# The Flightline

Volume 47, Issue 5 Newsletter of the Propstoppers RC Club AMA 1042 May 2017

## President's Message

We had hoped to hold the meeting outdoors on the field but the weather is not cooperating so we will meet indoors at the church meeting room as usual. Maybe the June meeting will meet the criteria for an outdoor affair.

So bring in your show & tells on Tuesday

See you there.

**Dick Seiwell, President**

*Agenda for May 9th Meeting At*

*At the CA Church Room*

**7:00 pm till 8:30**

1. Show and Tell
2. Membership Report
3. Finance Report
4. Club Calendar Review
5. Plan for Club Picnics

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## Propstoppers Club February Meeting

**April 11, 2016 at the Christian Academy meeting room**

Call to order took place at 7:20 PM by Vice-President Chuck Kime. This was delayed due to a high number of membership renewals

Roll call by membership chair Ray Wopatek showed 22 members present including one new member.

Treasurer's report was given by president Seiwell

Minutes of the February meeting were approved by the membership

**Old Business:**

Indoor flying on Tuesday at the Brookhaven gym from 10 to 11:00 AM will continue as far as we know.

The group voted to donate $250 to the Christian Academy church in lieu of all of their support.

President Seiwell said regular field cutting will begin mid April.

**Show and Tell:**

Al Tamburo showed a control line model he purchased at the Lebanon show. It needed a motor, so he adapted a 350 watt electric motor with a control line controller. He demonstrated the model and it seemed to have high power.

## Calendar of Events

### Club Meetings

**Monthly Meetings**
**Second Tuesday of the month.**
**Gateway Community Church at the Christian Academy. Doors open at 7:00**

**Next Meeting; 9th May at the Gateway Church room.**

**Tuesday Breakfast Meeting**
**Tom Jones Restaurant on Edgemont Avenue in Brookhaven. 9 till 10 am. Just show up.**
**Flying after in the summer at CA or Elwyn Field 10 am. Weather permitting.**
**Indoors at the Brookhaven Gym in bad weather 10:30-11:30 See dates allowable.**

### Regular Club Flying

At Old Christian Academy**; Electric Only**
**Monday through Friday after school till dusk**
**Saturday 10 am till dusk**
**Sunday, after Church; 12 pm till dusk**
**At Elwyn Field; Gas or Electric**
**Monday through Saturday 8 am till dusk**
**Sunday 12 pm till dusk**
**INDOOR Flying, see attached dates.**

### Special Club Flying

**Saturday mornings 10 am**
**Wednesday Helicopter evening in summer**
**Thursday evenings in the summer**
**Tuesday mornings 10 am weather permitting after breakfast.**
**Check our Yahoo Group for announcements;**
http://groups.yahoo.com/group/propstoppers/

### Beginners

**Beginners using due caution and respecting club rules may fly Apprentice or similar models without instructors at Christian Academy Field.**
**The club also provides the AMA Introductory Pilot Program for beginners without AMA insurance.**


Propstoppers RC Club of
Delaware County, Pennsylvania.
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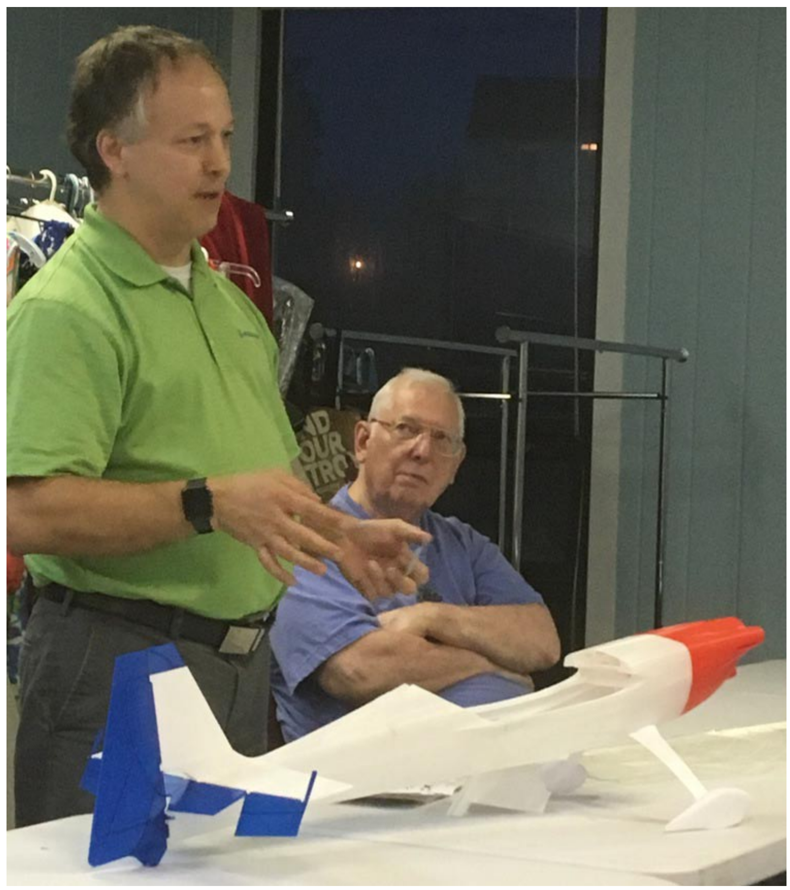
He also showed a five cylinder radial engine that he also purchased in Lebanon.

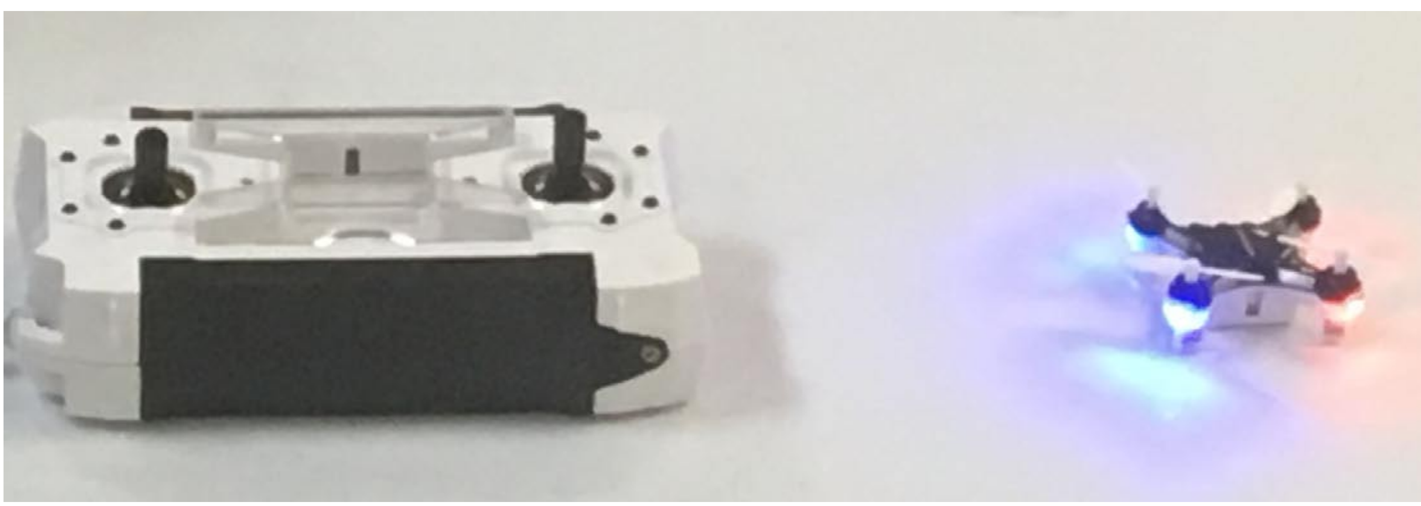
Al Basualdo showed an Edge electric model made by 3D printing.  He said it took about 80 hours of printer time.  It was printed in sections and glued together.  He has already flown it and it is still in one piece.

