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MAGAZINE

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ON THE COVER: Find out why we think the DJI Inspire 2 is ideal for aerial photography and videography in our review this issue. (Inspire 2 photo by DK Barrett; background image by stutterstock.com)

THIS PAGE: A DJI Phantom 4 captures a raft of Adélie penguins sunning themselves on an iceberg off the coast of Antarctica. Get the full story on this South Pole journey on page 66. (Photo by Simon Ager/Sea Shepherd Global)

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Antarctic Adventure

Gavin Garrison

Two years ago, Gavin's first-ever recorded aerial footage of a blue whale mother and her nursing calf near the coast of Antarctica sparked a conversation about the role of drones in modern conservation efforts and has since been coined "Conservation 2.0." Gavin has produced six episodes of *Whale Wars* in addition to four major specials and four documentary films, and in this issue, he outlines the challenges of flying a small drone near the South Pole.



Drone Swarm

Michael York

While researching this feature, Michael learned that drones can work together to create aerial shows and build walls and even bridges. He notes, "The advancement in technology has literally opened up a whole new way to look at drones. These sometimes-controversial flying machines are banding together not only to entertain us but also to soon make life easier and safer."



Hitec Vektor 280

Mike Gantt

A die-hard racer, we never have to ask Mike twice to take on a speedy machine. Mike writes, "About a year ago, I was bitten by the FPV bug when *RotorDrone* asked me to review a racing drone. I find FPV racing very exciting and challenging. I love the technical side of this hobby and look forward to seeing where things go in the future."

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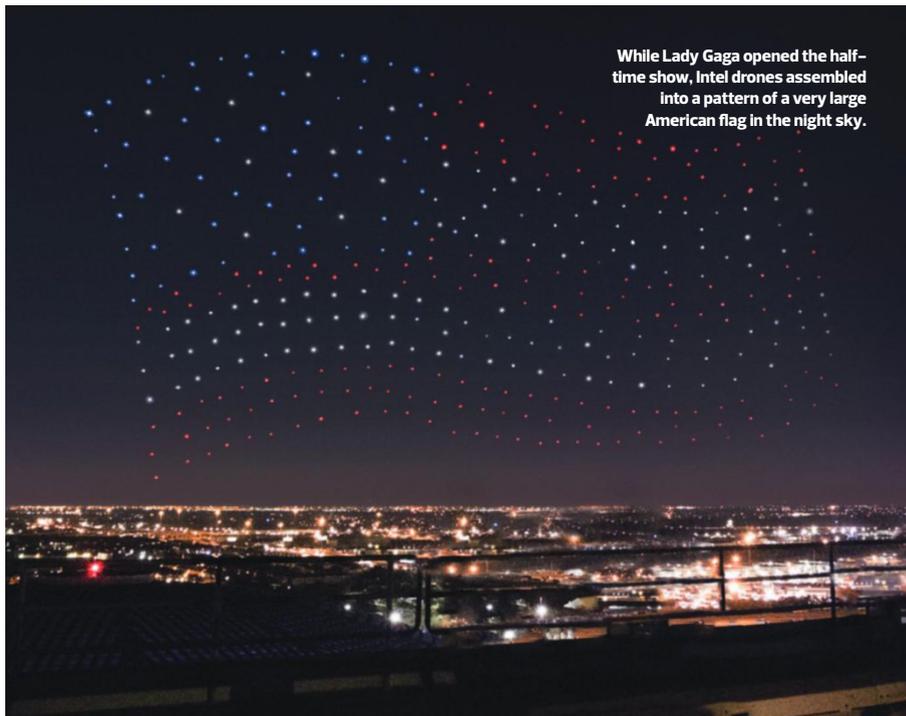
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While Lady Gaga opened the half-time show, Intel drones assembled into a pattern of a very large American flag in the night sky.

Lady Gaga's Super Bowl Drone Show



John Reid
Senior Editor
johnr@airage.com

Did you watch the Super Bowl? If you did you most likely saw the halftime show with Lady Gaga and the hundreds of swarming drones that lit up the night sky. Our contributor Michael York fills you in on how that was accomplished. His article on drone swarming technology shares the latest developments in that field and will give you an idea on what you can expect to see in the future.

Here it is our second issue of 2017 and the drone industry is still moving strong. We just returned from CES 2017, and there were drones everywhere at this electronics show. While a large section of floor space was dedicated to the drone industry, there were so many manufacturers that they had to grab any extra space they could. As a result, we traveled throughout the show and were able to see many other cool things. Be sure to check out our CES coverage in this issue. Are there any *Star Wars* fans out there? While at CES 2017, we found some

with articles and videos to make every flight a home run.

We had a blast working on this issue and putting it together; we hope you enjoy reading it just as much. Please send your comments and feedback to me at johnr@airage.com. I look forward to hearing from you and ensuring that *RotorDrone* magazine continues to be the premier source of rotor drone news, inspiration, and information.

really cool battle drones that are designed after *Star Wars* vehicles. We had so much fun with these aircraft, that we didn't want to stop "working" with them, and we have the full report here.

Speaking of the future, we received the new DJI Inspire 2 to test, and I can say that we put it through some heavy flight testing. Many of the new features are geared toward the commercial and pro cinematographer. If you want to improve your aerial footage, then you will definitely want to check out this drone. Its outstanding gimbal performance and camera-image quality produces some of the nicest footage we've seen. Add to that its high-speed performance and programming modes and you have a drone that is an all-around winner.

We have some terrific advice in this issue on shooting great still images using your drone (after all, who doesn't like a great aerial selfie?). Our professional tips will help you to set up the shot to capture the best image possible. And for those of you who are just getting your feet wet in the world of drones, we have a terrific "getting started" feature this month. It outlines what you need to know, from choosing a drone to successfully flying it. For even more drone basics, head over to RotorDroneMag.com and check out our Getting Started section,



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Aerial Photo and Video Guide

This great digital download includes four articles in 16 pages. "Straight Shot" provides some must-know techniques to set up your camera gimbal, and "Ready, Set, Action" shares 14 pro tips to create awesome aerial videos. "Aerial Photos 101" describes flying techniques and lighting design, and finally "The Secret Is in the Lens" offers a simple pro-lens modification for better aerial images.

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There's no doubt that *RotorDrone* magazine readers and our Facebook fans are a loyal group of enthusiasts! The *RotorDrone* crew would like to thank all of you for helping us reach this impressive social media milestone. Be sure to like us on Facebook to get the latest news on drones and gear, the inside scoop from racing events, informative and entertaining videos, and much more!

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We love hearing from readers. Your emails, tweets, and comments let us know what you'd like to see more (or less!) of in print and online. Here's what some of you are saying about *RotorDrone* magazine.



Glenn Ryan: *OK, drones may be a pain in the butt, but this one is cool. Ha, ha!*



Steve Ruedt: *I don't think it will hit 88mph!*



Karl Edwards: *"Where we're going, we don't need roads!"*



Adam Murphy: *The lights and the soundtrack are amazing. I want to build one myself!*



f Facebook *Back to the Future* DeLorean Drone

We posted this impressive video of the iconic DeLorean from the *Back to the Future* movie trilogy, and it got some attention. This DeLorean-turned-drone was built from scratch using foamboard and homemade detailed parts first posted on a Russian "Maker" forum by @native18, and it looks like it flies well.

f Facebook Get Ready to Race

The new RISE Vusion Extreme FPV Race Pack has everyone excited as it comes packaged with everything you need to race. Included is a video monitor that mates perfectly to an included headset for true FPV emergence, and the racing drone has rugged easy-to-replace snap-on arms. We posted some photos and information on it, and here's what you had to say.



Marcus Couch: *I already have one! I love it.*



Fred Huber: *Cool and good capabilities, but I am still waiting for something a little larger.*



Peggy Preston: *Oh great—another excuse to buy another drone! I'll have to hide this from my husband.*



RotorDroneMag.com Extreme Ribbon Dancing

It is amazing what kind of videos surface that are shot with the use of drones. Often these amazing aerial videos aren't even possible without the use of multirotor camera drones. One such video we posted on our website was shot under the Tatarna Bridge in Greece as extreme aerial dancer Katerina Soldatou plies her skills. A Rad Life Media production, this video showcases the amazing and inviting cinematography shot for a project called "Greece Has Soul" by Spiros Badios. Many thanks for Katerina for posting the footage.

Aaron Ballwich: *I am awed and terrified, all at the same time. You could never get a real helicopter in that close.*

Michael Ash: *I have seen some amazing ribbon dancers in Vegas Cirque du Soleil shows. Hanging from a bridge high over a river—that's nuts!*

Anton Popalowski: *It's hard enough to shoot aerial video with a drone when you are right there on the ground with your subject. I'm trying to figure out where Spiros was standing while piloting his drone.*

Rex Dailian: *Simply breathtaking. Katerina Soldatou is both an athlete and an artist.*

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Vuzix Drone Racing Cup

Cold weather didn't get in the way of hot racing in Las Vegas



THE VUZIX DRONE RACING CUP, held on the pool deck at the Westgate Las Vegas Resort & Casino during CES 2017, brought together a number of unusual pairings: FPV racing and HD video, Las Vegas and parkas, and celebrities and drones. In short, this was no ordinary competition. The event was made even more complicated by the fact that the Westgate is just 2.36 miles from the fence line at McCarran International Airport, well within Class B airspace.

To overcome any potential safety concerns, the organizers covered the entire course with netting, stringing together the poolside bar with guest cabanas to create a completely enclosed raceway. That made for an extremely tight course that tested the pilots' precision-flying skills and nerve—especially the narrow passageway known as the "Tunnel of Love," where opposing traffic crossed head on.

Left: Bundled up against the cold, one of the pilots competing in the Vuzix Drone Racing Cup flashes the thumbs-up to indicate that he has clear video in his goggles.



Above: The new Falcore FPV racing drone from Connex incorporates a novel design for the included prop guards, which provide robust protection for the propellers and the aircraft.

Below: The iconic curves of the Wynn Las Vegas and the Encore Resort on the world-famous Las Vegas Strip provided the backdrop for the drone racing at the Westgate Las Vegas Resort & Casino during CES 2017. The pool deck was closed for the event.





Above: Lydia Ansel, electric violinist and DJ, has performed alongside Rod Stewart, John Legend, and Enrique Iglesias. However, she had never flown a drone before sitting down to pilot the new Connex Falcore at the Vuzix Drone Racing Cup.

Below: As the event's title sponsor, Vuzix provided its HD iWear video goggles for pilots to use for their FPV video links throughout the competition.

Right: After three rounds of celebrity racing, these four Falcore quads from Connex are still ready to fly.

Bottom right: The Vuzix Drone Racing Cup provided a working demonstration of how the live video feeds from multiple Connex ProSight systems can be integrated into a broadcast environment.

FPV in HD

Needless to say, with Vuzix as the title sponsor, all of the pilots wore the company's iWear video headphones and watched the live video feed from their drones on a pair of high-definition 720p video displays. HD video is a spectacular way to fly FPV, but for the past several years, it has not been an option for drone racing because of one crucial factor: latency.

Until 2016, every HD video downlink added a small delay into the video signal: what the pilot saw happening on the screen actually happened to the aircraft half a second earlier. For general-purpose aerial video and photography, that delay was irrelevant. For a sport, however, where machines traveling at 75mph are expected to routinely punch through gates that are only about one yard across, it's a disaster.

All of that changed last year when Connex released its ProSight system for drones, providing latency-free HD video, not to mention less interference and simplified frequency management, when compared to the 5.8GHz analog video systems that have traditionally been used in FPV racing. ProSight has been steadily gaining traction in the industry since its release in May of last year.

Not Hot

With average daytime temperatures in excess of 100°F during the peak summer season, Las Vegas has a well-earned reputation as a hot town, in the

literal sense of the word. CES is held in January each year, however, when the cloudless desert skies turn chilly, which was not an eventuality that I came prepared to endure for very long.

Still, in a city that bills itself as "The Entertainment Capital of the World," the show must go on—and it did, complete with celebrities. Four Las Vegas headliners turned out to try their hand at FPV racing, piloting the new Amimon Falcore through a simplified course in Shield mode. [Editor's note: See our first look at this new racer elsewhere in Aerial Intel.]

Donning the goggles for the race were hypnotist Anthony Cools, The Amazing Johnathan (described as "The Freddy Krueger of Comedy"), DJ and electric violinist Lydia Ansel, and comedian Jeff Civillico. Only one of the four—Cools—had any previous experience with drones; he owns Avian Cinema, an aerial video production company.

Whether it was his background or some subtle form of mind control borrowed from his show at the Paris Las Vegas Hotel & Casino, Cools carried the day: often emerging as the only pilot to complete the course, while the other three lodged their aircraft in the netting or crashed into the cement of the pool deck. The four Falcores flying inside the cage shrugged off the abuse without complaint, being as ready to fly at the conclusion of the final race as they were at the start of the first. Not even Cools, however, was able to achieve the punishing speed that is typical for a competitive FPV race, so we'll need to wait until the Falcore ships later this year to find out how tough this quad really is. —Patrick Sherman





“

THE FIND POD IS A SONAR FISH FINDER. THE FISH POD IS CAPABLE OF SECURING AND RELEASING YOUR BAIT AND LINE TO THE DRONE SO THAT YOU CAN DROP IT WHEREVER THE FISH ARE BITING.

”



Top left: To “cast” your fishing line with the AguaDrone, simply attach the line to the drone and send it on its way.

Above: You can attach an optional FPV camera to the AguaDrone so that you can release your fishing line exactly where you want it.

Left: The father and son team of Daniel (right) and Christopher Marion have combined both of their passions—fishing and drones—and the future for their fledgling company looks bright.

Fishing has never been easier!

AT THE HELM OF AGUADRONE, the father and son team of Daniel and Christopher Marion has been working to develop an easy-to-use drone to help fishermen find and catch their prey. This 100 percent waterproof, modular drone has quick-change accessories, allowing it to accomplish multiple angler-related tasks, and with its water-tight design, the drone can land in and take off from fresh- or saltwater. Its easy-to-use GPS-guided flight controller (Pixhawk 2.1) and onboard flight-stabilization system make it ideal for flying in confined areas.

With its modular design, the drone has three removable pods that are used for various functions. The Find pod is a sonar fish finder that sends a graphic display to a handheld mobile device, the Fish pod is capable of securing and releasing your bait and line to the drone so that you can drop it wherever the fish are biting, and the Film pod houses a waterproof 4K camera that can capture digital images both above and below the surface of the water. In addition, the OS Pod lets users attach their own devices on the AguaDrone. The Marions are developing even more specialty pods for release later in 2017.

The watertight integrity of the drone's buoyant hull is accomplished by using a single-port entry setup for quick

and easy replacement of the flight battery pack, while the quick-change accessory system allows the pods to be attached without using any tools. Also, the design of the AguaDrone makes it completely operational in rainy weather that would preclude the use of other drones.

Its 2.4GHz transmitter controls all the functions and includes a mobile-device holder and a monochrome backlit LCD touchscreen, making it easy to program and make changes in sunlight or at night. The AguaDrone functions include Return to Home, Failsafe Return, and a Position Hold setting. Future app functions planned are Follow Me, Auto-Circle, and Waypoint navigation. With its rugged, easy-to-operate design and a flight range of about 1,100 meters, the AguaDrone also can be used aboard fishing vessels to go out and scout for fish, which helps save time and fuel costs. Ideal for both fishermen and multirotor enthusiasts, the AguaDrone has a battery charge time of 40 minutes and has about 18 minutes of flight duration, depending on the payload. Able to lift up to 2 pounds and with more accessories in the works, this drone's future looks bright.

—Gerry Yarrish
aguadrone.com



An “Uber” service for drones

WITH THE USE OF DRONES AT AN ALL-TIME HIGH these days, it is getting a bit overwhelming for people to find drone-centric sources to solve their rotor-drone needs. Whether you want to hire a drone company to accomplish a specific task or you're a budding drone entrepreneur with a fresh start-up, what's needed more than ever is a peer-to-peer, on-demand marketplace. Enter Up Sonder. Up Sonder helps drone owners and commercial pilots connect with potential customers to rent drones or contract for drone services.

Providing \$1,000,000 in liability-insurance coverage to protect its providers, Up Sonder is like an Uber service for drones. Up Sonder has teamed with UberRUSH, with the goal of getting drones into people's hands in 30 minutes or less in the New York, San Francisco, and Chicago metropolitan areas. And as a benefit to drone providers, Up Sonder offers \$150 cash back to users who have passed the Part 107 test. Providers will be required to submit a digital image of their receipt for the FAA's Remote Pilot Certificate test for sUAS and a digital image of their confirmation of passing this test on their profile. Details are on the website for how to be added to the list of providers. Commercial industries as well as farmers and agricultural companies will also be able to get in on the act to help reduce operating costs by setting up a business account to rent instead of own the required drone equipment. Whether you're an end user or a drone provider, get connected today at upsonder.com. —Gerry Yarrish

Unmanned Aircraft Systems Ground School

AVIATION SEMINARS HAS BEEN PREPARING STUDENTS to be knowledgeable, safe, and confident pilots for more than 40 years, and in recent years, the company has extended that same experience to the arena of UAS/UAV operations. The program includes online course material and two days (approximately 16 hours) of in-person ground instruction in a small-class setting that emphasizes personal attention and instruction. The class focuses on both FAA test prep and practical knowledge, and places UAS/UAV students alongside private- and commercial-pilot applicants. This has two distinct advantages. First, it guarantees that drone pilots receive the same quality education as any other student. Second, it promotes a mindset whereby pilots of every type conceive of the National Airspace System as shared with the other types, giving them a more complete understanding of the needs and limitations of all aircraft operating within that shared airspace.

