ground idle, lifting the craft to a stable hover 5 to 6 feet above the ground. Upon returning to land and achieving stable hover within 15 feet over the intended landing spot, pressing the same button again allows the autopilot to automatically and smoothly manage the descent to touchdown then reduce ducted fan power to ground idle.

eVTOL MODE vs AIRPLANE MODE

The joystick defaults to the eVTOL (helicopter) mode, but it also has a "Airplane" mode when its two-position *finger*-button is pressed *and held*. In this optional mode, the *altitude* is controlled differently than as described in the preceding 'Altitude Control' section.

In eVTOL mode, during the departure and arrival phases of the flight the pilot balances airspeed and altitude to achieve the desired profile trajectory. The joystick is moved forward or rearward while the altitude-controlled thumb-switch is pressed up or down. The two different actions and thought processes are similar to those required in a helicopter with movements of the cyclic and collective controls respectively but significantly easier, and without the need for anti-torque foot pedals.

Once cruise altitude and airspeed have been established, press and hold the finger button to enter airplane mode then push or pull the joystick to descend or climb, respectively – just like in an airplane. Regardless of flight mode, deflect the joystick left or right for a fully-coordinated turn, just like an airplane, with the added benefit that altitude is automatically maintained during turns.

It should be noted that the *Epiphany Transporter* achieves its uber-efficient economy range at cruise airspeeds between 120 to 130 mph when hover power is automatically dialed back about 85%. Pure hover and low-speed flight are extremely inefficient! Therefore, it is important to takeoff and accelerate to an efficient cruise airspeed as soon as practicable.

To climb during steady state level cruise flight (normally in default eVTOL mode), press and hold the finger-button, putting the joystick into airplane mode then pull back on the joystick. The autopilot will add power AND slightly increase vehicle pitch from nominal to nose-up (thruster tilt remains the same). Increasing pitch stops the airspeed from also increasing, while added power initiates a rate-of-climb, a function of how far back the joystick was pulled. Re-centering the joystick maintains the desired altitude. Releasing the finger-button returns the joystick to default eVTOL mode. Anytime in eVTOL mode while climbing, altitude control should remain a function of the thumb-switch.

To descend during steady state level cruise flight (normally in default eVTOL mode), press and hold the finger-button, putting the joystick into cruise mode then push forward on the joystick. The autopilot will reduce power AND slightly decrease vehicle pitch from nominal to nose-down (thruster tilt remains the same). Decreasing pitch stops the airspeed from also decreasing while reduced power initiates a rate-of-descent, a function of how far forward the joystick was pushed. Re-centering the joystick maintains the desired altitude. Releasing the finger-button returns the joystick to eVTOL mode. Anytime in eVTOL while descending, altitude control should remain a function of the thumb-switch.

The only difference between the two flight modes is the manner in which *altitude* is controlled:

√ In eVTOL mode, the thumb-switch controls altitude (thruster tilt doesn't change).

√ In airplane mode, pushing or pulling the joystick, like in an airplane, controls altitude (thruster tilt does not change).

Airspeed is controlled by thruster tilt, which is engaged by the autopilot only in eVTOL mode, and responds to forward or rearward movement of the joystick.

To summarize: In eVTOL mode (similar to how a helicopter flies), the *Epiphany Transporter* pilot uses the joystick (cyclic control in helicopter) for changing pitch/roll attitude, and the thumb-switch (collective control in helicopter) for changing altitude. Both controls are used together in a coordinated manner to achieve the desired departure trajectory getting to cruise altitude and airspeed, or maintaining glideslope during approach to landing. During steady-state cruise flight, the optional airplane mode eliminates thumb-switch activity, and the aircraft is flown as a conventional airplane whence the joystick can now control altitude, and turns, albeit without changing airspeed, making cruise flight easier, and more intuitive.

	Airspeed	**Altitude**	**Turns**
eVTOL Mode:	Fwd./aft Joystick	Thumb-switch	Left/right Joystick
Airplane Mode:	N/A	Fwd./aft Joystick	Left/right Joystick

SAFETY BY DESIGN

The *Epiphany Transporter* has been carefully designed to provide extraordinary levels of safety. Other than its spinning, *fixed-pitch* fan blades, it has only three (3) moving parts, i.e., its three pair of tiltable thrusters.