Duane Myers showed another 3D printed model that had a slightly different cowl.

He showed a UAF pilot license which is required by the FAA for commercial use of RC aircraft.



Mike Simmons showed a miniature 2 inch quad copter he purchased at CVS.  He flew it in the room but it was a handful to control.



Adjournment took place at 8:25 PM

**Dick Bartkowski, Secretary.**

# Eric’s Convergence

Well, this is not Eric’s, but it looks the same.
This is Eric after his first flight.

# Stall Speed is a Misnomer

**B**y Bruce Cronkhite

This short article is prompted by a batch of traffic on the EFLIGHT mailing list on the Internet related to the difficulty of determining the correct landing speed for a model.

The reason this is difficult is that there is no such thing. There is, however, a correct approach Angle of Attack.

Many people worry about slowing their model down to a reasonable approach speed for fear that the model will stall. Consequently they fly too fast on approach, and run off into the mulch, or the local equivalent.

The U.S. Navy had the same problem when trying to get pilots to land on carriers. It is critical that the airplane approach the deck at the slowest possible speed consistent with some margin above stall to account for turbulence and other unavoidable occurrences while on final.

The Navy discovered that while their airplanes of different sizes and configurations had widely varying stall airspeeds, they all stalled at very nearly the same *Angle of Attack.* This is regardless of type, number of wings, or prop or jet. This angle of attack is very near 15 deg. Not pitch angle, but *angle of attack.*

So the Navy developed a system of measuring and referring to AQA by a system numbered in *Units.* In this system a 'Unit" is approximately 2 deg, modified by some small quantities determined from the flight test data on the aircraft itself.

Now here's the magic. ALL Navy airplanes stall at 30 units AOA. Sure. There are some Navy pilots who can keep an airplane under control at higher than 30 units but they probably graduated from test pilot's school, and were working hard the whole time.

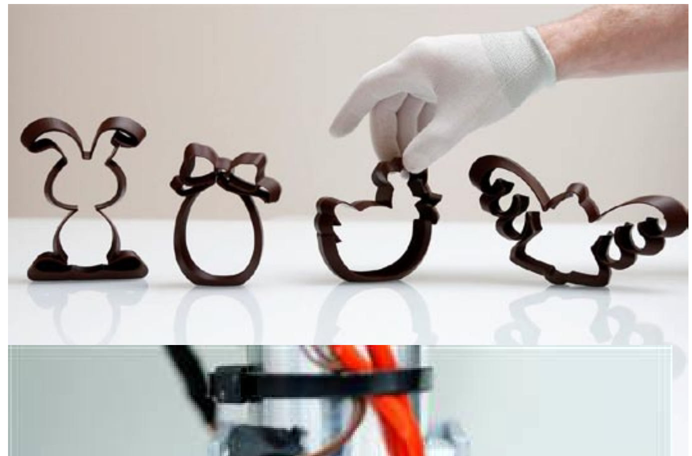
Well, what does that mean to us? Ready for this? Learn to see your model's angle of attack on final approach. You certainly can see 15 deg. so if you are less than that you *won't stall* if your model is aligned along your approach slope; you're going too fast at too low an angle of attack

That is the reason that I tell my students to keep the model fuselage level with the ground on final approach. This is a neat crutch that stabilizes the AOA at a reasonable number less than stall, but higher than supersonic, regardless of the angle of approach.

Try it.

**From the Silent Electric Flyers of San Diego Newsletter**

# Belgian Chocolatier Turns to 3D Printer for Easter Treats



Three-dimensional Easter-themed shapes printed at Belgian chocolate company Miam Factory in Gembloux, Belgium. Francois Lenoir / Reuters

Layer by layer, 0.008 inches at a time, a specialized printing machine at Belgian chocolate shop Miam Factory applies melted chocolate to shape a three-dimensional object.

Miam Factory - French for "Yum" - was spun off three months ago from nearby University of Liege's Smart Gastronomy Lab, which researches technology in the food and beverages sector, and operates four specialized 3D printers.

A 3D printing machine applies chocolate to a chocolate beer bottle. Francois Lenoir / Reuters

The company produces 3D-printed chocolate objects and also engraves chocolates and macaroons with messages or logos for clients, such as nearby brewery Bertinchamps.

The brewery wanted a unique prize for the winners of an Easter egg hunt and ordered chocolate beer bottles.

The chocolate is ready to eat straight after printing, which can take from 10 minutes to three hours. The bottles for the Bertinchamps Brewery took just under three hours and used up 80.7 feet of chocolate.

Gaetan Richard, founder of Miam Factory, adjusts three-dimensional chocolate logos. Francois Lenoir / Reuters

The company gets orders from hotels, businesses and individual customers. Prices range greatly depending on what kind of size, shape and chocolate is required.

While dark chocolate is most popular, milk and white chocolate are also available.

A three-dimensional chocolate printed at Miam Factory.


***Written by Lee Estingoy***
***Technical***
***As seen in the November 2010 issue of*** Model Aviation.

Mysterious events are often attributed to mystical causes, and brushless power systems are about as mysterious as things get in RC. Some systems work and others don't. Why?

The usual explanation is something along the lines of, "It's a mystery!" The reason for a component failure is a mystery to most involved, but understanding a bit more about brushless systems can go a long way toward helping a hobbyist enjoy outstanding reliability in an electric-powered airplane or helicopter.

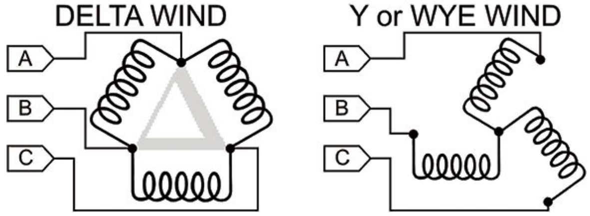
A brief description of the role of the brushless Electronic Speed Control (ESC) is that it must accurately make and break connections between the three input leads of the motor and the power source to drive the rotor magnets around the arc of the power plant. The most accessible way to describe the operation of the ESC is to break it down by functional sections.

A brushless ESC uses a microprocessor to manage the operation of field-effect transistors (FETs), using information from a rotor position circuit. Let's look at each of these more closely.

## Making the Connection

Before we go too far, let's make a few things clear about the operation of a brushless motor. It uses three sets of copper windings to push and pull permanent magnets attached to the shaft inside the power plant. It's important to understand that these windings are connected at one end inside the motor.

There are two ways this connection is made; one is the Delta, or D-wind, and the other is the Y-wind. The controller doesn't care which is used; the windings need only to be connected. The type of connection does affect the torque curve of the motor.



The two wind termination types are known as a Delta and a Y-wind. Delta wind gets its name from the Greek symbol. It's not much of a jump from there to understand the name for the Y-wind. A Delta-wind motor generally has nearly twice the Kv of a similar motor with a Y-wind.