The class structure addresses each subject as a separate unit—starting with instruction, followed by a review of the FAA test questions covering that specific subject—before moving on to the next. Students receive a completion certificate at the end of the class, and the \$429.00 course tuition includes a truly unique added benefit: Students may reattend another session of the class as a refresher any time within a year of their original class at no additional cost!

Some of the many topics covered include federal aviation regulations; aerodynamics and aircraft operations; navigation; maintenance and preflight-inspection procedures; aircraft loading and performance; emergency procedures; crew resource management; aeronautical information manual; aeronautical decision making; and weather reports, forecasts, and theory. —Matt Boyd

aviationseminars.com



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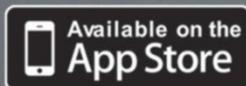
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A safety device that could save the day

ONE THING THAT ALL PILOTS FEAR is their drone falling out of the sky. This could happen for a number of reasons, and if it should, there is a lot of money riding up there on that aircraft and in camera gear. One company has developed a way to save your equipment by developing a parachute that not only can be activated by remote but also can deploy on its own if needed. We had a chance to talk with Kevin Kropp at Mars Parachutes about this innovative product.

RotorDrone: Are the parachutes based on the weight or size of the drone?

Kevin Kropp: At first, there were many custom-built drones, so we couldn't say for a specific drone. But now we specialize in the Phantom 3 and 4, Inspire, and others, so you could say we do purpose-built parachutes. We can also make adapters for different aircraft, such as RC fixed-wing planes or unusual quads that need something different.

RD: When testing out a new parachute for a quad, do you actually try it out with the aircraft?

KK: Yes, we do. When the Solo first came out, in our first test, we actually plowed the drone straight into the ground. Once we fixed it and got it flying again, we were able to do more tests, and everything went right with them. From there, we developed a parachute system designed for that quad. Sometimes there's a loss during testing, but it's all part of the process.

RD: The parachute can be activated by the pilot, but will it deploy by itself if there is a problem with communication between the aircraft and the pilot?

KK: Yes, it is called "May Day." Our circuit board has a couple of techniques to understand when something is falling—specifically, a drone. So it will omit certain information on one specific axis—such as rotation—to a certain degree. That way, the pilot can still pan with the drone without the fear of the parachute deploying. It works by sensing high-speed rotation and the loss of gravity.

RD: Do the parachutes always work?

KK: The only problems we have are if someone packs it up incorrectly or the drone is too low for the parachute to deploy in time. But even if the drone is sideways or upside down, the parachute will still shoot out and work perfectly. The spring ejects it with some force, and the fabric of the parachute has so much drag that it works all the time.

—John Reid
marsparachutes.com



The Mars Mini is a small package and is designed so that the parachute will clear the props. Inset: The Mars Mini in action.



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940 DJI[™] RONIN-M

945 DJI[™] PHANTOM 4

NEW RELEASES



RISE Vusion House Racer

Turn your home into an instant first-person-view flight course with this indoor FPV drone. It even has three flight modes: two gyro-assisted Stability modes for beginners and a Rate mode for more advanced maneuvers. The \$179.99 RTF version has everything you need, including a Tactic FPV-RM2 5.8GHz monitor, FPV-G1 goggles, and a RISE J2000 6-channel 2.4GHz radio system with Auto-Flip button and monitor holder. The \$79.99 FPV-ready version is compatible with virtually all FPV goggles and monitors on the market. Add indoor obstacles with the Vusion House Racer FPV Race Gate System (sold separately for \$39.99).
explore-rise.com

PRODUCT REVIEW

Lowepro QuadGuard BP X2

Everything any drone racer needs in one easy-to-carry package



One of the things that all drone racers have in common is that we all have a lot of stuff to bring to the race. Now, it is not a lot of big stuff, but there are a good number of small items that we need in the pits. I tried out a couple of different backpacks, but while they could hold most of my items, there was always something that could not make it inside and had to be carried by hand. Then I came across the Lowepro QuadGuard BP X2, a backpack purpose-built for drone racing. The QuadGuard fits well and is easy to trek some distance without feeling uncomfortable.

It has interior and exterior storage for two quads with their props on and a lot of interior storage for many of my fragile race gear. I was able to fit my transmitter, FPV goggles, a ton of batteries, tools, and even personal items (wallet and keys) in the many interior compartments, all of which are well padded and offer excellent protection. There is even a slide-out tool case, which holds all of my tools. Much of the inside is customizable to create a secure fit and let you optimize your pack layout. On the outside, there is room for at least one quad, but if you stack them, it is easy to get two of them on there. The side pockets can fit water bottles or a tripod or any other large items. In a zippered pocket at the bottom of the pack is an all-weather cover that can protect everything from the rain.

This backpack has served me well for some time now, and I am sure it will continue to do so for quite some time. If you are looking for a backpack to serve all your drone-racing needs, the Lowepro QuadGuard BP X2 is an excellent choice for \$149.95.—*John Reid*
lowepro.com



Aerodyne RC Nimbus 195

If, like us, you are constantly repairing your racing drone after it crashes, this new aircraft might be just the ticket. All of its electronics are safely protected inside its fully carbon-fiber, monocoque body, so it's practically crashproof! It's also fast—Aerodyne RC notes that the Nimbus 195 can reach speeds of 125mph. The Nimbus frame starts at \$190.00, and fully assembled and ready-to-fly versions are also available.

aerodyne-rc.com

Rotor Rage

Scheduled for broadcast in the United States on NBC Sports in 2017, Rotor Rage will bring together the world's top drone racers with cutting-edge technology. The first of six episodes of the 60-minute series, created by executive producer Marc Hayward, will see pilots' abilities pushed to their limits, reaching speeds of up to 100mph as they navigate circuits set in stunning locations outside of Los Angeles. The pilots will be challenged to navigate not only the natural landscape but also additional obstacles such as wind, fire, and smoke. Series producer James Capria says, "We're excited to be the first producers to incorporate drone racing into an entertainment format. We're also shooting in 360, so with an interactive VR headset, the viewer will be thrown into the pilot's seat and will experience flight in first-person view."



PRODUCT REVIEW

Vuzix iWear

A theater experience while racing

One of the most active areas in home entertainment is the world of virtual-reality video games. This new gaming technology has led to new video options for the drone-racing enthusiast. More goggle options are appearing on the marketplace every month, and one of the hottest ones out now is Vuzix iWear (\$499.99). This set of goggles offers some excellent features that will make your racing experience very enjoyable. The first is that the iWear has a very large field of view when compared to other goggles, coming in at a full 60 degrees. This is like watching a 125-inch screen from 10 feet away. Now looking at a large screen is great, but we need clarity and sharpness to make that a real value. These goggles deliver with a sharp HD image, along with 24-bit color. I noticed that the image was sharp from end to end, and this clarity gave me better control over the drone when flying.

When flying at 60–80mph, you also need latency that's as low as possible, and with goggles that are producing HD output, you might experience some delay. The manufacturer states that these goggles have zero latency, and I can say that I could not detect any latency; if there is any, it is very low and will not affect your flying.

These goggles are larger than my normal pair, but they conform to my face well and block out almost all light. They are easy to wear for a day of flying. My only issue is that, on a hot day, the ear covers start to get slightly uncomfortable. That's a reasonable tradeoff, however, for having a sharp digital image and a wide field of view that just isn't available in other goggles. If you are looking for the best view from the camera on your quad, pair the Vuzix iWear with the Connex ProSight and see the racecourse like never before.—John Reid

vuzix.com

**FIRST LOOK**

Amimon Falcore

A true drone racer for the newbie

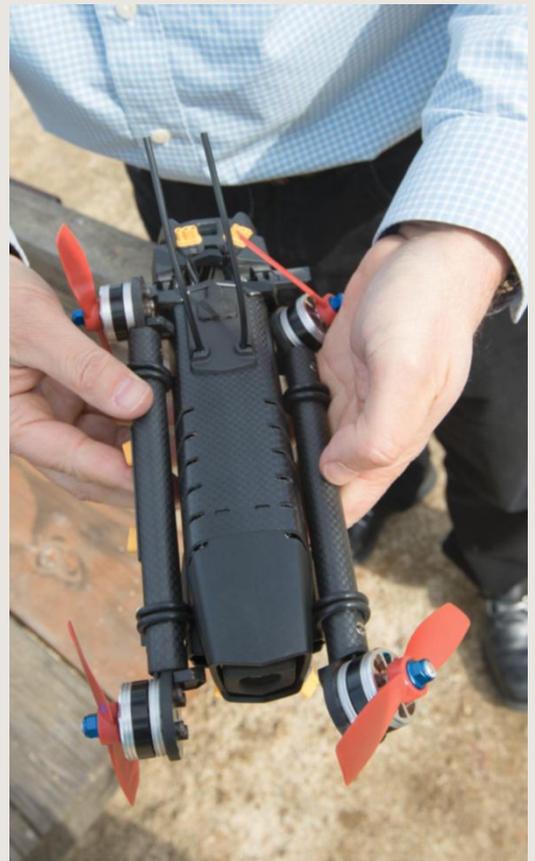
We heard about a new type of quad racer that was designed for new pilots looking to get into drone racing. In addition, this quad had a mode in which it would automatically fly 1 meter from the ground without crashing. When we found out it was made by the same company that designed the game-changing digital HD technology ProSight FPV transmission, we knew we had to check it out.

I met with Amimon's Senior Vice President Dave Scheffler in the company's California office to get a first look at the new Falcore drone racer. It's obvious that the Falcore is designed for new pilots. Its arms are easy to disassemble along with the antenna, so the racer can be packed in a very small bundle. The carbon-fiber tubular frame protects all the electronic components, and the flexible motor-arm joints are designed to come apart in the event of a high-speed impact, which protects the motors from damage. Assembly only takes a few minutes and requires no tools. The battery pack is designed to slide in and lock into place. From there, we slip on our goggles, flip the transmitter arm switch, and we are ready for flight.

The Falcore has three flying modes: Stabilized, Acro, and Shield. Stabilized mode keeps the drone level and allows the pilot to make any normal stick movement, Acro mode gives complete control to the pilot with no stabilization, and the patented Shield mode allows anyone to race from day one. Shield mode uses sonar and barometer sensors to automatically maintain flight altitude and coordinate turning to allow the pilot to use a single stick for flying.

After a brief visit at the office, Dave and I headed out to a park that had a few trees and other obstacles for us to fly around and through. The Shield mode system works incredibly well. I set the throttle up to full, and the Falcore lifted off and got about 3 feet high and locked in at that altitude. As the quad approached the hills, the ground sensors adjusted the flying height so that the quad remained at the same altitude over the changing terrain. There is a slight delay until the sensors pick up on the ground-height change, so when you are traveling forward at full speed, the Falcore will come close to the ground as the adjustments are made. I was extremely impressed by how well it flew. Even if you manage to hit the ground (which we did not) or hit a tree (I did manage to come close enough to scare some trees), all the gear is well protected and the motor arms are made to dislocate on impact. Priced at \$799.00, the Amimon Falcore comes with everything you need except goggles, and it looks like a great bird for new racers. I look forward to doing a full flight test on it in a future issue. —*John Reid*

amimon.com





IDRA Insurance for Racers

The International Drone Racing Association (IDRA), which last year signed a deal with ESPN to bring drone competitions to television, has announced that it will offer \$1 million in liability insurance to drone operators for training, competition, and recreational uses. IDRA CEO and founder Justin Haggerty notes, "It was clear that our first membership service should be a primary liability insurance to drone pilots around the world." The group has also started offering insurance to organizers of individual events, at a price of \$200 for a \$2 million liability policy. idra.co



MaxAmps LiHV+ FPV Race Edition Series

These high-voltage batteries will take your racer to the next level of power and performance! Engineered to hold a higher voltage under load during those high-amp draw spikes seen in FPV racing quads, this 1600mAh 4S 15.2V battery has 1mm-thick battery plates on its top and bottom for added protection from crashes. It costs \$69.99. maxamps.com



Hitec Phantom X4 Charger

If you fly a DJI Phantom 3 or 4 drone, this 4-channel battery charger will keep you airborne longer. The X4 will charge, storage-charge, and deep-cycle four Phantom 3 and 4 Smart Batteries simultaneously as well as charge two smart devices via USB ports. This sophisticated \$224.99 charger allows you to spend more time flying and less time waiting for batteries to charge.

hitecrad.com



PRODUCT REVIEW

Energen DroneMax

Energen, maker of portable power banks for mobile devices, has introduced the world's first portable drone charger: DroneMax. This charger is available in two versions: the P40 dedicated to DJI's Phantom 3 and 4, and the A40 Universal drone charger.

The DroneMax P40 is a large power bank for drones. It stores enough power to fully charge four Phantom 3 or Phantom 4 batteries, separately or at the same time. The unit is constructed out of aluminum, with two rubber handles on either side to make it easy to handle. The P40 comes with two sets of four charging cables for the aforementioned drones and a well-made carrying case that's molded to fit the P40 on the bottom, with a mesh, zippered pocket to store the charging cables and included shoulder strap. The controls are self-explanatory, but there is a well-written user manual included in the kit.

Using the DroneMax P40 is simple. Select the correct charging cables and plug them into the dedicated charging ports. Power on the unit and then plug the other end of the charging cable into the battery. To recharge the P40, simply use the DJI charger included with your drone. The unit uses the radio cable from that charger for connection, which makes sense considering that both the Phantom 3 and Phantom 4 use the same radio. The total time to fully recharge the P40 will depend on how many batteries you charge but if it is drained, it will require eight hours to fully recharge.

The DroneMax P40 is quiet and easy to use. At 6.7 pounds, it isn't light, but it sure beats carrying around a loud, smelly gas generator or using a possibly dangerous inverter to recharge your drone batteries. Final price has not been announced at the time of publication. Both DroneMax chargers will be available directly from Energen, and the company plans to add additional cables for all the recently announced drone products. —Kevin McCarthy

myenergen.com





Kespry Drone 2

Enhancements including higher performance and GPS capabilities make the Kespry Drone 2 ideal for an even broader range of commercial and industrial applications, including survey-grade uses in sectors such as mining, architecture, engineering, and construction. It is also available as the Kespry Drone 2s when paired with Kespry's additional high-performance ground receiver, which serves as a single ground-control point. Pricing available from Kespry.

kespry.com

Yuneec H920 Plus

Engineered for use in engineering/architecture, broadcast, law-enforcement, and inspections spaces, this updated drone has multiple modes (Waypoints, Orbit Me, Follow/Watch Me, Point of Interest, Journey, Smart, Curve Cable Cam, Angle, and Home); a refined ST10 Pro Ground Station; a CG04 camera with advanced settings; quick-disconnect propellers; a ProAction Grip handle, which extends the CG04 camera from sky to ground; and more. Price not yet available.

yuneec.com



PRODUCT REVIEW

Blade Quad Racer Tool Set

If you are racing quads, you will most likely want this tool kit. Housed in a nice canvas zippered pouch, which can easily fit into any toolbox or drone backpack, it has just about every tool needed to maintain or fine-tune drone racers. I like that all the tools are first-rate and made from good-quality steel.

There are five handle tools: 1.5mm, 2.0mm, and 2.5mm hex drivers, along with

5.5mm and 8mm nut drivers. The sizes are clearly stamped on the handles

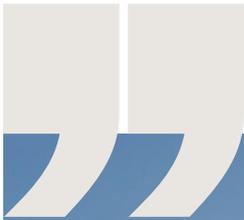
in large, easy-to-read letters; in addition, all the tips are replaceable and can quickly be removed by a single setscrew.

The motor holder prop installation tool looks like a pair of pliers and allows for a firm grip on the motor to keep them from spinning when replacing props—no more cut fingers. A stainless-steel stamped wrench should accommodate nuts of most sizes on the quad, starting with a 4mm opening, then 5mm, 5.5mm, 6mm, 7mm, 8mm, and finally 10mm openings. The last tool is an easy-to-assemble and compact prop balancer, with adjustable feet to level it out on any surface. If you are looking for that extra bit of speed to get you through the gates faster, you will be using this tool. Balanced props are more efficient and help the quad fly smoothly. All of these tools are well strapped in the transport pouch and will not fall out. At \$76.99, this pack offers a lot of tools, and they are the ones every drone racer will use.—*John Reid*
bladehelis.com





THE CAMERA HAS A MECHANICAL SHUTTER, ELIMINATING THE ROLLING-SHUTTER EFFECT SO OFTEN SEEN IN DRONE VIDEOS, AND IT CAN RECORD 4K VIDEO AT A MAXIMUM OF 60 FRAMES PER SECOND.



PRODUCT REVIEW

DJI Phantom 4 Professional

Commercial-quality camera drone

With more professional photographers and videographers adding drones to their tool kits, it is no surprise that DJI released an affordable drone with features designed specifically for professional photographers and videographers. That drone is the Phantom 4 Professional.

An extensive overhaul of the popular Phantom 4, the Professional has an all-new collision-avoidance system, with five directions of protection using dedicated forward-, backward-, left-, right-, and downward-facing sensors. DJI also included new automatic flight modes, such as Active Track Profile mode, Terrain Follow mode, and Tripod mode.

There's also a new high-capacity battery that provides 30 minutes of flight time.

All these features are significant but not nearly as significant as the all-new camera. For some time now, professional photographers have been calling for a more usable camera. DJI has granted their request by including a 20.1MP, 1-inch CMOS sensor on the Phantom 4 Professional. The camera has a mechanical shutter, eliminating the rolling-shutter effect so often seen in drone videos, and it can record 4K video at a maximum of 60 frames per second. But wait—there's more! Video can be recorded in either H.264 or H.265 codec, with the H.265 codec offering a production-ready bitrate of 100Mbps!

DJI also decided to include a second version of the Phantom 4 Professional: the Professional Plus. For an additional \$300.00, the Pro Plus comes with a custom 5.5-inch screen with 1080p resolution and 1000 cd/m2 brightness for easy viewing in direct sunlight. Also included are an HDMI port, a micro SD card slot, a microphone, a speaker, USB ports, and a rechargeable battery with five hours of use.