Although all key and life-critical components have been engineered, sized, stressed and tested to ensure that they will not fail, or be otherwise compromised, the reality is that components can, and do, fail… an unfortunate and adverse acknowledgement and testament to Mr. Murphy's longtime omnipresence. Accordingly, the *Epiphany Transporter* has been designed with redundant backup solutions for all potential, crucial single-points of failure.

DUCTED FAN THRUSTERS and POWERTRAIN

The ducted fan thrusters incorporate special purpose aerodynamic rings and rigid vanes designed to: 1) double the static thrust of the fans; 2) generate efficient lift when tilted at cruise airspeeds; 3) significantly reduce noise; and 4) provide protection to and from the rotating fan blades. The ultra-high tolerance rings are structurally rigid and are attached to the fuselage in a unique way that provides vertical thrust for hover, and, when tilted, longitudinal thrust AND efficient aerodynamic lift, during cruise. They can also be folded for garaging and transport.

Each ducted fan thruster is directly powered by its own electric motor. This *distributed* propulsion concept is the heart of the vehicle's safety. The motor is driven by its dedicated electronic motor controller, which in turn is wired to its dedicated high-energy density battery.

In the highly unlikely event of a total or partial loss of *any* component of a ducted fan thruster "system", for *any* reason, i.e., a failed fan, or motor, or controller, or battery, then the polar-opposite ducted fan thruster is simultaneously adjusted by the autopilot, instantly preserving the balance of the aircraft's lift and torque. At the same time, the thrust from the remaining four operating ducted fans is increased up to 150%, as required, to seamlessly maintain altitude and safe flight.

The motors and associated controllers are sized to accommodate this increased power demand, plus extra margin, allowing the aircraft to normally hover and fly requiring *less than one-half* of its installed power. In other words, the vehicle has a very large amount of excess power to deal with increased payloads, emergencies, hot weather, or high-altitude operations.

The motor controllers and batteries are physically separated from each other by firewalls to eliminate any cross-contamination between a failed unit and an adjacent unit. Since each ducted thruster system includes its own dedicated battery, the four batteries powering the four remaining fully-functional ducted thruster systems continue to produce required power, albeit with reduced aircraft range.

DUCTED FAN THRUSTERS and TRANSISTION FLIGHT

Flight associated with winged-eVTOL aircraft, and/or eVTOL aircraft with *fixed* free fans or ducted fans, specifically during transition between hover and cruise airspeeds, can be problematic and often spontaneously dangerous. The problem that develops involves the ever-changing *character* of lift vectors, e.g., powered fan lift versus aerodynamic wing lift. And as airspeed changes, different *locations* of the lift vectors result from migratory centers-of-lift relative to the fuselage. Changes in lift character and location create the problem of dealing with the complexity of managing varying powered-lift sometimes, and migrating aerodynamic lift other times.

The *Epiphany Transporter*, with its NASA-proven unique and proprietary ducted thrusters, benefits from a favorable amalgamation of powered-lift and aerodynamic-lift modulated seamlessly *throughout* its flight envelope without changes in centers of lift. Moreover, the character of lift production also does not change, i.e., thrusters are always generating both powered-lift and aerodynamic-lift, and do not experience the same transition issues as other eVTOL aircraft. The result is streamlined, safer flight testing, and ultimately day-to-day operations.

It is anticipated that bird strikes are effectively eliminated with the craft's relatively slow airspeeds allowing birds time to get out of the way. Ultrasonic air-powered sirens mounted on the vehicle's exterior surface provide an additional layer of insurance helping to eliminate birds in the flight path.

DUCTED FAN THRUSTER TILT SYSTEM

The front two thrusters, the middle two thrusters, and the aft two thrusters, are each tilted by their dedicated dual, intra-connected, electro-mechanical servos controlled by the autopilot. Either of the dual servos is capable of doing the job, albeit at half the rate with both servos working. In the highly unlikely event of a failed servo (even with a certified life of > 100,000 cycles), monitors ensure that all six thrusters tilt at the same rate so their positions always match.