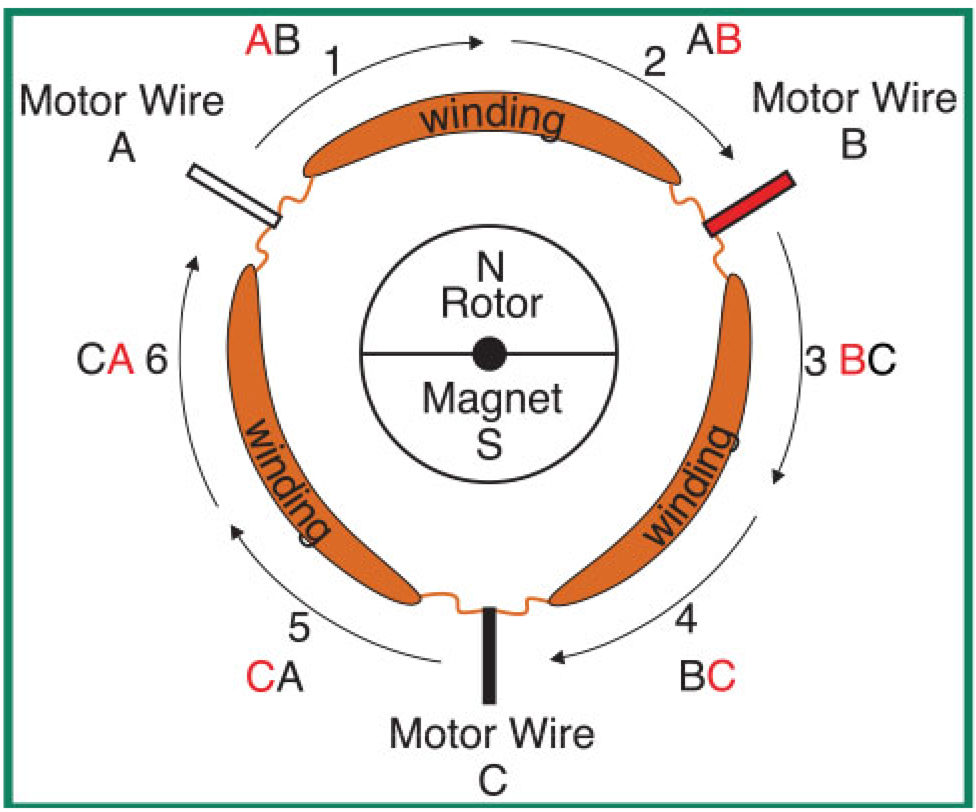
Let's call the three motor wires "A," "B," and "C," and their "free" ends, those that stick out of the motor, are connected to the ESC. The ESC uses electronics to connect any of these wires to positive or negative, to achieve one of six possible combinations that results in an electromagnetic field in a precise location in the motor. The timing and duration of these connections is critical—and unbelievably short.

Mechanical switches are simply incapable of the task. But high-power electronic switches—known as Metal Oxide Semiconductor Field Effect Transistors (MOSFETs, or FETs for short)—can turn on and off in a fraction of a second and are ideally suited for this application.

Let's do a bit of math to get an idea of the incredible activity going on inside the ESC. An outrunner motor with 12 poles that has a Kv (rpm per volt) of 1,500 and is powered with 24 volts (6S Li-Poly) will spin at 36,000 rpm (24 x 1,500 = 36,000).

The six coil combinations needed for a full magnetic rotation must be repeated for every north pole in the motor. The example motor has 12 poles, so the controller must switch the FETs 36 times per revolution of the shaft (6 north poles x 6 steps per magnetic rotation).

That means there are 1,296,000 electrical cycles per minute (36,000 rpm x 6 winding phases x 6 poles = 1,296,000), or 21,600 cycles per second. The controller must successfully switch between the phases every 1/21,600 second!

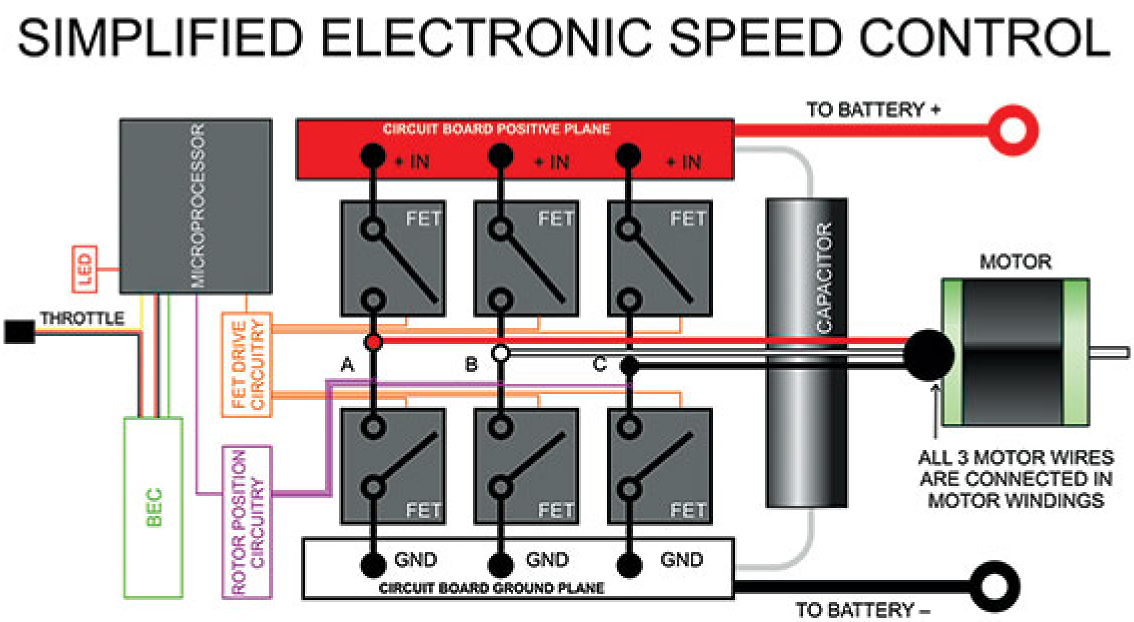



This is a basic drawing of connections required to drive a brushless motor. The three motor wires—A, B, and C—can each be connected to positive or negative poles of the power source by the ESC. The six possible combinations are numbered, and color-coded letters indicate connections and polarity at each point in the process. Red indicates connection to positive; black indicates connection to negative.

## FET Drive Circuitry

Turning an FET on and off is not as easy as it might sound. Each has three connections: gate, source, and ground. To turn the FET on and create a circuit, the gate leg has to be driven to a point that is 5-10 volts higher than the voltage of the source leg on the FET, whichis connected to the motor power source.

Refer to the simplified ESC diagram. If using a 4S Li-Poly battery, +IN will be roughly 14.8 volts (3.7 volts x 4). The gate requires 24.8 volts (14.8 + 10 = 24.8) for proper operation. The ESC must therefore be able to boost some of the power it takes from the batteries to the increased voltage to drive the FETs.




There are four main functional groups in an ESC: the power MOSFETs, the MOSFET driver circuitry, the microprocessor, and the motor position detection circuitry. A Battery Eliminator Circuit (BEC) is present in some controllers; it reduces the voltage of motor batteries to a level that is useful to the radio system in the vehicle.