With a new camera, added collision-avoidance sensors, and new flight modes, DJI also decided to release a separate app to be used specifically with the Phantom 4 Pro, Inspire 2, and Mavic Pro. There has been no official explanation offered for the release of this separate app, called DJI GO 4, but it is safe to assume that the company needed to make significant changes to allow for the added sensors and new flight modes.

The DJI Phantom 4 Professional is worthy of its name, and now, with the option of adding a dedicated display direct from the manufacturer, DJI has finally given the industry its first ready-to-fly out-of-the-box solution. The Phantom 4 Pro retails for \$1,499.00 and the Pro Plus for \$1,799.00.—Kevin McCarthy

dji.com





PRODUCT REVIEW

FLIR Duo

Thermal imaging for all

Above: Autel Robotics' famously orange line of X-Star quadcopters will receive the first of several planned camera upgrades in 2017, with the introduction of a fully integrated FLIR Duo in Q1. This will make the manufacturer the first to incorporate the new camera into its systems.

Below: The aptly named FLIR Duo incorporates two cameras: a Lepton thermal-imaging sensor as well as a HD visible-light camera. The output from both cameras is recorded simultaneously on the included micro SD card, regardless of which output is selected as the video download.

FROM PUBLIC SAFETY TO INDUSTRIAL INSPECTION and from livestock management to scientific research, few technologies add more to the capabilities of rotor drones than thermal imaging: the ability to see heat and discern the relative temperature of objects in the environment. Only two hurdles have stood in the way of widespread adoption of this capability: expense and ease of integration.

That is why I got so excited last year when I saw a prototype for the Duo, a new camera FLIR was developing. The size and shape of a GoPro, the Duo even had the same controls in the same locations as the ubiquitous sports camera. It could be easily integrated into any drone with a GoPro gimbal.

The Duo promised that if you could get a video downlink from a GoPro, you could add a thermal-imaging capability to your drone for \$999.00, a fraction of the cost of any existing system. Of course, the Duo was still months away from its debut, and I was sworn to secrecy. With its release at CES in January, however, the secret is out, and we can now tell you all about it.

Double Vision

The Duo gets its name from the fact that it incorporates two separate cameras: a thermal-

imaging sensor and an HD video camera. Video from both cameras is recorded simultaneously on the included micro SD card, and you can choose to display the thermal image or the visible-light image full screen or use the picture-in-picture option, which allows you to see both simultaneously.

You can also combine the two using FLIR's patented MSX technology. At least for the foreseeable future, thermal cameras are always going to be low resolution when compared with their visible-light counterparts, owing to the physics behind thermal imaging. The wavelengths of thermal photons are longer than visible-light photons, which means that the pixels on the sensors need to be larger to capture them. Larger pixels mean fewer pixels on comparably sized sensors and, thus, lower resolution. The Lepton sensor inside the Duo is 160x120 pixels and captures video at a rate of 9 frames per second.

MSX partially compensates for this. In real time, the microprocessor inside the Duo runs an edge-detection algorithm on the visible-light image and superimposes those edges on the thermal image, making it easier to recognize familiar shapes, such as buildings, cars, and people. This only works, of course, when the visible-light camera is able to capture imagery. If you're flying at night or in other low-light environments, MSX isn't going to function and you'll be relying exclusively on the thermal-imaging system.

Know Your Limitations

The Duo performs well when operating close to its subject, seeking to identify the thermal signature of a phenomenon that affects an area. A prime example is roof inspection,



where the Duo could be used to diagnose a number of problems more quickly and safely than using conventional techniques. Instead of climbing up on top of a building to examine a roof visually or to use a handheld thermal-imaging camera—risking a potentially deadly fall in the process—the inspector can launch a drone equipped with a Duo. A leak will be immediately evident because the water-soaked materials under the surface of the roof will absorb and release heat at a rate different from the surrounding material—a fact that will be reflected in the surface temperature of the shingles and plain to see on the thermal video coming down from the drone. Likewise, areas where the insulation is inadequate will also be apparent as heat escaping from the structure warms that portion of the roof.

The Duo has limitations as well. Although it looks very similar to a GoPro, has its Record and Bluetooth Enable buttons in the same location as a GoPro, and even accepts power and outputs video through the same type of micro USB connector as a GoPro, it does not have an internal battery like a GoPro, so it will not operate unless connected to an external power source.

The Duo does accept two PWM inputs, allowing you to connect it to the control receiver onboard your drone and make adjustments to the camera in flight using switches on your radio. All of the parameters can also be adjusted prior to takeoff using the FLIR sUAS app, available as a free download for both Android and iOS devices.

—Patrick Sherman

“
THE DUO GETS ITS NAME FROM THE FACT THAT IT INCORPORATES TWO SEPARATE CAMERAS: A THERMAL-IMAGING SENSOR AND AN HD VIDEO CAMERA.
 ”



Drone World Inspire 2 Case

This durable, waterproof, wheeled case has an ultratough base foam with strong white foam topper. It has room for the Inspire 2 in Fly mode along with an X4 or 5S camera installed, two remotes, four SSD drives, an SSD reader, and 10 batteries. In addition, there's a cutout for the new remote DJI focus wheel, extra space for accessories, and a miscellaneous space with a fitted lid cover. This case costs \$549.00. drone-world.com



With the FLIR Duo being officially launched at CES 2017 in Las Vegas, Nevada, the famous sign welcoming visitors to the city proved to be an irresistible subject for testing the new camera's capabilities. Notice that, with MSX enabled, the edges around the lettering on the sign and the sign itself are highlighted, making it easier to recognize the familiar landmark.



WhiteHot

HotMetal

Rainbow

The FLIR Duo includes three color palettes from which the user can select, determining how hot and cold objects within its field of view are rendered: WhiteHot, HotMetal (also known as IronBow on other FLIR thermal cameras), and Rainbow.



ReadyAction Office

This harness positions your tablet open, at any angle, for hands-free viewing and data input. It then conveniently locks in the closed position, against your chest, out of the way for mobility! The \$79.99 harness is ideal for drone operation because you don't need to add the tablet to your controller, which results in hand and arm fatigue, might block the view of the controller, and could potentially interfere with the antenna.

readyactiongo.com


PRODUCT REVIEW

Kodak Pixpro 360 4K

A virtual-reality camera takes flight

VIRTUAL REALITY (VR) HAS EXPLODED OVER THE LAST SEVERAL YEARS, and it is now possible to view 360-degree images on YouTube and Facebook, not to mention via several apps for your smartphone. Add the dimension of aerial VR and suddenly you open up a whole new world of airborne exploration! Priced at \$899.00, the Kodak Pixpro 360 4K Dual Pro Pack mounts the cameras

back to back for a full 360x360 view. There are many options of camera settings, including two modes of HD resolutions, frame rates, field of view, and VR modes.

Pairing the cameras to the remote is easy: Just navigate the menu to get to the pairing page and follow the prompts, and be sure to pair the cameras on the same frequency. The remote control can turn on both cameras simultaneously so that you end up with two shots of the same length to stitch.

Image Stitching

Kodak's Pixpro 360 4K stitching program is designed to give you one stitch to deal with in post. A "stitch" is literally what it sounds like: joining two overlapping images to form one seamless 360-degree image. With two opposite-facing cameras, both shooting 235-degree fields of view, there will be some overlap. Why not use two 180-degree fields of view? As Kevin Cruz of JK Imaging explains, "With two 180-degree cameras, theoretically you'd have a perfect stitch, but you had better be pixel-accurate with that stitch or you will be off. Now add a little to each camera and you have more overlap, more adjustment for an accurate stitch."

After you load both micro SD cards into your computer, you can insert video files into the Pixpro 360 stitching program. Drag and drop a video file from the Camera A folder to the midsection of the program and it will appear on top; repeat the process with the video file from Camera B. At this point, you get some metadata about your files, the resolution they were shot at, and their frame rate. The program will do a preliminary stitch of the two images, which, more often than not, is an excellent start. Depending on whether your cameras were side by side or up and down, the stitch line will be vertical or horizontal, respectively.

You now have your preliminary stitched shot in the main window of the program. Find the stitch where the two images come together and look for differences in the



KODAK AND JK IMAGING HAVE COME UP WITH A COMPLETE START-TO-FINISH SYSTEM, WHERE YOU CAN SHOOT AND EDIT TO COMPLETION WITH ONLY ONE STITCH TO WORK WITH.

corresponding images. Where can they look more uniform? Where do shadows appear when the corresponding image has none? Once you've found the stitch line, take your cursor and drag the image side to side and examine the entire image for flaws. Depending on how you planned your shot, you might need some additional calibration or none at all.

For additional fine-tuning, hit the Calibration button and up pops a new window displaying the separate shots next to each other with a set of controls underneath. You can control each connecting image by rolling it side to side (Roll), lifting it up and down (Distance), or panning/tilting it if needed. JK Imaging recommends fine-tuning first with Roll and Distance and only using the pan and tilt if all else fails. You can also make your stitch look a little smoother or sharper by hitting the Effect tab and tweaking sharpness, brightness, contrast, and color saturation. When all fine-tuning is completed to your satisfaction, hit OK to apply your tweaks.

Under the main stitched-image window is a trimmer that will shorten the original shot to start and end where you prefer. Experiment with the clippers by dragging them back and forth and viewing the image to adjust to a more desirable position in the shot. You can check frame-by-frame sync accuracy by unlocking the square padlock tab and highlighting each frame of each shot.

When you've finished all your tweaking and trimming, hit the Export tab on the main window. You can now browse your computer for the terabytes of storage you'll need to store these stitched 4K 360-degree shots. You can also choose the output resolution size and what camera audio track to accompany it (or uncheck the audio box for a future layover soundtrack). Finally, you can check an Upload to Social Network box and choose between YouTube and Facebook.

The Takeaway

I can't stress this enough: Less is more when shooting VR. Just look at random samples of 360-degree shots on YouTube or any VR smartphone app. In good VR, the camera almost never moves. Kodak and JK Imaging have come up with a complete start-to-finish system, where you can shoot and edit to completion with only one stitch to work with. Although my drone configuration is top and bottom, I can't help but want to experiment with a 3D-printed underslung camera mount to try back-to-back cameras and see what that gives me. So what are you waiting for? You can now fly your own virtual reality!

—David Tolsky

kodakpixpro.com



ZeroTech Dobby

You can fly this pocket-size, foldable drone using an app on your mobile device! Dobby's integrated camera has three-axis image stabilization, and the drone features gesture control, professional target tracking, and 10s short video. The app interface tracks the drone's location, connectivity, and battery status as well as camera settings. The Dobby costs \$399.00.

zerotech.com





The Eachine Goggles One from Banggood offer robust HD FPV capabilities for a budget price, but sleek industrial design is not one of them. It's how they look on the inside that matters, however.

PRODUCT REVIEW

Eachine Goggles One

AS HIGH-DEFINITION VIDEO DOWNLINKS have become more common from drone manufacturers, makers of video goggles have taken notice and begun to provide new HD display options. One unlikely and surprisingly capable entry in this category comes from the Chinese-based bargain-

technology website Banggood: the Eachine Goggles One.

While the Goggles One won't be winning any awards for their sleek appearance—they resemble nothing so much as a black shoebox strapped to your face—at a cost of just \$150 for a full 1080p display with an integrated 5.8GHz analog video receiver, they clearly deserve a look from anyone who is interested in flying in HD.

Up in the Air

Flying first-person view (FPV) using an HD display is a transformative experience—especially with the Goggles One 5-inch display, made to appear all the larger by means of a fixed Fresnel lens. Saying, "It feels like I'm flying" is a common sentiment among FPV pilots, but these goggles take it to the next level.

The impression you get is of sitting in a large movie theater—maybe a few rows closer to the screen than you might like—watching a clear, vivid aerial out of the latest Hollywood blockbuster, except that you control where it goes next. While engrossing, there are a few crucial points you need to keep in mind while using this product.

For one, most of the HD video-transmission systems that are currently available entail some small degree of latency: a brief lag between when the camera onboard your drone captures an image of the environment and when you see it on your display. That means that the tree you see coming up fast in your goggles is the tree you have already

WHATEVER YOU FLY. WHEREVER YOU FLY. AMA HAS YOU COVERED.

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hit in real life. So avoid proximity flying.

Also, make sure that you have a visual observer to keep any eye on your drone and the surrounding airspace. Your view of the outside world is totally obscured by the Goggles One, so you'll want to have another person available to alert you to any manned aircraft or other unseen hazards that appear while you're flying.

Thinking inside the Box

The Goggles One arrive with everything you need to put them into service immediately: the goggles themselves, a linear polarized 5.8GHz antenna, USB and HDMI cables, a battery, and even damp wipes for cleaning the screen. For the experienced FPV pilot, the included antenna will likely be set aside immediately in favor of a circular polarized model to improve reception.

The battery is a stand-out accessory for these goggles. While it is interchangeable with the ubiquitous 7.4V Fat Shark battery, it incorporates several useful features. First, it can be charged from any USB power source, such as your computer, using the included cable by means of a built-in micro-USB port. Second, it includes a series of blue LED lights and a push button you can use to check the charge state of the battery. For anyone who has ever sorted through a pile of batteries, attempting to divine which are fully charged, depleted, or somewhere in between, this is an especially welcome addition.

Seek and Ye Shall Find

For their many virtues, the Goggles One have a couple of quirks that detract from their overall usefulness. The surprisingly bright and vivid 1080p display, for example, manifests an issue with overscanning when receiving a 720p video source. If you're getting your video from the DJI GO app, this can lead to the telemetry display across the top and bottom of the screen being clipped out.

Also, the 5.8GHz receiver gives you access to the A, B, E, and F bands as well as RaceBand, but it provides only one button for tuning. Like the "seek" button on your car stereo, you press it and the goggles find the next channel with a signal on it; however, there is no display to tell you which frequency you're on, which can make finding your own aircraft in a crowded field a hit-and-miss process.

Still, especially for \$150, the Goggles One puts together a remarkable collection of features that make it a solid choice for pilots interested in trying out HD FPV flying.

—Patrick Sherman



The Goggles One comes complete with everything you need to start flying immediately, including a battery, USB and HDMI cables, and even wipes to clean the screen.



The battery that comes with the Eachine Goggles One incorporates some of its most innovative features, including a micro USB port for charging from any USB power source as well as a handy "fuel gauge" for determining the battery's charge state.



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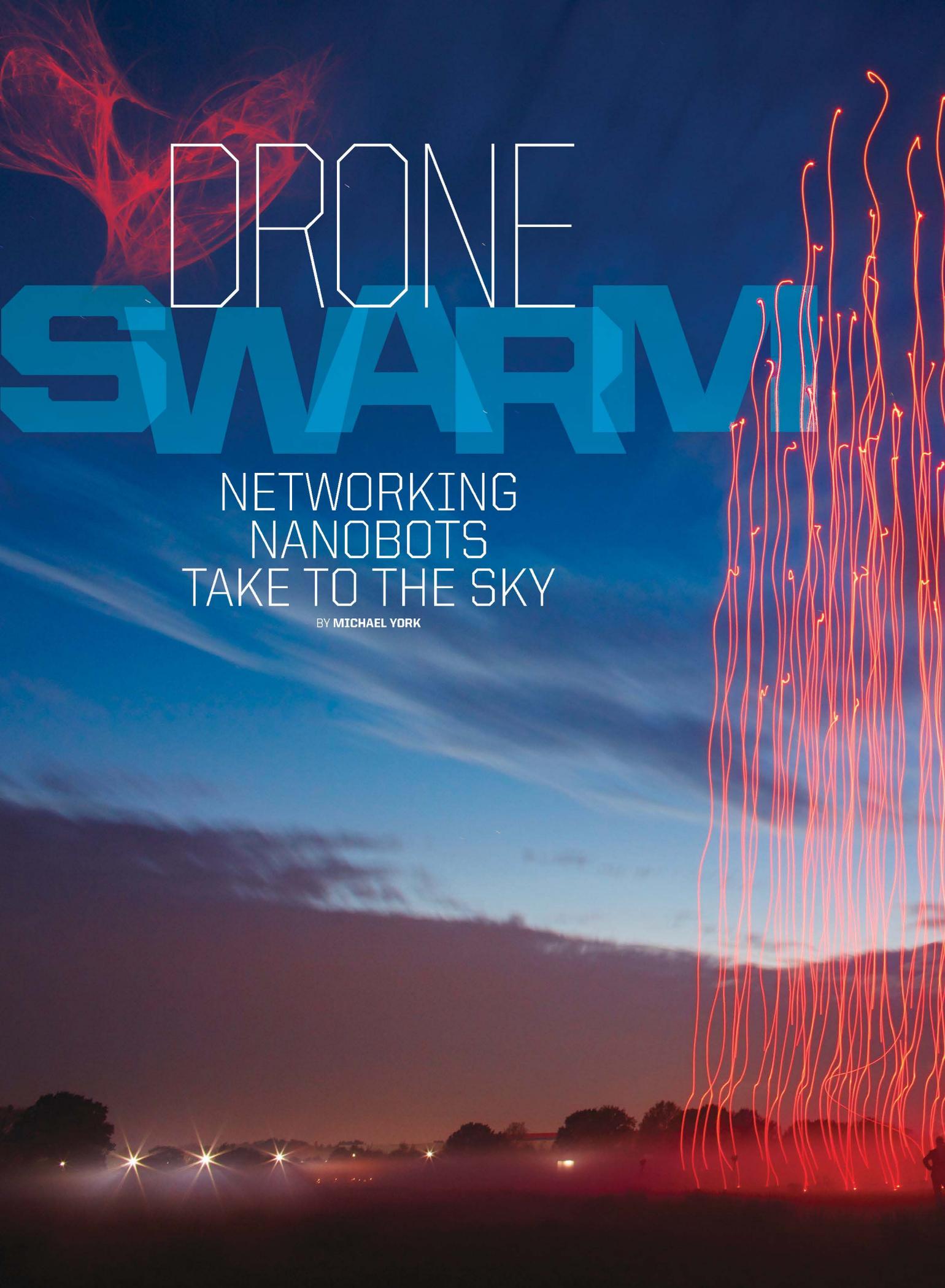


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DRONE SWARM

NETWORKING
NANOBOTS
TAKE TO THE SKY

BY MICHAEL YORK



The word “swarm” conjures up images of thousands of bees getting ready to launch an attack to protect their hive. Add the word “drone” and that image turns into something from a sci-fi horror flick. That same combination, however, is actually the very thing that’s starting to change people’s perception about drones. If you’ve seen an aerial drone show in person or online, it’s obvious that a swarm of autonomous flying robots is not ominous. In fact, it’s just the opposite. The rapidly advancing technology is allowing for a whole new era of art in the sky.