The craft also has the additional safety feature of a guarded, three-position toggle switch that provides an alternate method of directly powering the thruster tilt servos overriding the autopilot in the highly unlikely event of an autopilot problem.

JOYSTICK

The joystick, thumb-switch, thumb-button, and finger-button, and associated connective wiring are electro-mechanical devices and components, and as such are not immune from failure (even with a certified life of > 5 million cycles). The solution to this potential single-point of failure is the addition of a backup 3-axis joystick and altitude control switch located close to their counterparts.

These alternate components are miniature versions of the primary controls, and are wired in a specific manner to the autopilot, so, effectively, either set can safely control the aircraft. The secondary controls are powered by a dedicated electrical power bus, separate from the craft's normal system's power.

AUTOPILOT

The autopilot has true, triple levels of fault-tolerant redundancy and "democratic" arbitration. It automatically provides stabilization about the pitch, roll and yaw axes by biasing the relevant thrusters. It also manages airspeed, turns and altitude by receiving signals from the joystick and other sensors then processing that data before sending it to the motor controllers which modulate the thrusters, differentially or collectively, to achieve the pilot's commands. The *Epiphany Transporter's* stabilization is always running in the background, regardless of the pilot's commands. The autopilot also provides auto-takeoff/landing capabilities, plus collision avoidance heads-up notice from other aircraft and ground obstacles, including powerlines.

FUSELAGE AND AIRFRAME

A bolted together, multi-piece, carbon-fiber monocoque shell with integral bulkheads, rollbar, shelving and hardpoints comprise the *Epiphany Transporter's* fuselage. Missing is the conventional "space frame" with welded, precision-cut, problematic metal tubing requiring jigs and fixtures to ensure proper alignment and spacing, plus the additional requirements of sanding, priming and painting.

Twin passenger doors provide easy ingress and egress a short step above ground level. Large side door windows, with overhead tinted, IR and UV protection, compliment the large forward windscreen and dual lower "chin" windows, which together offer overall excellent forward, sideways, and look-down visibility.

Integral NACA-style vents in the fuselage provide fresh air to the multi-mode HVAC system eliminating the need for typically dysfunctional side window vents.

Fixed, front landing "legs" and wheels provide a lightweight, robust, yet forgiving main undercarriage. Twin ventral fins with rollerball-type wheels aid in the craft's directional stability at high speeds, while providing ground stability when parked.

HIGH-VOLTAGE WIRING

The remaining potential points-of-failure include the high-voltage, high-current, wiring and connectors for the battery, motors, controllers, and other like-kind electrical components. All wire and cable routing is designed to be properly secured to eliminate chaffing and/or other trauma, and terminal connections are specified to be effectively failsafe preventing overheating and outright connection failure.

These attributes and additional safety protocols are being vigorously designed and engineered into the wiring system making it extremely robust, using only the highest quality, properly installed, certified connectors, insulation, and shrink-wrap, while ensuring that there are no exposed high-voltage hazards to people or pets.

DESIGNED FOR RAPID MANUFACTURING & ASSEMBLY

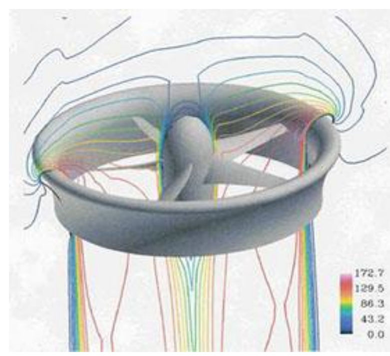
The *Epiphany Transporter* has been designed and engineered from the get-go to require only a very small fraction of the cost, time and manpower for manufacturing and assembly compared to other winged/wingless eVTOL aircraft.

Other than one-time production tooling for the carbon-fiber fuselage, ducts and injection-molded fan blades, and tooling for the acrylic parts, which are all outsourced to world-class vendor partners, all in-house scaled manufacturing and production becomes more of an assembly process requiring no fixtures, jigs, conveyers, autoclaves, paint booths, machinery, or other major CAPEX.

Outsourced OTS (Off-The-Shelf), and custom machined and "printed" components, are easily assembled, connected and bolted in place using only hand tools. There are no welded parts, and virtually no rivets! Final assembly requires minimal workforce, factory space and utility power. Aircraft total part count is less than 350!