## Motor Position Detection Circuitry

The ESC has to know the precise location of the rotor magnet(s) to accurately sequence the connections that the FETs make. This is the trickiest thing that the ESC has to do.

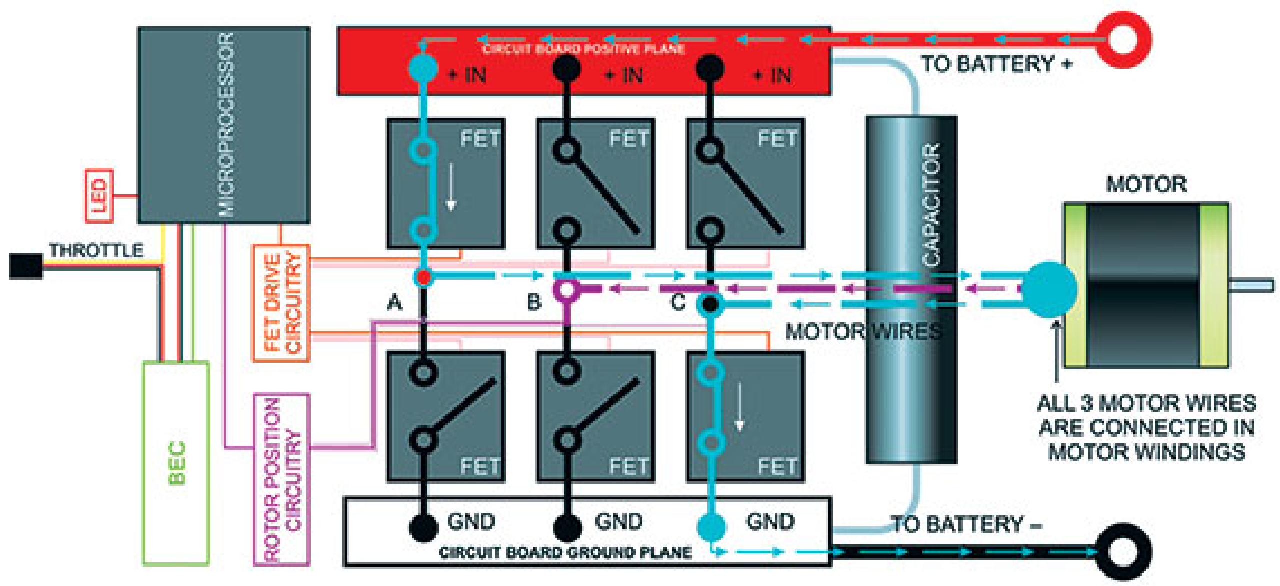
There are two main ways to go about this: sensored and sensorless. Sensored systems use electronic (Hall) sensors in the motor to track the rotor. This requires additional parts in the motor (sensors) and an additional wiring harness to connect the motor sensors to the controller.

Sensored motors and controllers are popular in RC car applications, because they provide a slightly smoother motor start than the sensorless controller. Sensored systems were popular in the early days of RC brushless aircraft power systems; however, they are generally considered to be less reliable and less efficient than sensorless systems, so they are no longer popular for such applications.

Sensorless/modern ESCs detect the rotor position through the power wires by “listening” to the third wire for signs of motor position while the power to the motor is applied to the other two leads.

The changing magnetic field caused by spinning magnets in the power plant generates a voltage in the third wire, and sensorless ESCs detect and measure that voltage to determine how far the rotor has turned. Then the information is used to switch FETs as needed to cause correct magnetic push or pull in the phases.

## CURRENT FLOW THROUGH A SINGLE CIRCUIT



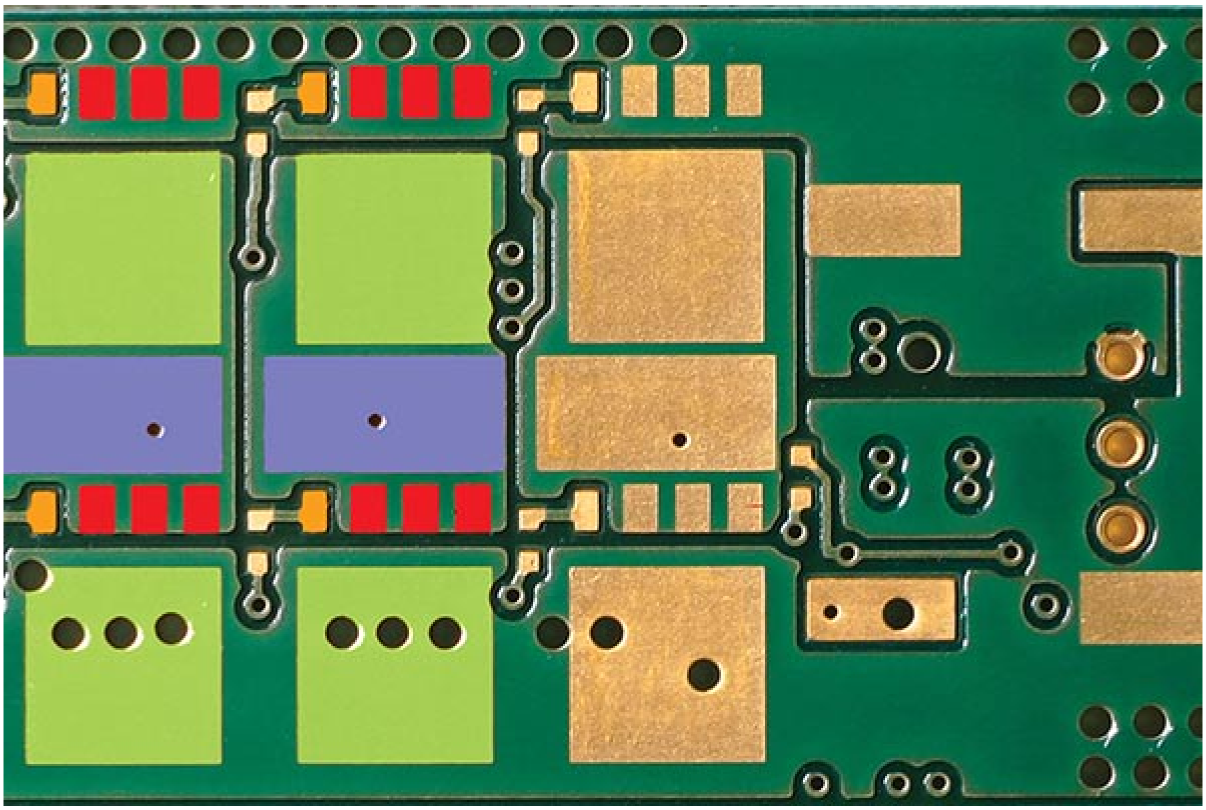

Current can flow in either direction on each of the three motor wires, making six possible combinations of current flow. This diagram shows one. The blue path traces current flow from the battery through the FET, controlling the “high” side of the red motor wire (A), to the motor windings and back through the black motor wire (C) and the FET controlling that phase’s low side. ESCs vary throttle by switching the low-side FET on and off rapidly during the period that a phase is powered; this is the PWM rate. The purple path traces the “backflow” in the third motor wire (B) of current generated by the motion of the rotor magnets relative to the windings. The rotor position circuitry measures voltage of this current to determine when to switch the FETs to drive the rotor around inside the motor.