So what exactly is a swarm? It’s basically a large group of individual things moving together as a unit. In nature, swarms come in many different forms. One of the most mesmerizing sights is that of a flock of starlings creating surrealistic shapes in the twilight sky (look up “murmuration” on the Internet if you’ve never witnessed it). Schools of fish behave in a similar fashion. And although we don’t think about it much, we humans swarm all the time: on the drive to work, at the store, or anytime we’re dealing with crowds.

Researchers and engineers have been working hard to replicate swarm behavior in the robotics world, and there are endless possibilities for its use. What most don’t realize is just how difficult it is to replicate this subconscious behavior in a digital/mechanical fashion. It takes remarkable processing power to perform even simple autonomous synchronized flight between a dozen drones. Extrapolate that to hundreds—or thousands—and you can imagine the hurdle that needs to be cleared. Luckily, technology in computing power is advancing at a rate that makes it possible for hundreds of drones to fly together autonomously. Ten years ago, it was an amazing feat to see a just a few nano quads flying through suspended rings or other obstacles, aided by motion capture. Today, hundreds of autonomous lighted multirotors perform dynamic art shows in the night skies around the world.

The night sky provides a stunning canvas on which to exhibit three-dimensional drone art. These autonomous drones have started to gain tremendous popularity due to dynamic performances like these. (Photo courtesy of Intel)

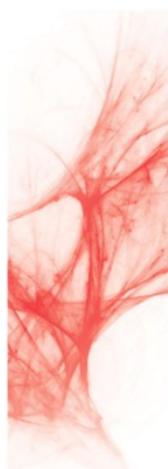
DRONE SWARM

HOW IT WORKS

A little more than five years ago, researchers at the GRASP (General Robotics, Automation, Sensing, and Perception) Lab at the University of Pennsylvania made remarkable strides getting tiny drones to start flying with autonomy, thanks to the addition of onboard cameras and proximity sensors. Another big step toward having these little flying robots do it all by themselves was the decentralization of commands. A centralized program structure relies on a single drone to provide all information, such as the entire area map and obstacles that need avoiding, to each individual member of the group. This is a lot of information to pass along and can cause delays due to bandwidth limits. Also if something happens to the lead bot, the entire swarm is in trouble because they are relying on that one drone for the data.

In a decentralized system, each drone communicates with its immediate neighbor in a network style, which is faster because there is less data being passed along and it creates a more dynamic operation. This is similar to the way you move within a crowd: You pay attention to your immediate surrounding neighbors rather than to each and every person in the group. You don't necessarily see obstacles in advance, but as they appear your "proximity sensors" tell you to move as necessary to avoid a collision with the obstacle and the persons around you, and they, in turn, do the same. This behavior also allows individuals to join or leave the crowd without greatly affecting the overall flow. To look at it another way, let's say that 20 first graders are told to stand an arm's width apart from each other and make a circle. The circle is formed without them really needing to know the exact spot where each person is going to stand. Just knowing the intended shape and distance from their classmate is enough to make this simple shape. If a student is added or subtracted, the size of the circle will adjust, again without having to tell anyone the actual dimensions needed to compensate for the addition or subtraction. This is obviously a simplified example, but you get the idea. This is a seemingly simple task

TECHNOLOGICAL ADVANCEMENTS TEND TO BE EXPONENTIAL, SO WHAT SEEMS DIFFICULT OR IMPOSSIBLE TODAY WILL BE RUDIMENTARY IN THE NOT-TOO-DISTANT FUTURE.



A swarm containing thousands of starlings is one of nature's most mesmeric avian performances, something engineers someday hope to reproduce with drones.

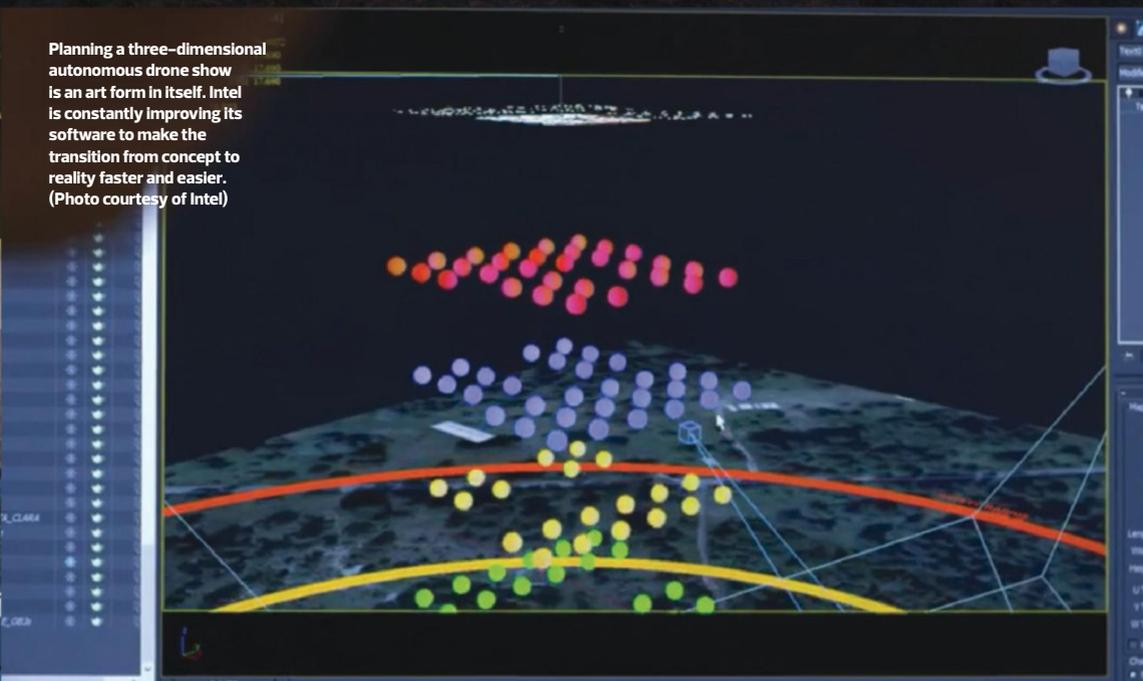




On the evening of November 4, 2015, one hundred lighted drones eagerly await nightfall to take a record-breaking flight over Tornesch, Germany. (Photo courtesy of Intel)



Ars Electronica Futurelab engineers and Intel are hard at work performing a final systems check prior to their Guinness World Record "Drone 100" flight. (Photo courtesy of Intel)



Planning a three-dimensional autonomous drone show is an art form in itself. Intel is constantly improving its software to make the transition from concept to reality faster and easier. (Photo courtesy of Intel)

DRONE SWARM

LADY GAGA'S HALFTIME LIGHT SHOW... WITH DRONES

It did not take long for the rumors to start flying a few days before Super Bowl LI, when Lady Gaga hinted at what her halftime show would be about. Actually, it was her rooftop warm-up before her indoor show on 50-yard line that included the word "drone." And what a light show that turned out to be.

The sky above the stadium roof at the Super Bowl was lit up by Intel's Shooting Star drones (300 of them, to be exact) in a choreographed aerial light show that was as amazing to watch as it was to actually execute. Perhaps the most amazing thing of all is the fact that only one pilot with one computer controlled the entire swarm of light-emitting drones. (There is, of course, always a second pilot and computer on hand as a backup.)

The software and animation interface on the Intel Shooting Star drone system allows a light show to be created in a matter of a few days or weeks depending on how complex the show's animation has to be. Intel's control programs use proprietary algorithms to automate the creation process. The programs use reference images to calculate the number of drones required, while also determining where each drone should be placed, to formulate the fastest paths needed to create the various images in the sky. The



Intel Shooting Star drones are designed specifically for light shows and weigh only 280 grams—less than the weight of a volleyball. They feature built-in LED lights that can create over four billion color combinations. The Intel Shooting Star drones are constructed with a soft frame made out of flexible plastics and foam containing no screws, and the drones can perform for up to 20 minutes.

This was the highest the Intel Shooting Star drones have ever flown, and Intel received a special waiver from the FAA to fly their fleet up to an altitude of 700 feet. Intel also received an additional special waiver to fly the drones in the more restrictive class B airspace. This was also a record-breaking event as this was the first time that drones have been used during a televised event and to complement an entertainment event of this scale.—Gerry Yarrish

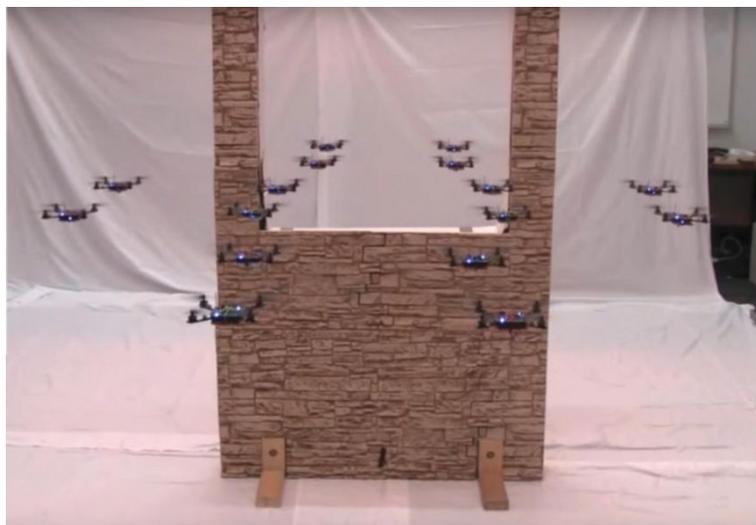
for us humans, but onboard computers acting as the drones' brain have to perform hundreds of calculations per second; this has certainly been a limiting factor in just how many of them can be safely flown at one time. Technological advancements tend to be exponential, so what seems difficult or impossible today will be rudimentary in the not-too-distant future.

INTEL'S SWARMING DRONES

In the past few years, Intel has been making headlines with its own drone-swarm efforts. In 2015, a talented team of engineers from Ars Electronica Futurelab and Intel successfully broke the Guinness World Record by getting 100 drones to fly in an autonomous aerial display over an airfield in Germany, with an orchestra adding a fitting soundtrack. They called this the "Drone 100," and a few months later, they re-created this feat over the desert in Palm Springs, California, to prove drone safety to the FAA. The first public display was performed in the night skies over the harbor in Sydney, Australia, with the Sydney Youth Orchestra providing musical accompaniment. Less than a year after the initial 100 took off, the team broke their own record by performing the Drone 500. Yep, you guessed it: They flew 500 drones. Although it might not seem like a big difference, it is a tremendous leap in less than a year. Improved algorithms and hardware led to an effective increase of the resolution



Who needs cranes or scaffolding when you can use a group of autonomous drones to create buildings? Here, multirotors from ETH Zürich build a nearly 20-foot-high brick wall.



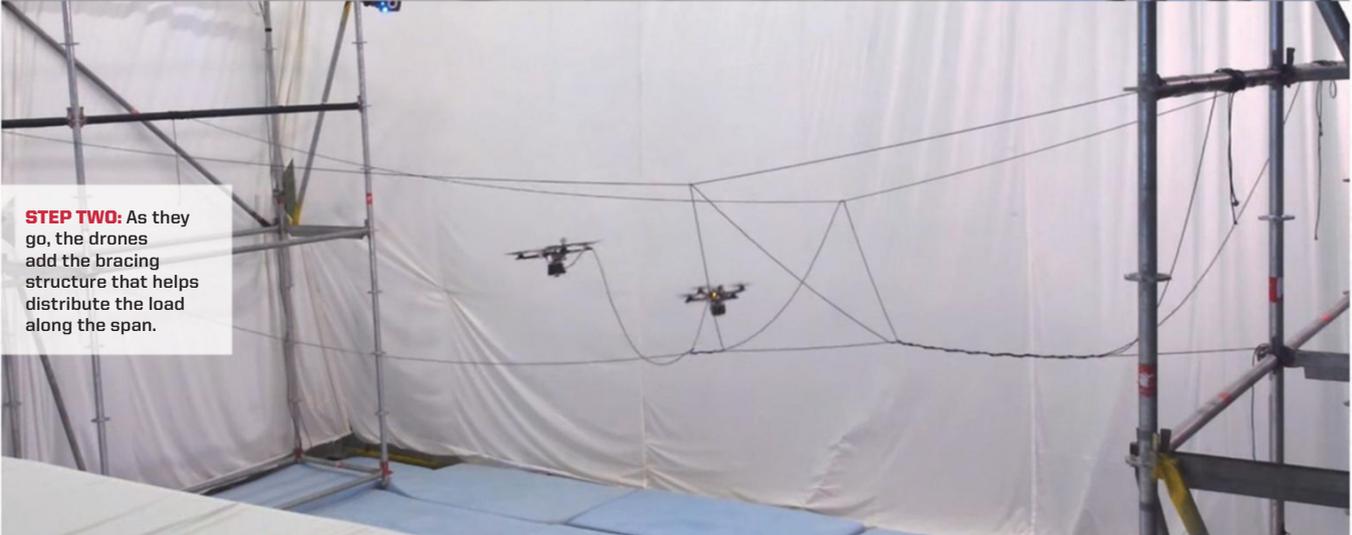
Just like a group of people exiting a door, autonomous quadcopters can reconfigure their formation to allow them to pass through openings. Here is an early example from the GRASP Lab at the University of Pennsylvania.

BRIDGING THE GAP

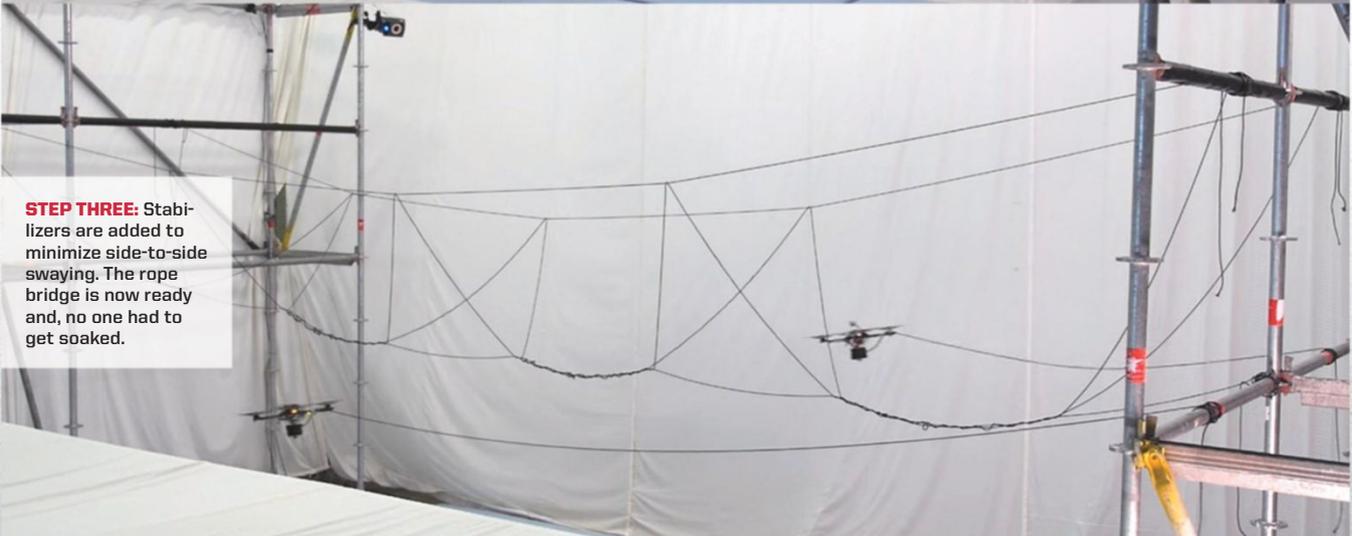
In the past, if you needed to build a rope bridge over a river, somebody had to get wet crossing to the other side in order to anchor the rope. In the not-too-distant future, you'll just unpack a few drones and they'll do all the work for you. A team from ETH Zürich's Institute for Dynamic Systems and Control shows how it's done.



STEP ONE: The quadcopters anchor primary lines on both sides of the gap, then braid additional rope to reinforce the lower line.