PROTOTYPE CONSTRUCTION, FLIGHT TESTING, & CERTIFICATION

The *Epiphany Transporter's* development plan goes from "drawing board" to full-scale, manned prototype. Fundamental to that decision is the belief that nothing substantive is gained by diverting money, time and resources towards a scaled prototype aircraft, then trying to interpret results from nebulous scaling laws of questionable value when applied to thrusters operating in full-envelope testing.



Previous development and testing of identical-sized thrusters as those used on the *Epiphany Transporter* have been carried out in both high-speed NASA wind tunnels and full-scale manned aircraft tests. *Hundreds* of wind tunnel tests produced valuable and repeatable data during both hover and high-speed cruise conditions with changing thruster tilt relative to the airstream. And *over sixty* successful flight tests on the full-scale, manned, *SoloTrek XFV* aircraft were carried out providing additional data in hover and low-speed translation flight.

SoloTrek XFV

The CFD program developed and refined over a twenty-five-year period, and used to optimize the design of the ducted fan thrusters, has been validated with its predicted results within 2% of real-world testing results. The thrusters used on the *Epiphany Transporter* directly benefit from all of this previous work.

Prior to beginning actual flight testing on the *Epiphany Transporter*, a custom-built flight simulator will provide SIL (Software-In-the-Loop) capability to safely test all of the software, including algorithms, PID (Proportional-Integral-Derivative) settings, control laws, etc., to ensure proper vehicle behavior in various flight situations from hover through high-speed cruise.

Once the full-scale, *Epiphany Transporter* manned prototype has been built and ground-tested, tethered hover tests will take place. At the same time, application will be made for a LSA airworthiness certificate, then for experimental R&D certification which will allow the craft to legally fly free of the ground tether, albeit with some operating restrictions likely imposed by the FAA. However, as the *Epiphany Transporter* will only be flown with a pilot on board, it will not be subject to rules for unmanned "drones" requiring flight testing to take place only in FAA designated "test ranges".

After demonstrating stable and controllable hover within a few feet of the ground, and during very low-speed translation, the flight envelope can begin to be safely and slowly expanded. Unlike conventional airplanes requiring high-speed flight and high altitude for testing, the *Epiphany Transporter* can take careful, measured, baby steps slowly and safely opening up the flight envelope to learn about and document its performance and manners.

One of the most crucial areas of eVTOL flight is the transition from hover to cruise flight, and back. Winged eVTOL aircraft must deal with powered-lift during hover flight, changing to aerodynamic-lift during cruise flight, with resulting centers of lift, e.g., fans or jets, migrating from one area of the fuselage to another, e.g., to wings. Typically, this has proven very problematic during flight, and difficult for the aircraft's control system to "get right".

However, the *Epiphany Transporter*'s thrusters are *always* producing both powered-lift and aerodynamic-lift, with their resultant centers of lift remaining virtually in place. For these reasons, it is believed that the craft will not suffer from the same translational issues plaguing winged eVTOL aircraft.

The new MOSAIC rules greatly simplify and speed up certification while significantly lowing certification costs. Moreover, without wings, ailerons, flaps, rudders, or the need for stall testing or spin testing, the *Epiphany Transporter's* certification is further simplified and speeded up.

PROFORMA P&L SUMMARY AND ENTERPRISE VALUATION

Assumptions

PER UNIT AVERAGE RETAIL PRICE:	$599,000 USD (*2027 Base price LSA-certified aircraft*)
PER UNIT COGS @ 54%:	$323,000 *(Includes materials and direct mfg. labor)*
PER UNIT GROSS PROFIT @ 46%:	$276,000
PER UNIT OPEX @ 18%:	$108,000 *(Includes SG&A, and assembly/QA/testing labor)*
PER UNIT NET PROFIT @ 28%:	$168,000 (EBITDA)
ANNUAL PRODUCTION RATE:	104 Units (*Ramped up in 18 mos. to 2 aircraft per week*)