# The Microcontroller and Its Firmware

The microcontroller is the “brain” that runs the whole operation. Operating a brushless motor takes tremendous computing horsepower, and better controllers use processors that operate at 25 MIPS: 25 million instructions per second.

Controllers with less-capable processors might be unable to process the data quickly enough to run high-pole-count motors at high speed, because they hit a computational redline long before the motor reaches its full rpm/power capability. This is particularly true with high-pole-count outrunners in high-rpm (geared) applications, such as helicopters.

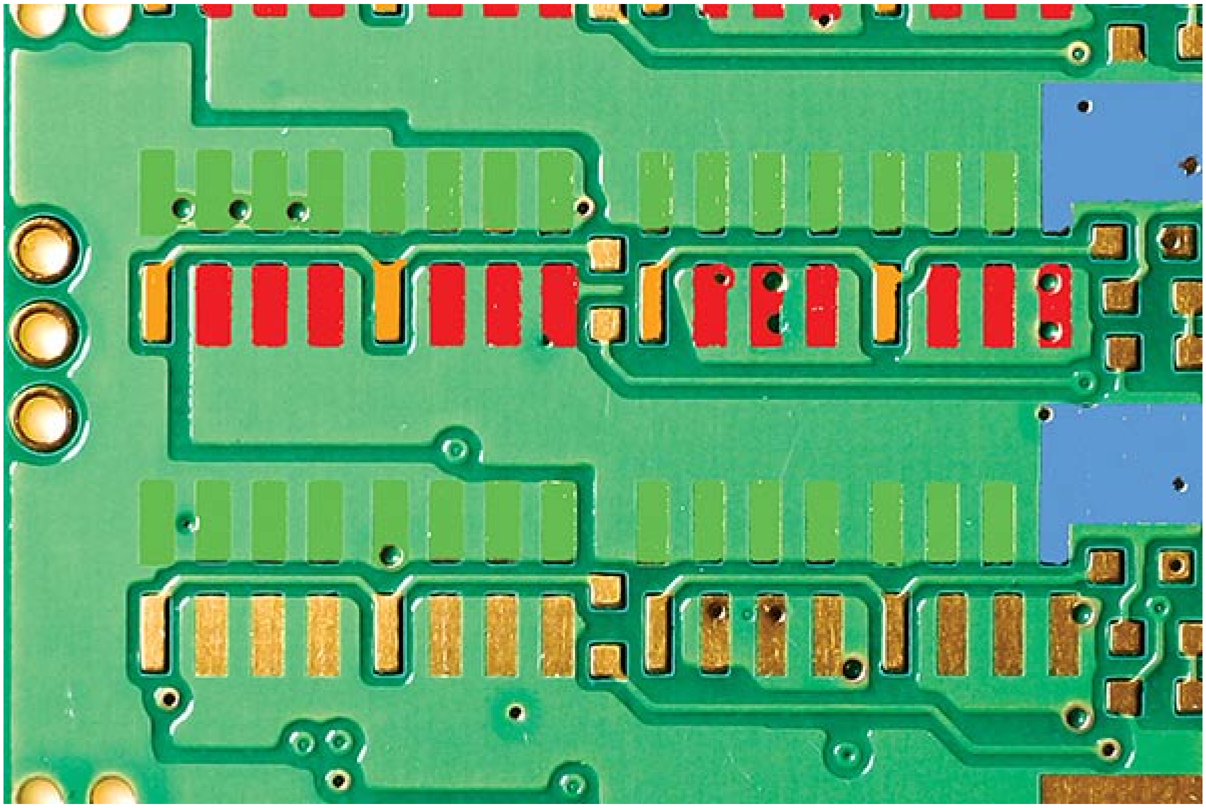
Microcontrollers run software in much the same way that computers run programs. The software must manage a number of processes taking place simultaneously in the motor/controller system.



Typical ESC power board designed for the Power Pack FETs. Two phases are color-coded; blue pads = motor wire connection, green and red pads = FET drains and sources, and orange pads = gate connection.

I’ve mentioned how the controller switches FETs and keeps track of the motor position. Don’t forget that the microcontroller also has to process input from the receiver to compute the desired output power and flash indicator LEDs.

The user might not want to run at full throttle all the time, so we have to be able to limit the output power by pulsing those FETs between the usual positional pulses. If that’s not enough, there may be special routines that govern motor speed, record data, monitor battery voltage, watch for overcurrent or overtemperature conditions, and manage activities of the switching BEC.

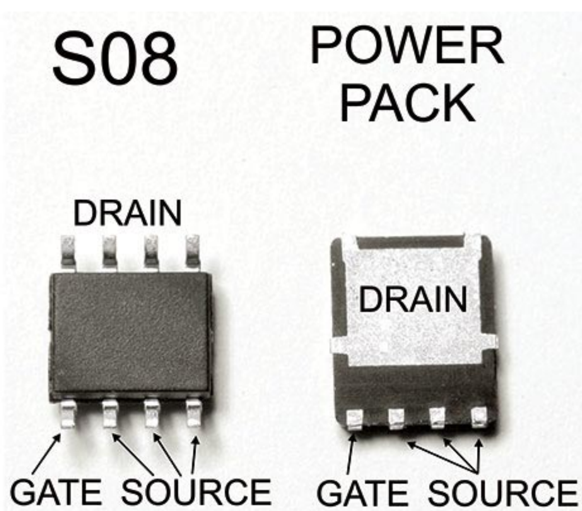


Typical ESC power board designed for the older S08 FETs. Two phases are color-coded; blue pads = motor wire connection, green and red pads = FET drains and sources, and orange pads = gate connection.

There is a lot going on here!

## Input Capacitors

The large tubular devices that are an obvious part of most ESCs are capacitors. These are essentially fast-acting reservoirs for electrical power, and ESC designers use them to smooth out the power as it enters the controller. But why is this an issue at all?



Improvements in FET packaging, the way the internal silicon components are connected to the circuit board, play a huge role in the improvement of the ESC in the past few years. The older S08 packaging (L) connects with the tiny legs, while the huge Drain pad on the newer Power Pack FET (R) provides a much larger connection to the circuit board. The net effect is that much more of the heat generated in the Power Pack FET can be transferred directly to the circuit board.