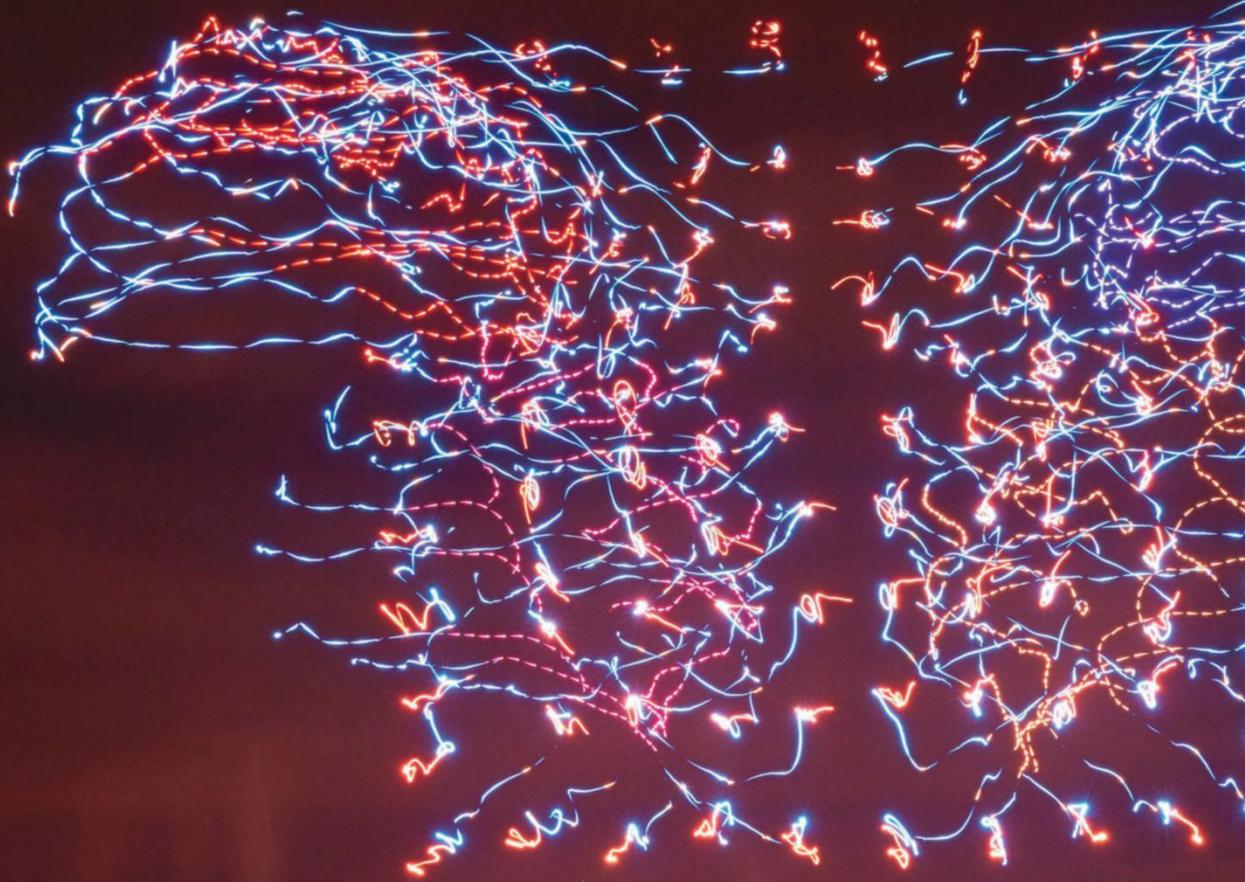
STEP TWO: As they go, the drones add the bracing structure that helps distribute the load along the span.



STEP THREE: Stabilizers are added to minimize side-to-side swaying. The rope bridge is now ready and, no one had to get soaked.

DRONE SWARM

The past and future of entertainment is melding. Here, a hundred autonomous drones dance in the night sky to the classically themed soundtrack performed by a live orchestra. (Photo courtesy of Intel)





on their sky canvas, allowing them to choreograph a very elaborate 3D light show. The computer programs that helped transform the multidimensional sketches in the designers' minds into digital flight instructions for the drones progressed as well. What used to take months can now be done in weeks. Intel has also procured special FAA waivers that allow all the drones to fly using only one pilot, who monitors the ground computer as the drones perform their routine.

Each space pixel (or "spaxel," as Intel calls it) consists of a quadcopter called a "Shooting Star," which Intel designed specifically for use in aerial light shows. This lightweight, roughly 15-inch-diameter drone is weather resistant and made almost entirely out of soft materials, with caged propellers to ensure safety in public displays. Adorned with LED lights that can produce four billion color combinations, the drones give the show's designers a nearly endless palette with which to work.

ADORNED WITH LED LIGHTS THAT CAN PRODUCE FOUR BILLION COLOR COMBINATIONS, THE DRONES GIVE THE SHOW'S DESIGNERS A NEARLY ENDLESS PALETTE WITH WHICH TO WORK.



THE FUTURE

At this point, we are at the very beginning of what I believe could become a whole new form of entertainment. The popularity of displays like Disney's "Starbright Holidays" drone show is merely a hint of what is to come. While it's hard to argue against the visceral effect of a good pyrotechnic show, hundreds of drones performing a synchronized aerial spectacle in the night sky is also hard to beat. As "resolution" improves, so will the complexities of the shows.

But entertainment isn't the only place that will benefit from this technology. We've all seen the humorous depiction of what package delivery by a swarm of drones might look like, but it might very well be part of our future. Technology we used to laugh about is now something we can't live without. People laughed at Motorola's Bag Phones, which fit in a soft briefcase but allowed you to make calls while on the road. Those things will never progress beyond being a novelty item...right?

Then there is the humanitarian side. Search and rescue is one area that will benefit immensely by the use of drone swarms. Imagine the sheer area that a large group of camera-equipped multirotor bots could cover when searching for lost individuals in difficult terrain. Or inversely, a group of tiny drones could search for victims in damaged buildings that humans or search dogs might not be able to access safely.

Infrastructure will surely be another benefactor of these potential workhorses. The same benefit of large-area scanning that will benefit rescue missions can also be used to map terrain in both 2D and 3D. Autonomous drones have already been used to build mock structures out of bricks and other building materials. Imagine a group of drones building a shelter in areas that might be difficult to access via ground transportation. They could be used not only to fly supplies into position but also to build the structure itself. A group of flying cranes could also run cables across a gorge to help build a suspension-type bridge.

As you can see, a swarm of drones does not have to relay a negative connotation. Some of the greatest technological inventions had to overcome public-opinion issues, but once they took off (so to speak), people became accepting of and even reliant on them. I'm sure future generations will look back at this moment the same way we now reminisce about the time before smartphones. ✨

DJI Inspire 2

A proven design gets bigger, faster, and even better!

BY JOHN REID PHOTOS BY DK BARRETT



When DJI comes out with something new, it always makes news, and its new Inspire 2 is the hot ticket right now. Improving on a well-built and tested design, the Inspire 2 is a little bigger and faster than its predecessor. We tested out the package that came with the Zenmuse X5S and two transmitters.

HIGHLIGHTS

The Inspire 2 comes in a nice case that holds everything you need for a successful flight: the Inspire, two transmitters, a Zenmuse X5S camera and case, up to four batteries, a charger, and extra props. Setup only involves starting the transmitters, installing the two battery packs (one of the updates is that the Inspire 2 uses two flight batteries), pressing the start button five times to get the quad from storage configuration to landing configuration, and finally attaching the X5S camera and props.

One of its new features is an obstacle-avoidance system that can



1 / LOW RIDER The landing configuration has just enough room for the camera to clear the ground.

2 / BATTERY PACKED Twin battery packs now provide more flight time and redundancy.



This small camera does the job of many larger production cameras, and it has a dynamic range of 12.8 stops, great for postproduction.

Zenmuse X5S When shooting video, the camera is king, and the Zenmuse X5S is right up there with some of the best. It is very compact but still able to produce some impressive stats. It has a micro 4/3 sensor and mount that can support up to eight professional lens from different manufacturers. It can shoot 5.2K video at 30fps and 4K video at 60fps, plus up to 20.8 megapixel stills. It has the ability to shoot in fast and efficient workflows, such as H.264/265, CinemaDNG, and Apple ProRes. Add to all that its enhanced camera stabilization and you end up with some really amazing image quality in both the video and photo production.

detect obstacles up to 30 meters ahead, which means protection at up to 35mph. I can say that, from our flight, this works quite well. The Inspire 2 also has much larger motors and props to lift the larger overall bird, and it has a top speed of 58mph in Sport mode. Recorded video can now be stored simultaneously on the DJI Cinessd, inside the fuselage between the batteries, and an easily accessible micro SD card.

Some of the flight-program improvements include Spotlight Pro, which allows a single pilot to capture complex images that used to require a dedicated camera operator. When flying by myself, I found this feature to be very helpful. TapFly uses the onboard FPV camera to show a separate view from the main camera; just tap the route for the Inspire to fly and you can concentrate on the main camera. ActiveTrack programs the Inspire to follow objects moving through the environment while keeping them in frame.



ONE OF THE NEW FEATURES IS AN OBSTACLE-AVOIDANCE SYSTEM THAT CAN DETECT OBSTACLES UP TO 30 METERS AHEAD, WHICH MEANS PROTECTION AT UP TO 35MPH.

AT A GLANCE

**MODEL**

Inspire 2

**MANUFACTURER**

DJI (dji.com)

**TYPE**

Pro camera rig

**SIZE**

605mm

**ASSEMBLY TIME**

5 minutes

**FLIGHT DURATION**

25-27minutes

**CAMERA QUALITY**

5.2K 30fps video,
20.8 MP stills

**PRICE**

\$6,495.00 as tested
(\$2,999.00 for the Inspire 2)

WHAT WE LIKE

- + Well-built drone
- + Precise flying capabilities
- + Solid gimbal performance
- + Fast! Able to keep up with most subjects



Getting the Shot Flying with a dedicated camera person is the best way to improve your cinematic production, but it really does take practice—and more practice—to get it right. The first thing to do is to make sure that both of you know each other's jobs very well. Having a pilot that knows how to shoot and a camera person who knows how to fly will really improve your image captures. In addition to that, you will need a dedicated person to be the spotter; this will allow the pilot to concentrate on flying the drone.

AERIAL RECAP

I have to say that flying the Inspire 2 was fun. It is very precise in the sky, and it's easy to get it from one point to the other. Then there is the speed at which this bird can fly. In most cases, you don't really want that much speed because the shot will look rushed, but the gimbal does an excellent job of maintaining a nice level and smooth video, even when in Sport mode and while doing some very aggressive flying. Flying with a dedicated camera operator allowed me to concentrate on a nice, smooth flight, working around our subject and getting the Inspire in the right position. But I have to say that the new flight modes did make it easier to fly as a single pilot to capture some great video.

There was never a minute that I did not feel comfortable flying this quad. Even flying close to the ground at high speeds was easy because of the Inspire 2's solid feel and control. I followed a fast-moving vehicle and really had no problem at all keeping up and staying on top of it. Even if you should lose your orientation on the drone, the Return to Home function requires just the push of a button and the Inspire will come back, avoiding obstacles along the way as it returns.

THE BOTTOM LINE

Perhaps the biggest drawback to this rig is the price: You will have to shell out about \$6,500.00 to get the setup we tested. But if you want a solid-flying quad that can produce top-quality video and images, this is the bird you want. ✈️

Communicating is essential before the flight to make sure that each person knows what to do.



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RISE RXS255 Extreme Speed FPV Racer

This fully built speed demon is ready to race!

BY MICHAEL YORK PHOTOS BY JENNY & MICHAEL YORK



You know a sport is becoming more mainstream when you can watch it on ESPN! Last year was the inaugural season of the DRL (Drone Racing League). As with most racing sports, people assume that it takes lots of money or building skill to get into it, but that is certainly not the case with the sporty Rise RXS255 FPV racer.

HIGHLIGHTS

The RXS255 is completely assembled and all you need to do is install a 5+-channel receiver, and provide your battery and, of course, some sort of goggles or monitor (although it's still a thrill flying line of sight).

The chassis is made out of carbon fiber with a few aluminum and brass standoffs. While the majority uses 1.5mm carbon, the arms are double that thickness and have mostly wireless motor connectors, which reduce snag damage. The speed-control modules and flight controller are also modular and are protected between the lower chassis plate and PCB board/battery plate.

Installation of the receiver is simple, and a built-in connector adapter can be used with either PWM- or SBus-type systems. The

instructions guide you on how to connect the wires, then it's a simple matter of going through the transmitter setup in LibrePilot. There is no need to do anything with the CC3D flight controller or Oneshot125 speed controllers as they have already been configured from the factory. If somehow you do lose the factory default, RISE has it available on its website and can easily be flashed to the controller through LibrePilot.

RISE designed this quad for racing, which means that sometimes you might have to disassemble it to repair the inevitable "racing is rubbing" incidents. Little things, like brass mounting-screw inserts in the plastic body, show that RISE intended this to be raced, not babied, and the whole thing is modular, making it easy to replace damaged parts.

Flight-Controller Programming

The CC3D flight controller comes fully programmed with recommended defaults from the factory, but you still have to setup your transmitter. This is done via the Ground Control Station program from LibrePilot (librepilot.org). Simply connect the RXS via a mini USB port located on the side of the chassis to a computer and follow the easy transmitter wizard (always remove the props for safety!). This only takes a few minutes, and because the RXS comes from the factory with the recommended settings, this is all you really need to do to get airborne. If you do want to modify things to your taste, you can really go to town. If you get too far from the norm and can't remember what they were, simply flash the factory settings available from the RISE website.



AT A GLANCE

	MODEL RXS255
	MANUFACTURER RISE (explore-rise.com)
	TYPE Racer
	SIZE 257mm
	ASSEMBLY TIME 30 minutes (transmitter programming)
	FLIGHT DURATION 4-5 minutes
	CAMERA QUALITY 1000TVL
	PRICE \$399.99

WHAT WE LIKE

- + As fast as it looks
- + Fully built out of the box
- + Three distinct flight modes
- + Modular construction

The battery is well protected inside the chassis of the RXS255, yet thanks to the hinged upper-half design, it is still easily accessible for rapid battery swaps.

AERIAL RECAP

"RXS" stands for "RISE eXtreme Speed," and the company isn't kidding. This thing can haul! It is very responsive and definitely not a beginner's drone. There are three flight modes

LITTLE THINGS, LIKE BRASS MOUNTING-SCREW INSERTS IN THE PLASTIC BODY, SHOW THAT RISE INTENDED THIS TO BE RACED, NOT BABIED, AND THE WHOLE THING IS MODULAR, MAKING IT EASY TO REPLACE DAMAGED PARTS.



This is one racing drone that looks fast sitting still. While some have a Spartan or industrial look, the RXS255 looks more like a MotoGP race bike. I'm sure that is something that will attract more people into this sport.

FPV Gear Included Obviously a big part of FPV racing is video gear. The installed camera is a 1000TVL CMOS FPV camera that can be adjusted between 0 and 45 degrees. A 200mW (switchable to 25mW) video transmitter sends the signal via a cloverleaf antenna, and the easily accessible DIP switch at the rear of the chassis lets you quickly change between race frequencies. I had no problems synching the RXS255 to my Fat Shark goggles. Image quality is excellent, even in my makeshift tree-lined racecourse (at this time, I had not had a chance to fly the RXS indoors).



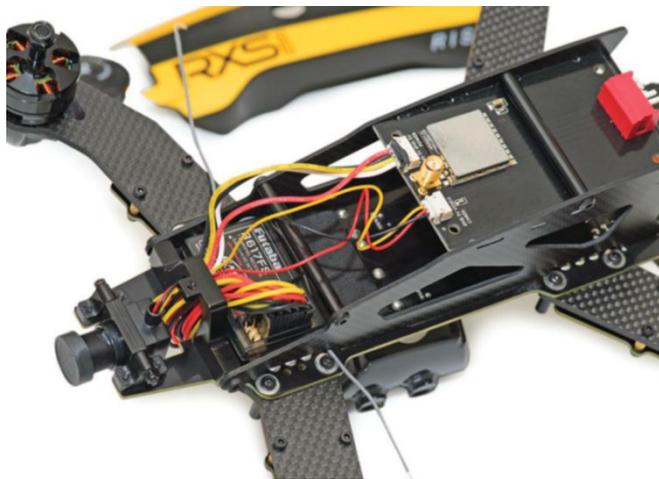
Coming or going, the RXS255 is easy to see—something that is important when flying this speed demon via line of sight. During FPV flight, the bright taillight is easily seen by the racers you're leaving in the dust.

programmed into the control board's factory settings that are controlled by a fifth-channel three-way switch on your transmitter. The first is Stability mode, which limits the amount it can tilt and also levels itself when the controls are centered. This is great for the first few test flights, but it does have a bit of a notchy feel due to the self-leveling feature. It is nice for some easy loitering as you don't have to be "on" the whole time. Position two, and my favorite all-around option, is FPV (first-person-view) mode. It does not limit the amount of tilt and will not level itself when you release the controls. It is not overly sensitive and is much more fluid in the way it reacts to control input—great for courses that are a bit more open and flowing. Then there is Acro mode. As the name implies, this is where things are turned up to 11. Roll and pitch rate are very fast,

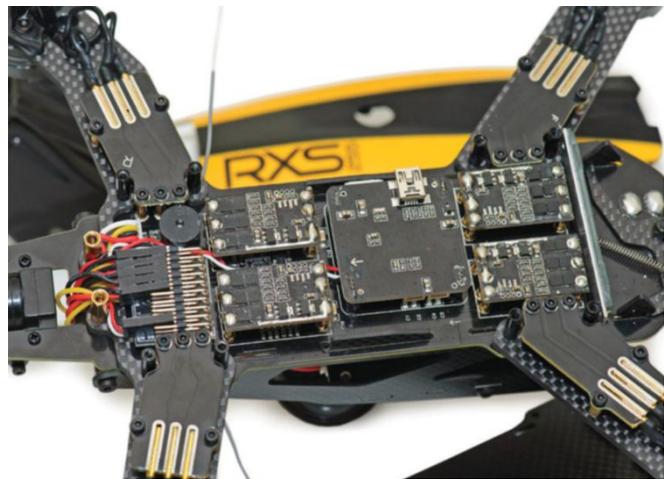
enough to make less-experienced pilots dizzy, but man, is it fun! All of these settings can, of course, be fine-tuned to your personal likings using LibrePilot.