Projections

ANNUAL REVENUE:	$62,296,000 (*1st full-yr. production after 18-month ramp*)
EBITDA @ 28%:	$17,442,000
ENTERPRISE VALUATION: [1] @ 60X P/E	$1,046,572,000 (*@ 104 units per year*)
PROFORMA VALUATION: [2] @ 20X P/E	$348,840,000, (*with LSA certification and early* orders)
MARKET VALUATION: [3]	$70,000,000 (*with 1st prototype manned flight*)
CURRENT (JV) VALUATION: [4]	$TBD (*pre-prototype stage*)

[1] Valuation multiple of 60X to 80X for listed high-technology companies based on established (enterprise) earnings.
[2] Valuation multiple for listed high-tech companies based on future (proforma) earnings.
[3] Valuation consistent with comparative eVTOL development programs at this stage, e.g: AIR ONE, XPeng X2, Doroni H1, none of which have *Epiphany Transporter's* predicted performance, utility and commercial market potential.
[4] Valuation to be negotiated and stipulated by agreement between the JV partners.

Notes:

Estimated cost and time to complete development work, build the POC prototype aircraft, and successfully achieve manned hover and low-speed translational flight:

$3,000,000 and 18 months.
(Using hand lay-up, and low production composite tooling)

Estimated *additional* cost and time to build three (3) first-article aircraft and complete LSA certification:

$12,000,000 and 15 months.
(Using pre-peg with autoclave, and scaled production aluminum tooling)

ABOUT APPLIED eVTOL CONCEPTS

Applied eVTOL Concepts is a privately-held, debt-free, development-stage, virtual company with stated mission to design and produce innovative eVTOL flying vehicles. The company principals have a combined eighty-three year history of design, engineering, fabrication and successfully testing various ducted thruster related VTOL and eVTOL manned aircraft.

Its two visionaries, CEO and Chief Designer, Michael Moshier, and Chief Engineer and Senior Aerodynamicist, Rob Bulaga, have proven acumen and experience relating to key aspects of a vertical take-off and landing aircraft for personal, non-commercial use. One of their previous VTOL aircraft prototypes was awarded ‘Invention-Of-The Year’ by *Time Magazine* back in the day, with their *SoloTrek XFV* aircraft today remaining on permanent display at the *Hiller Aviation Museum* in San Carlos, California.

The company’s current headquarters are in Newport Beach, California, however, similar to the way the *Epiphany Transporter’s* propulsion is “distributed”, ongoing development work has also been distributed to world-class development partners in the USA and around the globe. Without incurring burdensome overhead, headcount, or investors, the company has been able to make remarkable, cost-effective progress while teaming with these partner-organizations, each responsible for different aspects of the vehicle’s development.

Applied eVTOL Concepts has successfully integrated (“Applied”) its proven propulsion technology, into its breakthrough aeronautical design and engineering, leading to the world’s first truly *practical* “flying car”. With that work essentially complete, the company is seeking a joint-venture or similar collaborative relationship with a strategic, aerospace industry partner to take the lead in expediting the manned prototype-build, testing and LSA certification. Thereafter, introducing the *Epiphany Transporter* to an eager, long-waiting, worldwide marketplace.

INITIAL CONTACT

Thank you for your interest in the *Epiphany Transporter*. After reviewing this Development Report, interested candidate partners should contact the company by email with "Epiphany JV" in the Subject line. Please include the following information in your introductory correspondence:

1) Your name, title, and organization;
2) Your organization's available workforce to undertake an engineering review, and lead the remaining development including prototype and first-article build, testing and LSA certification;
3) Your organization's available facilities to support line #2 items;
4) Your organization's aircraft certification experience, or similar experience with the FAA;
5) Your organization's scaled manufacturing and production experience and acumen, with an emphasis on high-performance aircraft or land vehicles;
6) Your organization's established industry, FAA, DARPA, and military contacts and relationships;
7) Your organization's history of agility and ability to meet aggressive milestones while demonstrating "Skunkworks-like" performance; and
8) Your organization's executive and financial commitment to the project.

The information you provide will be held as strictly confidential. I will personally review your introductory email and respond back to you by email in short order.

Respectfully submitted,

Michael Moshier, Founder, CEO, and Chief Design Engineer
Applied eVTOL Concepts [mwmoshier@gmail.com]