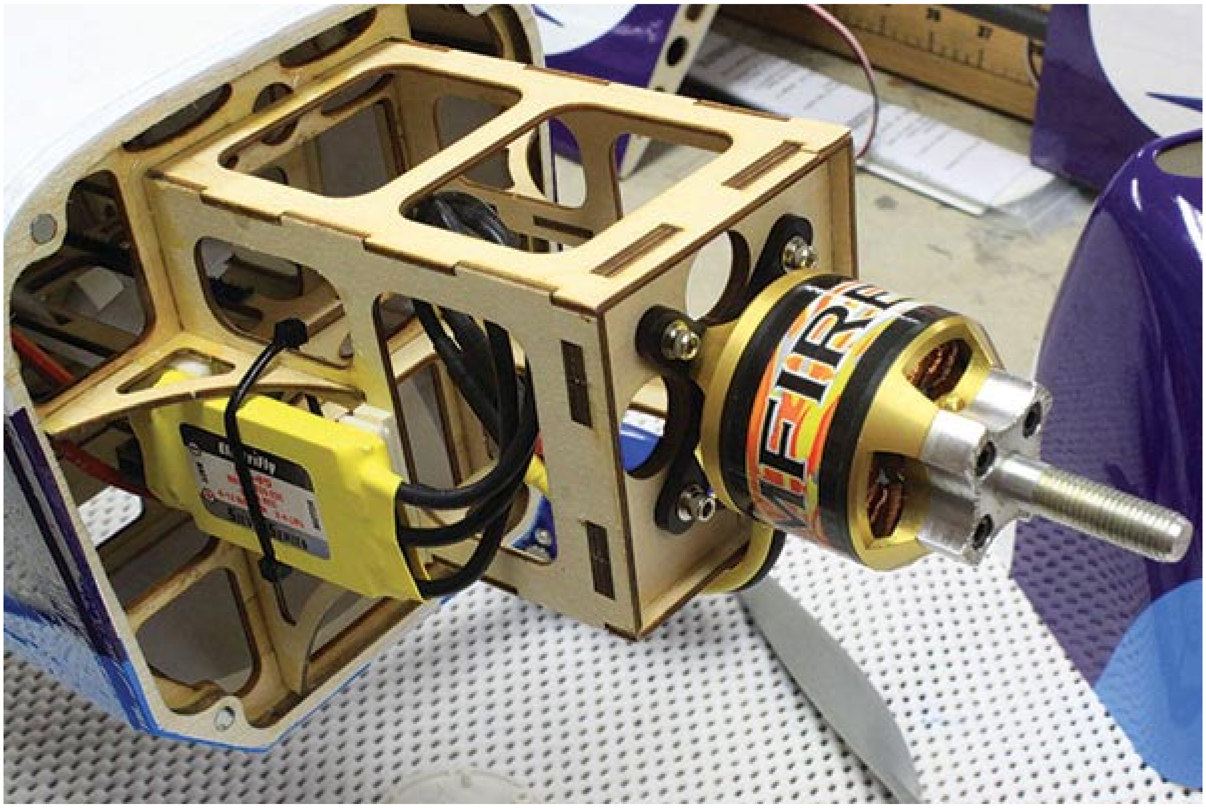
Remember that the FET gates need to see a stable voltage to operate properly. In practice, the voltage that comes from the battery is not a constant value; a graph of battery voltage would look like spurts of voltage.

Each spurt starts at a higher level than at which it ends during each power cycle of the FETs, however incredibly brief. A graph of this would look like a ripple. This changing voltage is called “Ripple Voltage.” ESC designers can smooth out this ripple to some extent by using capacitors, but there is a limit to how much the capacitors can fix.

The FET gate must be 10 volts higher than source. If the source is crashing and recovering a bit between each cycle, the voltage in the gate circuitry might unexpectedly meet/exceed the 10 margin over the source voltage in the FET. That causes the FETs to turn on unexpectedly— and create nasty connections in the controller that typically lead to a bad day at the field.

It’s not such a bad thing if the FETs turn off. It is bad when they all turn on at the same time that the smoke comes out.

Advanced topics in ESC design include the following, any one of which would provide plenty of material for an engineering graduate paper. These are simple descriptions.



Great Planes motors are sold under the ElectriFly brand name. They feature plug-and-play electric-power systems for models weighing 5 ounces to 50 pounds.

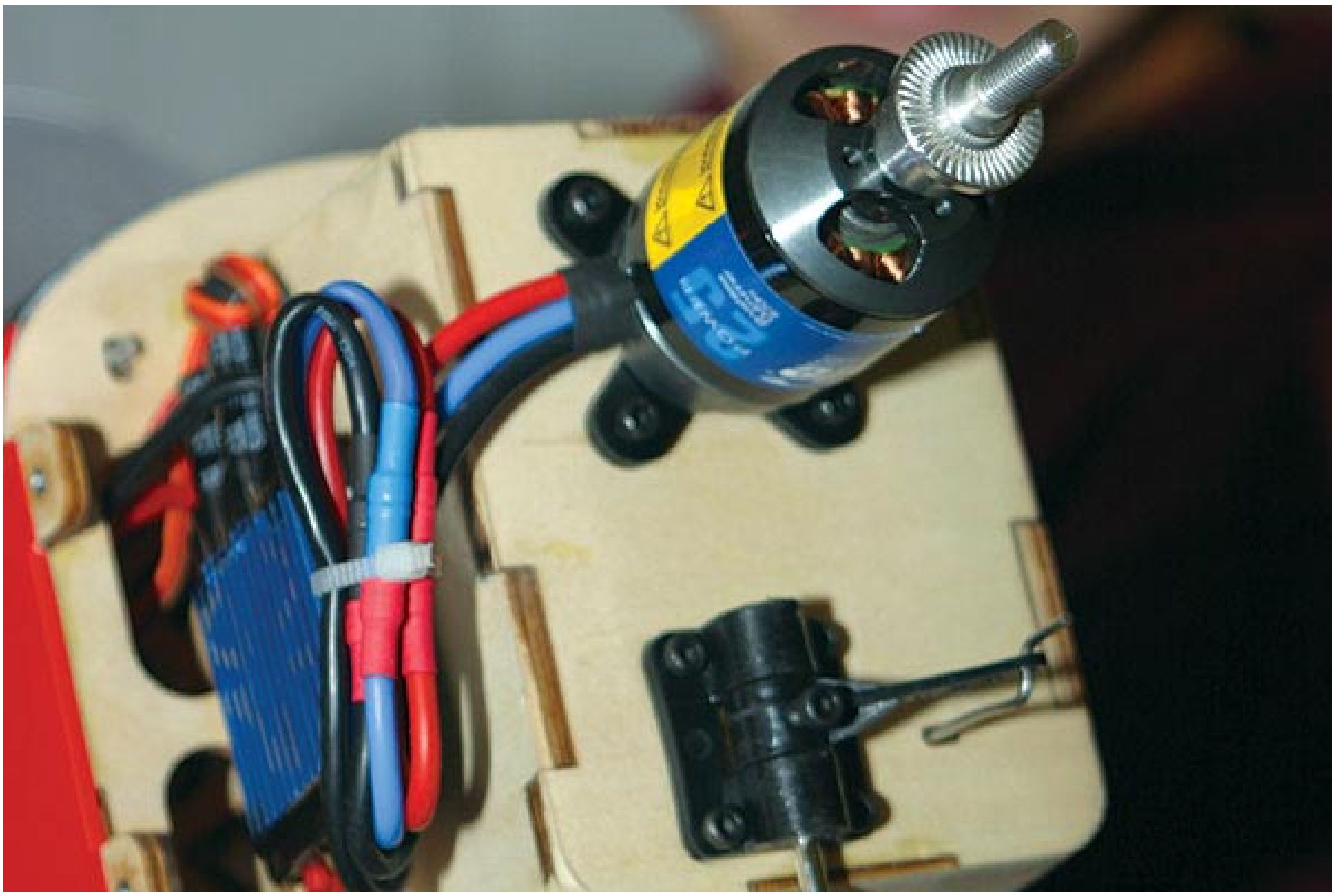
### Controlling Speed

Running at partial throttle is merely a more complicated case of running at full throttle. Instead of leaving two FETs (positive and negative) on for the entire period of the motor pole's transit of the motor winding, one is turned on, while the other is rapidly pulsed on and off to reduce the average power seen in the winding.

At low throttles this second FET is barely on, but it is on almost the whole time near full throttle. The frequency (times per second) at which we pulse the power for speed control—not the polarity switches that drive the motor—is called the PWM rate, or switching frequency.