THE BOTTOM LINE

If you're at all interested in getting into the drone FPV racing scene without the teething issues usually associated with building your own, the RXS255 definitely needs to be at the top of your list. It has an unbeatable price, and out of the box to flight is less than an hour. But be careful: It might lead to an addiction to FPV racing. 🚀



Only the front portion of the RXS's race fairing may need to be removed to make it easier to install the receiver, but I removed the rear portion so that you can see the layout of the video transmitter, antenna, and DIP switches.



With the lower chassis plate removed, you can see the clean modular layout. The CC3D controller is surrounded by the four Oneshot125 speed controls, and in front of that is the PWM/SBus adapter. At the rear is a spring-loaded quick release for the upper hatch.

NOW HIRING DRONE PILOTS! CALL 888-ABJ-1931

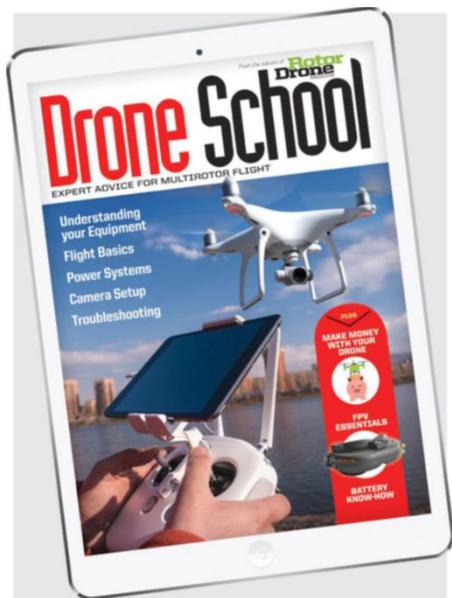
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From the editors of **Rotor Drone** MAGAZINE



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GETTING INTO DRONES

Tips and techniques for success

BY TEAM ROTORDRONE

Today's multirotors have evolved into amazing "very smart" aircraft, and they have a lot to offer. Whether you are just looking to try something new, get some really cool digital aerial photos and video, or want to experience the excitement of drone racing, there are plenty of choices available. Let's see what all the excitement is about.



GETTING STARTED

If you have no experience with flying RC, a great way to get information is to check out our website, RotorDroneMag.com, and peruse the "Getting Started" section. You can access many how-to articles and see the latest news items and products by using your mobile phone, tablet, or PC. You'll want to start with a ready-to-fly drone, which comes with everything needed to get it into the air, including the radio and battery charger (see the sidebar on our top picks). Some drones don't come with a controller at all and are flown with your smartphone or tablet using a downloadable app. You load the app on your mobile device, and you tell the drone what to do using the touchscreen.

By starting out small, you'll save money as these aircraft are much less expensive than the larger camera drones that are so popular today. Also, because they don't weigh very much, they are somewhat more crash resistant. You have to fly them into something really hard to cause a lot of damage, and most come with a spare set of propellers and removable propeller guards. Fortunately, there is no real flight training required, and you can start flying your mini drone inside a large playroom or garage. Flying indoors also eliminates gusts of wind that can make it hard to control your drone. To maximize your time airborne, consider getting an additional set of propellers and an extra battery pack or two to shorten your downtime.



Left: Many ready-to-fly drones come with everything needed to get into the air including simple dual-stick controllers, like this one from Dromida. This controller also has a holding bracket for a mobile phone, which is used to control the airborne camera. Below: The Nano Hexagon has six motors and props, and it comes with everything needed in one package. Distributed by Hobbico, this micro filer is a great first drone and costs less than \$30.

THERE IS NO REAL FLIGHT TRAINING REQUIRED, AND YOU CAN START FLYING YOUR MINI DRONE INSIDE A LARGE PLAYROOM OR GARAGE.

HAVE A PLAN

After reading the instructions and learning how to start, stop, and control your multicopter, the first thing you need to learn is how to hover. Each of your flights will always begin and end in a stable hover, and you need to get really good at holding your drone's flight position. Place a large poster board in the center of the room, and use it as a landing pad to take off and land on. The first step is to advance the throttle smoothly and gently to hop the quadcopter up a foot or two above the poster board. Keep it there for a bit of hovering, and then reduce power slowly to land. Avoid the urge to just chop the throttle if the drone starts going somewhere you don't want it to. This will only make it fall to the ground and possibly bust a prop or landing skid.

Using the poster board approach gives you a visual target to help keep you aware of your drone's relative position. You will find that without this reference point, instead of controlling the hover, you will most likely be reacting to the drone's drifting, spending most of your time trying to correct the flight. By practicing hovering over your poster board, you'll be more aware of what corrections you need to make to keep your drone over the takeoff point. Set your controller's response rate to Low (or Beginner) and try to maintain a relatively stable hover for your entire flight. Maintain the same altitude over the poster board, and don't let it wander away. When you can do this consistently, you'll be ready to move on to more advanced maneuvers.

ONE STEP AT A TIME

Practice first with slow forward flight, going from hover to another hover point about 10 to 15 feet away. Do this moving forward and again moving backward back to your starting point. Next, try this moving sideways to a new hover position and then return to your starting point. As this gets easier to do, bump up the speed slightly and increase the distance you fly away from yourself. When you have this mastered, you can then move in large flight paths while avoiding obstacles in the room. Try more precise maneuvers, like figure-8s and square circles.

If your drone is large enough and has enough power, try flying outside. Pick a day with calm conditions so that no gusts will affect your flight. Flying outside will help you get accustomed to how your quadcopter looks when it is farther away. Remember that if you become disoriented and aren't sure in which direction your drone is flying, simply neutralize your controls and enter a hover, then reduce power and let it land. Then go get it while you let your nerves calm down. Stick in a new battery, and try again. When you become comfortable flying outdoors, you'll be ready to move up to more advanced drones. And the good thing here is that larger, more sophisticated drones are actually easier to control and fly because of their global positioning system (GPS) navigation.



With flight times of 12 to 15 minutes, the camera-equipped Dromida Ominus is a rugged quadcopter, ideal for indoor or outdoor flights.

GPS NAVIGATION

Stepping up to this level, you are exposed to the benefits of GPS navigation. With this feature, both stability and ease of flying are greatly enhanced, and this improves the quality of the video and digital photos you can take. Also, GPS-enabled drones offer some handy functions. Of the various flight modes used with drones, the three most popular are Normal, Stick Relativity, and Return to Home.

Normal mode is when the drone moves in response to the direction the control sticks, as if you were sitting in the aircraft. Left and right stick movements make the drone move to its left and right (your right and left if it is facing toward you). Stick Relativity, often referred to as "Smart" mode, makes the drone move in whatever direction your transmitter's control stick is pushed, regardless of which way the drone's nose is pointing. This is great for



More advanced drones have a display screen that offers a lot of flight information. Downlink telemetry lets you know the condition of your drone's systems, like battery voltage, as well as altitude, air speed, and the distance from you to the drone.

new pilots learning to set up shots. As its name implies, the Return to Home mode automatically brings the drone back to its starting point. This is good for when you lose sight of your drone or get disorientated. Other popular flight modes are Orbit, where the drone circles you while keeping you in the frame, and Follow Me, where after you set it at a certain distance and height from you, it will follow you wherever you go. Some controllers with touchscreen control also offer Waypoint Navigation, in which you can select specific points on a map and the drone will follow and perform various functions at and along the path of waypoints. With some drones, you can even pick a specific point or object and set the drone to orbit around it while keeping it in frame.

When it comes to actually setting up shots for your video and digital photos, the GPS functions do a great job stabilizing the drone so that you can concentrate on positioning it exactly where you want it, using the FPV screen as a reference. You don't have to think about controlling the drone as it will stay where you put it.

CAMERA DRONES

The combination of digital cameras and drones is a match made in heaven. With today's more advanced camera drones, it's easier than ever to get great professional-looking airborne shots. Whether you want to shoot video or are looking for unique digital stills, there are many reasonably priced camera drones that come out of the box ready to go with everything you need.

The main difference between a regular drone and a camera drone, besides the camera, is the built-in first-person view (FPV) that provides you with the bird's-eye view of the world. Combined with the onboard camera, the video downlink system sends the video signal to your transmitter or to a mobile device, such as a smartphone or a tablet, attached to your transmitter. In either case, you are able to control the digital camera, turning it on and off and, with more advanced setups, switching from still shots to video. You can choose from basic low-res to high-end 4K digital cameras with adjustable-viewing tilt angle and video-stabilizing gimbal mounts.



A good ground-station video monitor is a great way to get started when lining up your aerial shots. Less expensive than FPV goggles, monitors give you a drone's-eye view of the world.





When it comes to getting good-quality aerial video and digital photos, it's all about the camera. The 4K-capable cameras, like this one from Yuneec, come equipped with an image-stabilizing gimbal, and the camera's shooting angle is controlled by the transmitter.

TIPS FOR USING A CAMERA DRONE

The first thing you need to do before operating a drone (also known as an "unmanned aircraft system," or UAS) is to register it. Go to the Federal Aviation Administration (FAA) website (registermyuas.faa.gov) and follow the online instructions. Drones are so numerous that, last year, the FAA started the registration system for any UAS weighing more than 0.55 pound. The registration fee is \$5 and must be renewed every three years.

HERE ARE SOME POINTS TO IMPROVE YOUR PHOTOS AND VIDEOS:

- Before flying over something to take photos, be sure to get the property owner's permission.
- Always shoot the sunlit side of your subject. This means keep the sun to the back of the drone. Shooting into the sun or the shady side of the object will produce dark images.
- Because digital photos are free and there's no film to develop, experiment with different camera settings, camera angles, and altitudes to find interesting and unusual images.
- If your controller or FPV screen does not have a sunshade, make one out of cardboard to shade the screen. This makes it easier to see the images.
- Keep the camera lens clean, and use only photography-grade lens paper or a micromesh cloth to avoid scratching its surface.
- Don't fly in any national or state parks. These are restricted areas.

As with any type of equipment, it takes time and lots of practice to get good at operating your drone. With all their built-in features, however, you'll find that even though they are relatively large and complicated, they remain some of the easiest multirotor craft to fly.



Left: This is what the Breeze control screen looks like. It displays what the camera sees and offers touchscreen controls to fly the drone. Below: The Yuneec Breeze is a camera drone that's controlled with an app that you load into your mobile device or phone.



RACING DRONES

One of the fastest-growing segments in the multirotor world, racing quads are literally flying off the shelves and pilots are gathering at makeshift racecourses in remote spots to compete. Today, there are even high-end races being highlighted on the ESPN Sports cable channels. These racers follow the course through gates, and to make it even more exciting, there are some very small openings that must be navigated, all while being timed by the clock. Let's check out what it takes to race these fast little quads!

WHAT'S IT ALL ABOUT?

FPV racing involves flying a multirotor by viewing the flight from the multirotor itself. Full-size aircraft do this all the time because the pilot is actually sitting in the cockpit. Drone racing uses a camera and video transmitter built into the drone to send video instantaneously to the pilot's monitor or to FPV goggles the pilot wears.

These small quads can really take a hit, even cartwheeling along the ground, and after you replace a few props, they are ready for the next heat. A durable quad is a definite requirement. When you first try FPV racing, three things will happen: you'll bang up your drone a lot, you'll be replacing a lot of props, and from your very first flight, you will be hooked. Let's take a look at what's needed.

THE QUAD

The first requirement is a race machine, and a 250mm-size bird is just the ticket. It costs as little as \$15 and can go all the way up to \$300. Get the best one you can afford; quality counts, and \$100–\$200 quads usually have a nice thick carbon-fiber frame that can stand up to the abuse of FPV racing. The frame protects all of the internal parts, which could easily add up to more than the cost of the frame. Plastic or thin carbon-fiber frames will shatter when they hit something (trees do always seem to get in the way), and once that frame goes, all the internal parts tend to follow in the destruction.



Because a racing drone files with its nose slightly down, its FPV camera is angled slightly up so that you can see the racecourse instead of looking toward the ground.

Thick booms/arms are another thing to look for as they offer some protection to the motors hanging out on their ends. One common thing that tends to happen when you're first learning to fly FPV is flying your quad too close to the ground at full speed. This can lead to some spectacular cartwheels as the drone rapidly slows down. Quads with thick arms tend to fare much better.

RADIO

You can use whichever brand you prefer, but you'll need at least four channels. Six channels are better; a 6-channel radio lets you set up various flight modes. Many race pilots fly without any GPS assistance or automatic stabilization. This allows the quad to be very maneuverable and hold the heading it is put into. Once pushed into forward flight, the quad maintains that angle, so the pilot only has to concentrate on guiding it through the racecourse and navigating through the small openings.

The required FPV equipment consists of a small video camera mounted on the front of the quad. Be sure to use one with as wide a view as possible without distortion. Many racing quads are designed so that the camera is protected, so don't be afraid to invest in a quality FPV system.

Drone races are exciting and are held around the world. Once you get good at flying your race drone, it will be no time before you get with some friends and start experiencing the excitement only racing can offer.

DAVID STOCK





The video transmitter that sends the camera's video signal to your FPV goggles is usually mounted in the back of the drone to help protect it during any collisions.

FLIGHT TIPS

You do have to walk before you can run, and FPV racing is definitely running at full speed. So if you've never flown a quad before, start out by flying a small quad around the house. This way, you can learn how to control it and even fly under and through obstacles.

When you're ready to move on to your racing quad, any 250mm-size quad will work. Fly it around in an open field to get used to using the controls, hovering, and moving around imaginary obstacles. When you feel comfortable, open it up and fly forward at the fastest speed possible. This will be your normal racing speed, so get used to the angle of the quad and see what it's like to make quick turns and other maneuvers. You are now ready for FPV flying.

high the actual quad is compared to what you view when using the goggles. Your perspective will be off at first, but after a few flights, you will get the hang of it.

One of the best learning tools is to have a calm person (emphasis on calm!) stand next to you as your spotter and tell you just how high you are flying. This really works and helps you understand that what you're seeing through the goggles is very different than reality. After about 10 flights, you should begin to feel more comfortable while navigating around your flying field. The key is to keep at it. If you do, then you will eventually learn how to handle your quad wearing FPV goggles just like an expert. See you at the races!

IT'S RECOMMENDED TO LEARN HOW TO HOVER WITH AND WITHOUT FPV GOGGLES SO THAT YOU CAN LEARN HOW HIGH THE ACTUAL QUAD IS COMPARED TO WHAT YOU VIEW WHEN USING THE GOGGLES. YOUR PERSPECTIVE WILL BE OFF AT FIRST, BUT AFTER A FEW FLIGHTS, YOU WILL GET THE HANG OF IT.

FLYING USING GOGGLES

When you first start flying with FPV goggles, be prepared to be really frustrated because it will feel as if you're learning to fly all over again. It's recommended to learn how to hover with and without FPV goggles so that you can learn how

For safety, drone-racing pilots control their racers from a seated position. The experience is simply amazing.

AIRBORNE TRANSMITTER

The FPV camera is connected to a transmitter aboard the quad that relays, in real time, the video signal to a ground station, which the pilot monitors. ImmersionRC 600mW 5.8GHz transmitters are a popular choice for pro racers, and many pilots add some type of circular or mushroom antenna to make sure that the signal is continuous and strong to create a good visual link between the camera and pilot. A semiflexible antenna is a good addition; it will flex instead of breaking off.

GROUND CONTROL

Most pilots use FPV goggles (Fat Shark units are a popular choice) to convert the video signal into a heads-up display of what the quad sees. High-quality goggles will improve your vision and make it easier to guide your drone through the racecourse. Goggles block out light and make it easier for you to direct all your attention to controlling your race quad.

Another somewhat less expensive option is to use a small to midsize video monitor to see what the camera is transmitting. A sunshade for the screen is also a good investment; it prevents any extraneous light from interfering with your image quality. The only disadvantage is that you don't get that feeling of total immersion as you do when using goggles. The advantage is that you can easily look up to guide your drone in for landing.



EIGHT HOT CAMERA AND RACING DRONES

A BEGINNER'S GUIDE TO SUCCESS

Looking for your first camera drone or racer? All of our picks here get two thumbs-up for ease of operation and flight characteristics.

CAMERA DRONES



Dromida HoverShot

Not too long ago, you needed to pick and choose compatible equipment that would work properly together, but today, there are a lot of drones ready to go without any additional equipment needed. One of these is the new the HoverShot FPV 120mm camera drone from Dromida, and it really is a blast to fly. And best of all, it comes with everything you need to get this little ready-to-fly (RTF) quadcopter into the air. It comes with a built-in 720p FPV (first-person-view) camera for in-flight still pictures and video footage. The transmitter has camera control buttons for Start, Stop, and Pause functions, and after takeoff, a built-in Altitude Hold feature helps the HoverShot maintain a stable hover for good-quality aerial photography. A built-in safety feature is the Motor Start/Stop button, which must be engaged before you can fly. To get the HoverShot airborne, press the Motor Start/Stop button to activate the motors. Next, press the Auto Takeoff/Land button and the drone will lift off to about a 3-foot altitude. If you don't move the throttle stick, the built-in Altitude Hold function will try to maintain the same altitude. Overall, the new HoverShot FPV Camera Drone is a winner in both stability and the quality of the airborne photography it offers. I think anyone wanting get an easy-to-fly camera-equipped quadcopter will love it.