One of the paradoxes of brushless-motor controllers is that partial throttle operation generates more ESC heat than full-throttle operation. FETs have a small resistance when they are fully on and current is flowing through them. This generates a relatively little amount of heat. As always, there's more to it.

FETs don't simply go from an on to an off state; there is a bit of a ramp to the process in which the FET is neither open nor closed. Electricity can flow through the FET during these periods, but the resistance in the FET is much higher than when the FET is fully on. This leakage across a high resistance generates a significant amount of heat.



Plug-and-play systems are noted for their ease of use—no soldering. Electric-power systems from E-flite are that easy and are labeled with a system that correlates with glow-power designations.

At partial throttle, FETs are required to cycle much more rapidly than at full throttle, so a great deal more heat is generated at partial throttle than at full throttle. Similarly, more heat is generated in controllers set to run at high switching rates than those set to run at lower switching rates.

**Hardware Voltage Limitations—4S, 6S, HV**

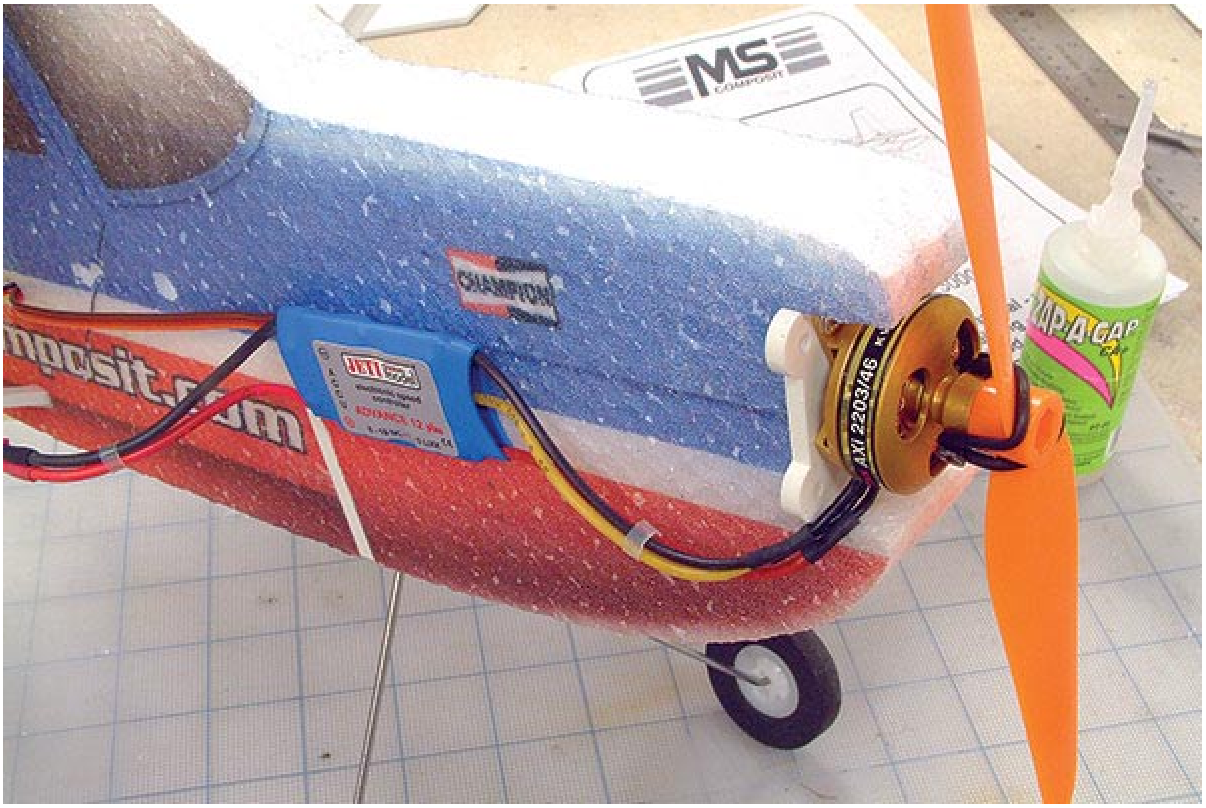
Brushless ESCs are generally rated for a specific range of voltage. This is due in part to the voltage rating of the FETs themselves. Generally, higher-voltage FETs are usually more resistive than lower voltage FETs, so higher-voltage controllers will require more FET capacity than lower voltage controllers to handle the same amount of current. The drive circuitry must also be modified to handle the higher voltages.

The FET voltage limitation is a hard number. Exceeding the FETs voltage limit usually results in instant destruction of the FET. Always pay attention to the voltage limits recommended by the ESC manufacturer.

**Hardware Amperage Limits—10 amps, 25 amps, 35 amps, etc.**

Unfortunately amperage limitations are not always blackand- white. A number of considerations determines the current an ESC can handle successfully.

There is a current above which the silicon inside the FETs or the metal legs or connections on the FET break down and fail. Damage from excessive amp draw takes place in an instant.



AXi motors can arguably be credited with making electric power available via mass production and reasonable pricing. They are among the most efficient systems available.

Think of a fast-acting fuse, except that an ESC is seldom considered to be expendable. It is difficult to anticipate high currents and shut down the controller in time to prevent the current spike from damaging the controller.

Partial throttle operation generates more heat, as does high PWM rates. The amperage capability of an ESC is limited by the ability of the device to dissipate heat generated by the resistance of FETs and circuit boards. If a controller is making more heat than it can dissipate, a “runaway” condition occurs.

This can lead to thermal destruction of the controller; solder holding the components to the boards literally melts, and the parts are free to float away.

A great way to rate a controller is to determine its “steady state amperage.” That is the maximum current it can carry at its rated voltage without experiencing further temperature rise. This can vary a bit, because the temperature rise depends on ambient air temperature and the amount of cooling airflow over the ESC.

A dangerous way to rate a controller is to state its “surge” or “burst” capabilities. These indicate that the controller might be able to handle higher currents for short periods, but those periods are sometimes shorter than the pilot would hope.

That is another area in which manufacturers can rate their products based on their own, often ridiculous, definition of a controller duty cycle. Read the fine print.

Like the proverbial duck on water, things look calm on top but there’s a whole lot going on inside a brushless motor controller. A great deal of engineering goes into the physical design, and the software is surprisingly complex. Always use a power system inside its performance envelope for best performance and reliability.

***-Lee Estingoy***
*lee@castlecreations.com*

# Uber to Test a Fleet of Flying Taxi Cabs by 2020

BY PAUL A. EISENSTEIN

Tap a button on your smartphone and ride-sharing giant Uber will have a vehicle waiting at your door within a matter of minutes. But in the near future, Uber officials revealed during a Dallas summit meeting on Tuesday, the ride they send your way soon might have wings.

Flying cars have long been the stuff of science fiction, though it's a fantasy that confounded even Henry Ford, a pioneer of both the automotive and aerospace industries. But now, the idea seems poised to take off.

An Uber Elevate flying taxi cab approaches Dallas. Uber

Uber is just one of a number of companies looking into the potential for flying taxi services, along with start-ups like Munich's Lilium and aerospace giant Airbus. Meanwhile, after years of delays and setbacks, a handful of firms have announced plans to begin taking orders on vehicles that can operate on both the ground and in the air.