\$99.99 | dromida.com



Yuneec Breeze

The Breeze comes fully assembled and only requires downloading the Breeze Cam app along with a quick charge of the batteries (two are included) before getting it in the air. A solid little quad has the camera gimbal mounted on the back so that it is always facing the pilot and ready to capture photos or video selfies. Any smartphone will give you control of the Breeze through the Breeze Cam app. About the only thing easier than sharing images on social media with this quad is flying it; it is, without a doubt, one of the easiest quads to fly that we have ever reviewed. This is the perfect first drone for anyone, and the best part is that it is loaded with all kinds of great features that are usually only available with higher-priced quads. Its smart features offer a number of cool video and photo options. Pilot mode gives the operator complete control over the drone, and Orbit mode puts the Breeze into an orbit around you or any external object. This is a drone that is made for everyone: It's stable, safe, and easy to fly. If you want a drone that can take good images and allow you to easily share them, the Breeze is the perfect quad for you.

\$379.00 | yuneec.com



Traxxas Aton+

This all-in-one aerial video/camera package with three solid flight modes is ideal for pilots at all levels. Because everything you need is included, this is an aircraft that you can buy and take right to your flying site! The Aton+ will arrive in Film mode for smooth, stable flight, so you can concentrate on getting the aerial shot you want. When you exit a turn or stop abruptly from lateral movement, the quad will slowly return to a hover without jerking to ensure stabilized footage. Engage Sport mode and you can now fly faster, perform higher banked turns, and do flips. You can also use the higher speed to film faster-moving subjects. In Expert mode, the Aton+ will do almost anything but fly inverted, and it's impressive when it rips by at full speed. Don't worry about pushing the aerobatic envelope too hard; the airbrakes do a great job at settling the quad back down to a hover from your high-speed antics. The included "batwing" 2.4GHz transmitter has a small digital screen, which gives you info such as flight-mode status, throttle level, transmitter-battery level, and flight-battery level. The included flight pack with the Aton+ model is a 3-cell 5000mAh LiPo. The model is equipped with a Traxxas High-Current Connector. Without a camera, you can expect up to 20-minute flights; with a GoPro HERO4 you can expect up to 15-minute flights.

\$399.99 | traxxas.com



DJI Phantom 4

As with its predecessor, the DJI Phantom 4 is mostly a hollow plastic shell, with highly optimized electronics at its core and a fully integrated camera system. It comes preassembled and, after a summary firmware update and system check, will fly right out of the box. Anybody could fly the Phantom 4 with ease, yet it is intended for intermediate to professional pilots. The basic package comes with a radio, a single battery, a charger, two sets of propellers, a 16GB micro SD memory card, and accessories. DJI also sells a premium kit with two extra batteries and a backpack. We must also mention the included lens-cap/gimbal-holder clip, which is both useful and practical, contrary to the one that came with previous iterations of the Phantom. It comes in a durable, compact, reusable, stiff foam case with a handle and a latch that serves both as product packaging and as a practical way of carrying your drone around. It's large enough to carry the aircraft with three batteries, the radio, and a few spare propellers and accessories. You will need an Android or Apple phone or tablet to display the video (FPV) with on-screen display.

\$1,199.00 (basic) | dji.com



Blade Mach 25 and Teleporter Headset Bundle

Blade's first venture into the world of FPV racing, the Mach 25 FPV Racer looks as if it means business. Easy to fly and enjoyable for everyone, this multirotor comes out of the box completely assembled and ready to bind with your Spektrum radio. There is just enough room to get the bind plug into the controller to perform the binding operation without having to remove anything. The battery is mounted in a recess located on the underside of the body using Velcro fastener material. The small 25mW micro FPV camera system includes a video transmitter, and it works rather well when flying alone. The Lexan frame does move around a bit while flying, but overall, the setup works quite well. And because of the canted motor mounts, landings are a bit easier. To get started, you will want to get at least 2 to 3 feet high right away before testing things out. The Mach 25's stabilization is very good, and it wants to get up to speed right away. It can quickly get moving if you are not careful. Control response is really good in the High-Bank-Angle mode, and you could easily race in this mode. But if you're looking for really quick and snappy flying, then the Agility mode is what you want. You'll have a blast scooting around the field. Throw in a few obstacles and another racer and you will be totally hooked on FPV racing.

\$349.99 | bladehelis.com



Hitec QuadRacer 280

This little drone is designed for the new pilot who wants to get into FPV drone racing but doesn't want to spend a lot of time on construction. Out of the box, this is a very stable flying bird, which is easy for any pilot to control. It comes with everything you need to get into the air quickly. The first thing to do right out of the gate is to start charging the included 3S 2000mAh battery, along with the included 4.3-inch LCD video monitor. Then it's easy to attach the props and the video antenna. Connect the monitor and install the included AA batteries into the supplied transmitter and you're ready to race! This quad also comes with a durable clear canopy, which lets you customize your racer to suit your personal style. The two stabilizing modes make this a very easy quad to start your racing career with. Add to that the stable, solid flight performance and you have a quad that is easy to grow with as you become more proficient at the sticks. The QuadRacer 280 offers high and low rates as well as switches for mild or fast responsiveness. We like the fact that it's ready to fly and doesn't require any flight-controller programming.

\$399.99 | hitecrad.com



RISE RXD250

Made out of carbon fiber and foam, the Rise RXD250 comes assembled and ready to accept your receiver and FPV equipment. A 250-size racer, it comes completely built with just about everything to get airborne; all you need is a receiver and battery. The flight controller, motors, and speed controls are all securely mounted and ready to go. LEDs on the bottom help with orientation, and there is even a power plug for your FPV transmitter, which has been soldered in place. All the key components are surrounded by foam, plastic, or carbon fiber, so there isn't much risk of damaging anything expensive. The landing gear is strong, but it has plenty of flex, so it won't just break off; it does a nice job of protecting your battery. The RXD250 can be flown with or without FPV gear, and we were impressed by how well it performed. Taking off with the FPV gear obviously required a little more throttle, which was to be expected. Once in the air, it was pretty nimble with both setups. Even in Stability mode, it had a nice response and reacted quickly to our inputs. It's easy to toss around but still holds its line well. For a drone that is built to withstand more crashes and hits, we're impressed overall with how well this 250 handled.

\$129.99 | explore-rise.com



RISE Vusion

The RISE includes everything you need to join the racing craze. A high-grade injection-molded plastic is used for construction, and there are LED lights on the arms. The arms themselves are quickly and easily replaceable, and if you know anything about racing quads, that feature is extremely welcome. The power system is quite adequate with 2280Kv outrunners paired with OneShot ESCs. A 3-cell 1500 LiPo flight pack also arrived in Vusion's box of goodies, and it even has a mating plug soldered on. There is also a balance charger thrown in with an AC adapter, a spare set of propellers, and four AA batteries for the radio. A short and simple calibration process has the Vusion up and flying within a minute. The guidance transmitter has dual rates, which allows for more stability or agility as well as a switch for flight modes. Mode 1 is the most stable, features self-leveling, and allows the aircraft to tilt up to approximately 30 degrees. Mode 2 also has the auto-level attribute but now permits up to a 45-degree tilt. Mode 3 disables the self-level feature and lets the model fly at any angle and perform aerobatics. All modes feel solid, and this tells the pilot that the model is tuned quite well from the factory. Acquiring all of the equipment that plays nicely together can be a chore in itself but not with this setup, which is basically plug and play.

\$350.00 | explore-rise.com

Hitec Vektor 280

Fun freestyle/race-ready quad

BY MIKE GANTT PHOTOS BY JOHN REID



Hitec has released a new airframe with an aggressive look and some cool features. When you receive yours, you'll be happy to see that there is little to do to get it flying. Simply add your radio and receiver, set up the included flight controller, and install the included propellers. And yes, a charged battery helps!

HIGHLIGHTS

Clean and solid-looking 3mm carbon-fiber arms are premounted to the main frame with hex-head fasteners. Underneath, foam-rubber pads keep the quad's body off of the ground. Preinstalled on top of the arms are the 2204 motors with wire-loom wrapped leads, which feed into the main frame. There are decals on the motors that illustrate motor direction and also included are 10mm prop nuts, which are color coded according to location. Four 6x3 propellers complete the power package. The Vektor 280 utilizes a circuit board system, and it has all of the required power pads and speed controls built into it. Rather than the typical stack of components, you get a slim, compact setup with the aforementioned and other built-ins, such as programmable LED lighting and DSM and SBus support. If you like doing the PWM thing (one wire per channel), you can because there are wire harnesses for either option. An XT-60 plug is presoldered to the board, and a hook-and-loop battery strap is provided. The flight controller is the CC3D Atom and was configured through LibrePilot. Formerly known as OpenPilot, LibrePilot is a free, open-source firmware available online.

AERIAL RECAP

An addendum on Hitec's website gives you all of the needed info for the setups of both your Vektor 280 and your guidance transmitter. "Playing" around with the LibrePilot GCS (ground control station) for a few minutes led to some fairly intuitive results, and I was able to get flying in short order. For safety, I removed the props before programming. Using a 10mm socket makes quick work of prop changes. When the motors spun up for the first time, the Vektor climbed very smoothly and was easy to hold in a small location in Stability mode. Initially, while untrimmed, only minimal inputs were required to keep the machine in place. Releasing cyclic control at any time allows the self-level to kick in and right the vehicle back to a solid and flat attitude. When you're ready for unlimited control of the quadcopter, you can switch to Acro mode, which can be set up on any of your radio's switches. In Acro mode, aerobatics are much more lively, and flying at a steeper angle is possible. In fact, this is typically the preferred mode for experienced pilots because there is no "force" trying to level the quad; only the pilot's inputs are to blame!

THE BOTTOM LINE

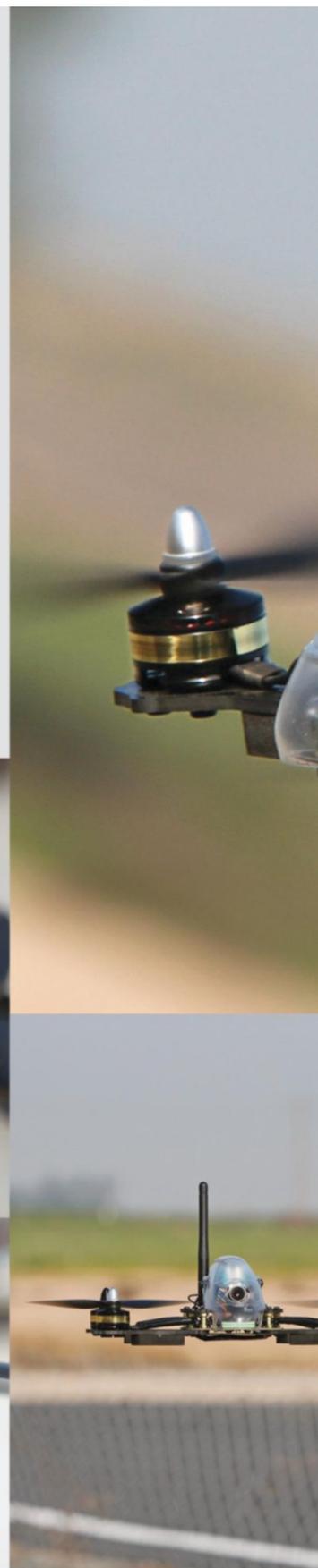
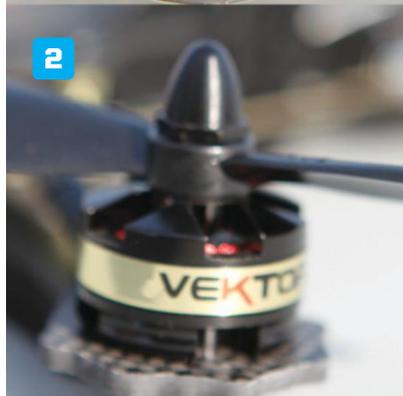
Truly almost ready to fly, the Vektor 280 is also "almost ready to FPV" with a camera preinstalled and prewired to an included 600mW video transmitter. Just add your receiver and display and you're ready to rip. 🚀

AT A GLANCE

	MODEL Vektor 280
	MANUFACTURER Hitec RCD (hitecrd.com)
	TYPE X-type racer
	SIZE 280mm
	ASSEMBLY TIME 5-10 minutes
	FLIGHT DURATION 3-7 minutes (w/ 3S 1300mAh LiPo)
	CAMERA QUALITY 400K pixels, 135-degree FOV
	PRICE \$270.00

WHAT WE LIKE

- + Minimal completion involved
- + Strong 3mm carbon-fiber arms
- + SimonK Oneshot speed controls
- + Built-in finder function



WHEN YOU'RE READY FOR UNLIMITED CONTROL OF THE QUADCOPTER, YOU CAN SWITCH TO ACRO MODE, WHICH CAN BE SET UP ON ANY OF YOUR RADIO'S SWITCHES.

1 / SAV CHEESE The included camera is prewired and has an adjustable tilt.

2 / REV IT UP! The motors come wired up and connected right out of the box.

3 / IT'S HITEC There are options to go PWM or with a satellite/SBus guidance system.



One of the amazing exhibits was this surround visual display from LG OLED TV. This presentation attracted a lot of spectators.



CES 2017

THE LATEST AND GREATEST ELECTRONICS, FROM GADGETS & GEAR TO DRONES

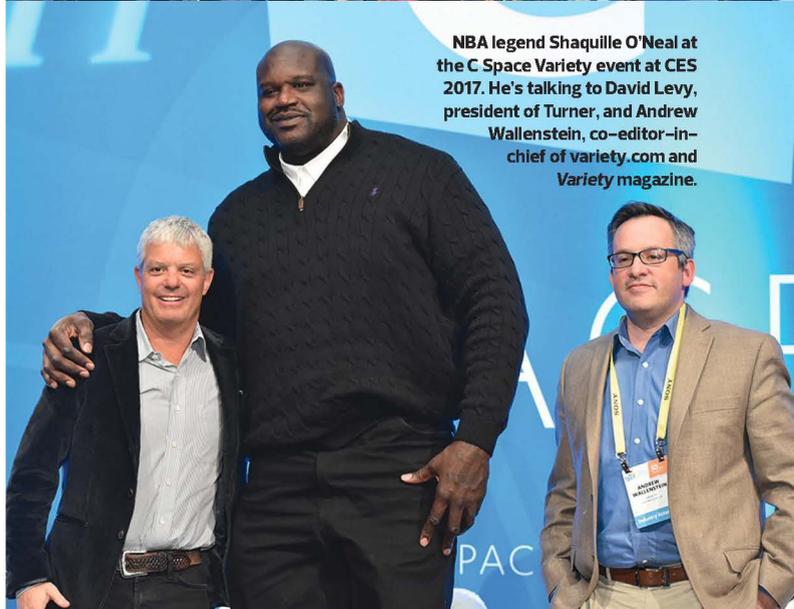
BY **TEAM ROTORDRONE**

Held in Las Vegas, Nevada, every January, CES is one of the largest trade shows around, with more than 200,000 attendees getting a first look at the latest and greatest technology. This year, unmanned aerial vehicles filled the South Hall of the Las Vegas Convention Center and ranged from selfie drones to giant-scale commercial aircraft. While we were there mainly to check out the latest in drone technology, we just couldn't help looking at all the other cool electronic products.

Attendees explore the show floor on CES opening day. While this day had some very large crowds, all of the other show days were just as packed.



NBA legend Shaquille O'Neal at the C Space Variety event at CES 2017. He's talking to David Levy, president of Turner, and Andrew Wallenstein, co-editor-in-chief of variety.com and Variety magazine.





Above: Smart rings are nothing new, but so far, the Motiv Fitness Ring seems like one of the more interesting ones we've seen so far. Having a ring as a fitness tracker seems fairly nonintrusive when compared to one in your pocket or on your wrist. A built-in three-axis accelerometer can track active minutes, activity intensity, sleep duration, heart rate, calories, distances, and (of course) steps.

Right: This SuperSession on the "Power of Hidden Figures" discusses the importance of diversity and the essential roles of technology in getting that information out there. The panel featured special guests from the highly anticipated Twentieth Century Fox film *Hidden Figures*, including actress Octavia Spencer.



Above: The PowerVision PowerRay is a very cool underwater drone that can be used with the PowerRay Fishfinder. The Fishfinder is detachable and can be used as a stand-alone device. Detailed information such as fish distribution, underwater temperature, depth, and fish alerts are all displayed on the mobile app. Once the fish are found, you can use the PowerRay to place the fishhook at the desired location and then it is just a matter of waiting for that nibble.

Below: With a push of a button, the PowerVision PowerEgg takes off automatically and hovers at the designated altitude. Landing is just as easy: Push the button and it lands automatically. The controller, called the Maestro, is a gesture-recognition remote control and makes it easy for anyone to fly this bird. Other features include a safe user distance, smart maximum-distance mode, and a pause function that freezes the PowerEgg in midair like an emergency brake. It's priced at \$1,288.00.



Above: A cool little foldable drone, the Mola-UFO fits into the palm of your hand, and it has a number of intelligent features. It has advanced three-axis EIS image stability to take high-quality images, even in a windy environment, and its Vision Lock with intelligent track lets it recognize and follow the subject and lock onto it. The UFO can even be programmed to recognize more than six types of gestures!

Below: Now your pet can have its own personal trainer, just like you can. The Canhe-Fit collar-mounted pendant will monitor your pet's daily activity and make nutritional recommendations based on its energy expenditure, breed, age, and weight.



RotorDrone Magazine Winners

At the 2017 CES extravaganza in Las Vegas, we were amazed by how many new and innovative drones were released at the show. As a CES Media Sponsor, *RotorDrone* magazine had the honor of giving out six awards to the top drone and drone-related products at CES. These aircraft and accessories are amazing!