That includes a Slovakian start-up that showed off its AeroMobil Flying Car at the annual Top Marques Monaco, the elegant principality's annual showcase of all manner of luxury goods, last week. Company officials announced they were ready to take pre-orders for the five-seater which is expected to carry a price tag of somewhere between $1.3 million to $1.6 million once deliveries begin by 2020.

Looking like it rolled off the set of a sci-fi flick, the Flying Car's wings can be opened or folded up in a matter of minutes, depending upon whether the vehicle was going to fly or drive. On the ground, AeroMobil claims its craft will top out at 100 mph and travel up to 434 miles between fill-ups. In the air, range jumps to 466 miles, with a top speed of 223 mph.

The AeroMobil Flying Car was actually one of two such crafts on display in Monaco, a Dutch start-up also exhibiting its three-wheeled PAL-V, which it claims to be "the first certified commercial flying car ever." At a more affordable $400,000 to $600,000, the PAL-V looks more like the offspring of a three-wheel motorcycle and a gyrocopter and will hit 112 mph in the air and travel up to 310 miles on a tank of fuel.

The downside of these and other flying cars now under development — such as the Terrafugia Transition, developed by a group of MIT alums — is that they will require operators to hold drivers and pilots licenses.

Uber expects to avoid that costly and time-consuming hassle with its proposed Uber Elevate Service.

Play

- 

**From 'Jetsons' to reality: This flying car prototype doubles as a sports car** 4:25

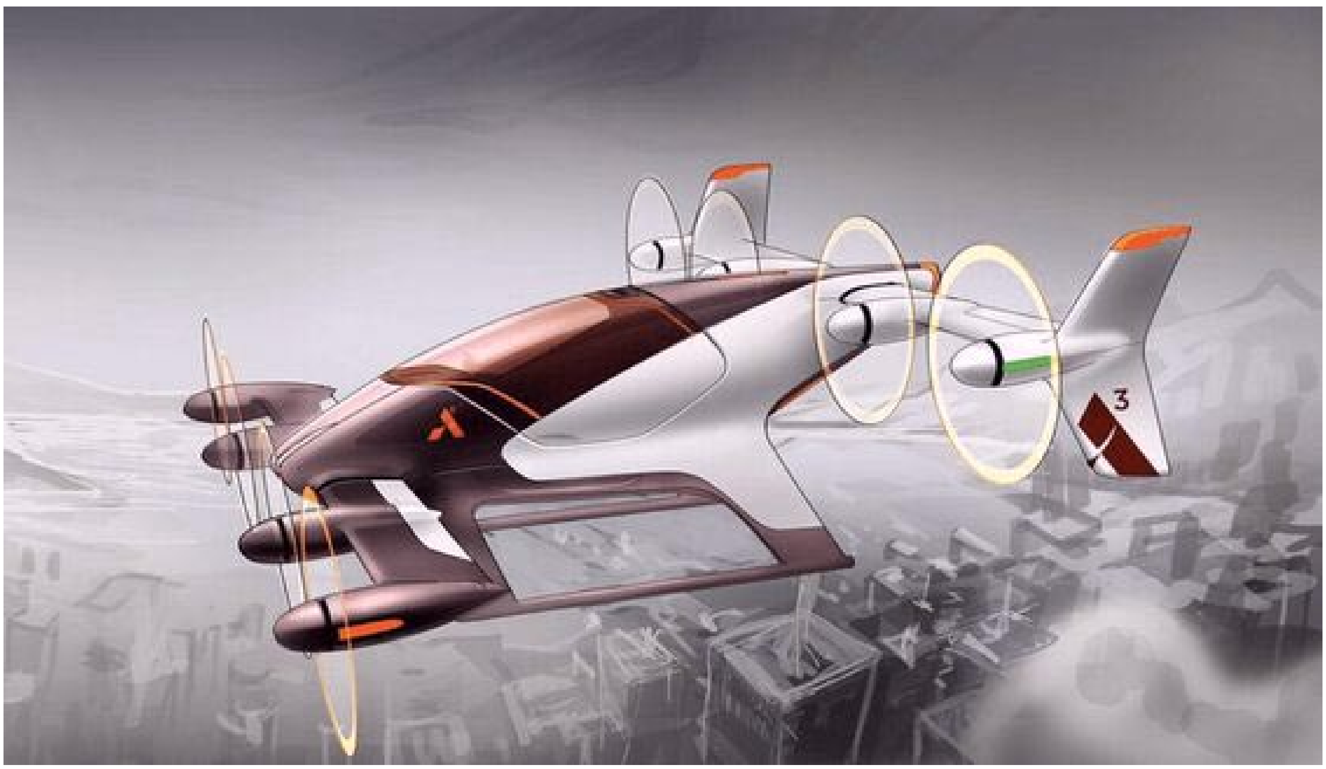
## Takeoff by 2020?

The San Francisco-based firm says it has already lined up a promising list of partners, including the cities of Dallas and Dubai — the latter hoping to have a pilot test ready to take place in time for its 2020 World Expo.

"Urban aviation is a natural next step for Uber," chief product officer Jeff Holden said ahead of the opening of the three-day Elevate Summit in Dallas. "That's why we're working to make 'Push a button, get a flight' a reality."

Uber says it also has five aircraft partners on tap, including Brazil's Embraer, best known for its widely used regional jets, as well as Bell Helicopter. Uber officials say their "flight on demand" service could ultimately make use of a wide variety of different aircraft. Most would likely be vertical take-off-and-landing, or VTOL, craft that could lift directly into the air and then fly more like conventional airplanes, switching back to VTOL mode to drop a passenger off.

Among the manufacturers exploring that option is aero giant Airbus, the European manufacturer recently releasing an animation of a concept it calls Vahana.




Developed in cooperation with Italdesign, it relies on modular components, including a four-rotor drone unit that would attach to the top of a passenger car's cabin. The vehicle's wheels and chassis would be left behind as the aircraft flew to its destination. There it would mount on a new chassis, the drone portion separating for use with another flyer, while the now-wheeled vehicle would drive to its final destination.

Munich-based start-up Lilium has already run test flights of a drone-like craft that would lift off and hover before extending its wings and then flying like a more conventional aircraft. The company plans to boost the capacity of that prototype from two seats to five and claims it will be able to travel up to 190 miles at a speed of 190 mph.

**Related: A Look Inside the Heart of Uber**

"We have solved some of the toughest engineering challenges in aviation to get to this point," said Lilium Chief Executive Daniel Wiegand in a recent statement.

With its well-established ride-sharing service now operating in nearly 600 cities around the world, Uber could have a wing up on competitors interested in establishing a flight-on-demand service. And with a market capitalization of around $70 billion, it has plenty of capital — some of which it is already using to fund development of autonomous and fully driverless vehicles.

Focusing on Other Issues

On the other hand, Uber has had plenty of problems of late, including allegations of sexual harassment and technical issues with its self-driving vehicles, that could be major distractions.

More broadly, the idea of filling the skies with flying cars and cabs might sound appealing — and it has become a staple of sci-fi films like "Blade Runner" and "Star Wars" — but there are a number of challenges that would have to be overcome, beyond the ability to get those vehicles off the ground. The current air traffic control system struggles with the load of aircraft in the skies today. Adding thousands, perhaps hundreds of thousands, more small craft would require some serious infrastructural updates.

But the prospect of adding that third dimension to urban travel, especially at a time when roadways around the world are increasingly overcrowded, could give the idea of flying cars and cabs the added momentum needed to finally take off.

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