TOP VALUE › Propel Star Wars Drones

Now you can bring the magic of flight to a whole new dimension with these *Star Wars* drones. The Speeder Bike, X-Wing Starfighter, and Advanced X1 can fly at speeds above 35mph, and they can interact with exciting multiplayer laser battles. Each hand-painted drone sells for just under \$200.00 and is extremely detailed, certified, numbered, and packed in a collectible display box. But they are not meant to stay in those display boxes; these are extremely durable quads designed to last, battle after battle. → us.propel.com



TOP INNOVATION › DJI CrystalSky

Yes, we know this is not a drone, but it goes hand and hand with them. This screen was created for outdoor aerial imaging and features an ultrabright screen that is clearly visible in sunlight. It is designed from the ground up to work seamlessly with the DJI GO app, giving camera operators a clear view and total control. → dji.com

BEST OF SHOW › Yuneec Typhoon H520

This new drone builds on the proven Typhoon H platform and has commercial-grade cameras and features for high-end professional use. Three new cameras will also be released for this drone: the CGO3+, an ultrastable 4K ultrahigh-definition video camera; the CGOet, a dual-streaming camera that can record infrared and residual light in separate streams so that you can overlay them; and the CGOci camera, which is optimized with an all-glass seven-element lens that is the equivalent of a 50mm lens—perfect for cinematic and industrial use. This bird features retractable landing gear and offers longer flight time, greater payload-lifting capabilities, and a modular design for simple camera swaps. → yuneec.com





BEST CONSUMER DRONE › Hover Camera Passport

This durable, light drone has a carbon-fiber body with a soft rubber coating. It is a foldable, self-flying personal photographer that will follow you around for a unique perspective. This \$599.00 device can spin and take 360-degree panoramic videos and orbit around you. It will also do face and body tracking. The props are all enclosed, making it safe to fly anywhere. → gethover.com



BEST COOL TECH › Wingsland S6 4K Pocket Intelligent Drone

This pocket selfie drone can take off from your hand and record 4K 30 UHD video in the air. It can be connected to your smartphone so that you can instantly share your aerial selfie videos. Priced at \$370.00, it has features like smart return, voice control, panorama mode, slow motion, time-lapse, and automatic follow-me mode. Options also include obstacle sensing and avoidance, a searchlight, a display board, and a mini cannon. → wingsland.org



BEST PROFESSIONAL DRONE › DJI Inspire 2

What can you say about the Inspire? It was a leading drone for the pro shooter, and now there is the Inspire 2. Some improvements include 25 to 27 minutes of flying time, plus this drone can support many types of cameras and fly at speeds of up to 58mph! Its all-new image-processing system records at up to 5.2K, and its revised flight autonomy provides two directions of obstacle avoidance and sensor redundancy. This is a solid drone, and it costs less than \$3,000.00. → dji.com

Eight Oddities

While CES hosts some incredible technologies, there are a few items that are, ahem, a little offbeat. Here are eight of the most unusual products we saw at this year's show.



Hushme

Sitting at the office and a private call comes in? How can you talk without your coworkers hearing what you say? One way is with the Hushme, billed as "the first voice mask for mobile phones." It is designed to let you gab without the fear of your coworkers judging what you say. No guarantees, however, that they won't judge you for looking silly.



Smart Toast

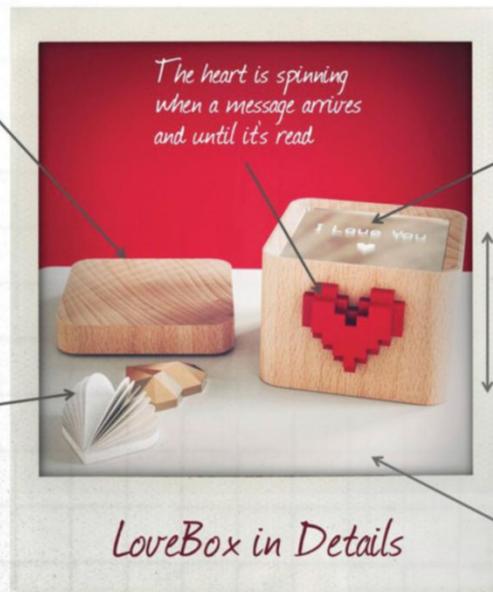
Need to get the perfect piece of toasted bread? Griffin Technology might be able to help with its Connected Toaster. This Bluetooth toaster syncs up with a smartphone app, with which you can dial in your precise toast settings. Need that perfect toast again? No problem; the app remembers the settings. (Wait, isn't that what the rotary dial on a toaster does?) But for \$100.00, you do get this cool-looking appliance.

The LoveBox

This little wooden trinket box connects to the Internet and works with a mobile app. When you get a new message, the heart on the front spins and the text appears in a mirror on the top of the box. It's just \$99.00.

LoveBox is made out of a solid piece of beech wood from Jura

Choose from three different hearts to personalize your LoveBox



The heart is spinning when a message arrives and until it's read

Your secret message is sent from the LoveBox mobile app and magically appears in the screen covered by a mirror

8 cm

Located near you, on your bedside table plugged into a power outlet and connected to a WiFi

LoveBox in Details



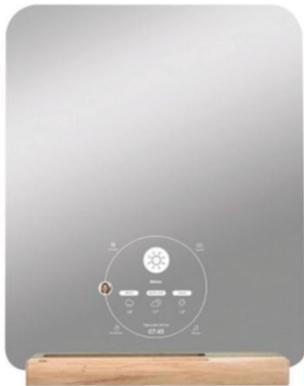


Airdog Fitair

How about some fresh air? All you have to do is strap this \$100.00 device on your face and the air is delivered fresh and clean. Now, if it only came with a Darth Vader voice...

Don't Trash That!

Getting ready to throw something away but you wonder if it is worth something or is recyclable? Well, now, you can use Eugene to scan the bar code on the package and tell you. Of course, this is assuming your trash has a bar code on it. For just \$99.00, you don't need to squint anymore to see the recycling label on the container.



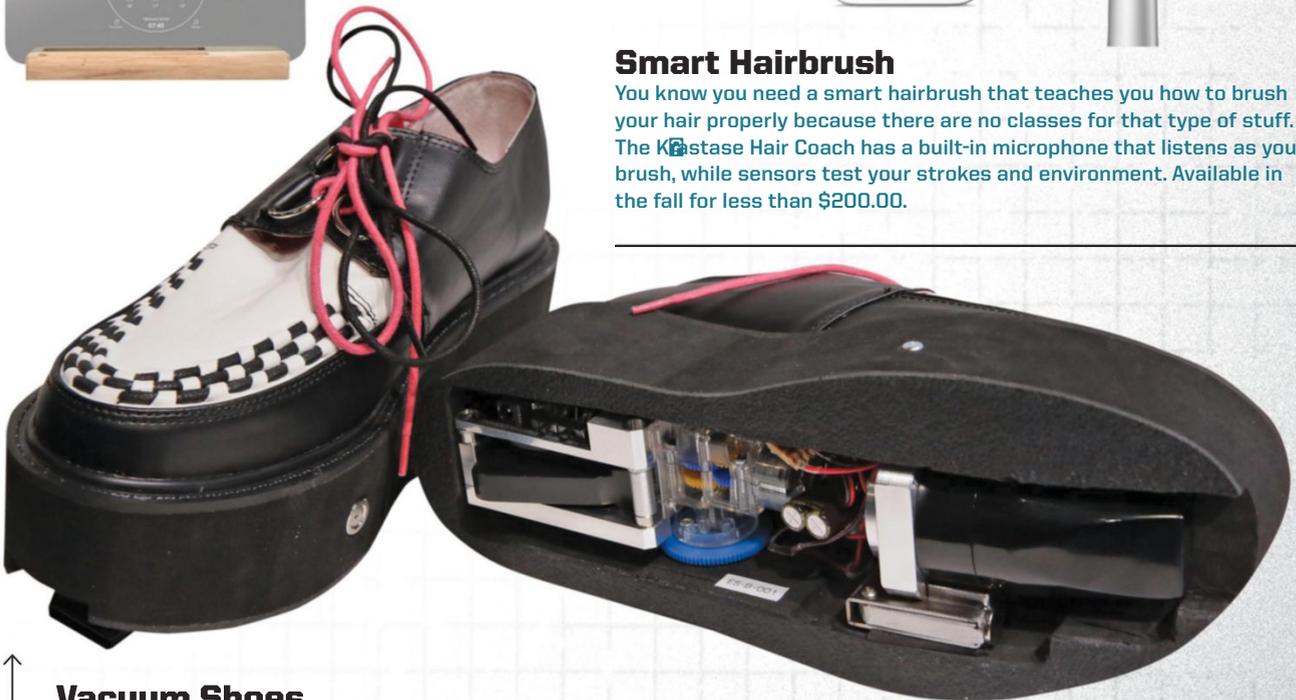
Smart Mirror

Have you thought your mirror should be used for more than grooming and assembling outfits? Then this is the mirror for you. The Ekko smart mirror plays music and videos, displays the news, tells the time, and much more. It will only set you back \$399.00.



Smart Hairbrush

You know you need a smart hairbrush that teaches you how to brush your hair properly because there are no classes for that type of stuff. The Kestase Hair Coach has a built-in microphone that listens as you brush, while sensors test your strokes and environment. Available in the fall for less than \$200.00.

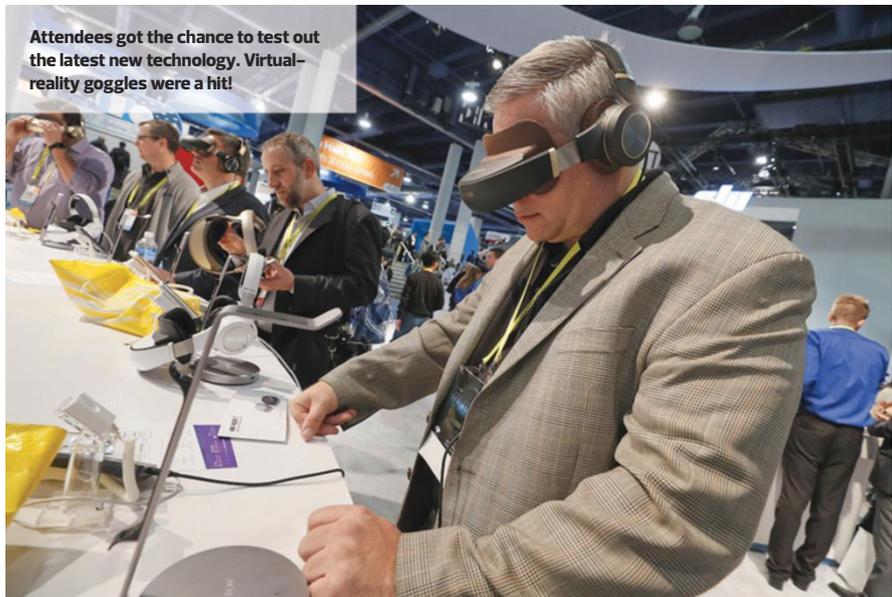


Vacuum Shoes

Now you can look good *and* have a clean floor! Yes, these are vacuum shoes, and they don't use batteries. Every time you take a step and press down on the pedal (sole), the motor is powered and sucks up dirt into a small internal dustbin. Sadly, there is no word on availability.



Polaroid was at the show, with its vintage look updated for the digital age. The Polaroid Pop can produce a print just like the traditional Polaroid did, but this version also saves a digital copy. It has a 20-megapixel camera and a 3.97-inch LCD touchscreen.



Attendees got the chance to test out the latest new technology. Virtual-reality goggles were a hit!



Many of the booths had interactive displays and ways for attendees to try out the products. Here, at the Voxx booth, there were different methods to enjoy the music and have some fun while learning about the product.



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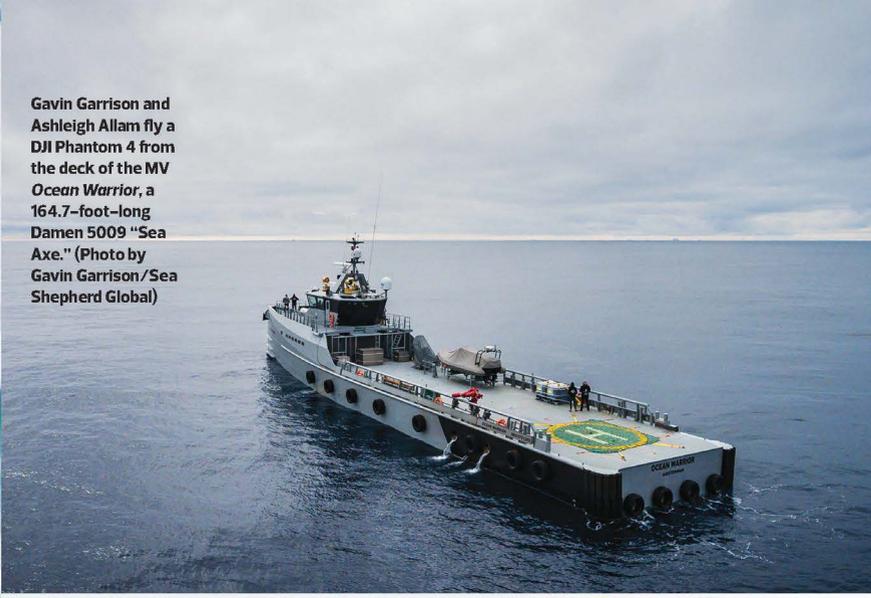
Sunday, April 9
9am-3pm



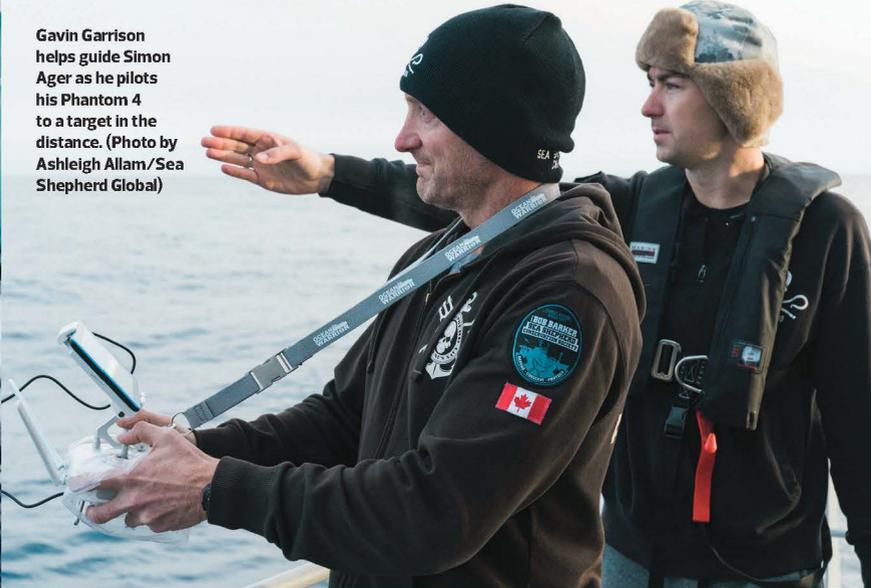
ANTARCTIC ADVENTURE



A herd of Antarctic fur seals sun themselves on an ice floe. Antarctic fur seals grow up to 6.5 feet long and weigh up to 474 pounds; each seal eats approximately one ton of krill and fish every year. (Photo by Gavin Garrison/Sea Shepherd Global)



Gavin Garrison and Ashleigh Allam fly a DJI Phantom 4 from the deck of the MV *Ocean Warrior*, a 164.7-foot-long Damen 5009 "Sea Axe." (Photo by Gavin Garrison/Sea Shepherd Global)



Gavin Garrison helps guide Simon Ager as he pilots his Phantom 4 to a target in the distance. (Photo by Ashleigh Allam/Sea Shepherd Global)

WHERE CAN'T A DRONE GO?

BY GAVIN GARRISON

In late 2016, I was driving north through Alaska when I stopped in a quaint town, the not-so-aptly named "North Pole," which sits at 64°N. Knowing that the Arctic Circle was still several hours north of me, I looked into the town's coordinates, curious to see how far away I actually was from the North Pole. The town was nowhere near the actual North Pole (90°N) or the North Magnetic Pole (86°N); North Pole, Alaska, was just a place. But this research revealed a chance discovery for me: There are more than just two poles. As we'll see, the Earth's magnetic pull has quickly become the biggest thorn in my droning, here in the iceberg-laden waters off the coast of Antarctica. I'm sailing along the continent's edge with the ocean-conservation group Sea Shepherd Global on a brand-new \$12-million-dollar patrol vessel MV *Ocean Warrior* on the annual campaign to save whales from being poached in the Australian Whale Sanctuary.

SIGNS OF TROUBLE

For years, I've flown drones from ships, so I didn't expect there to be any particular challenge when flying a Phantom from the considerably large deck of this Damen FCS 5009 Sea Axe. When I boarded the ship in Hobart, Tasmania, I was warned by Simon Ager, the first mate, photographer, and drone pilot, that "something" in the ship had caused a loss of control and crash of a Phantom a month earlier. The leading theory was that there was a strong electromagnetic field emitted by the generators onboard. The few people that had had a chance to fly from the ship had also reported other strange instrument behaviors, but nothing was confirmed.

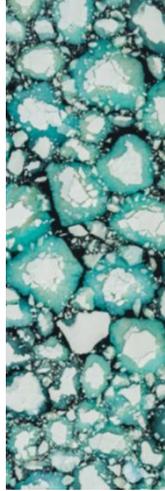
While preparing to depart for Antarctica, Simon and I flew a handful of test flights while we were still docked. Everything seemed to be in order: the Phantom's Inertial Measurement Units (IMUs), compasses, and positioning were all checking out, and the drones flew fine. The transit to Antarctica is renowned for being unpleasant, so we left the drones stored in their CasePro cases until we made it through to the Antarctic coast. Because we were on a mission to patrol the Southern Ocean for illegal whaling activity, it meant that we wouldn't get an opportunity to stop and drone; we had to fly at a moment's notice while the ship was on the move. We would wait for moments when the magical trifecta of perfect weather, lighting, and interesting subjects aligned, so we had to be prepared to get in the air quickly if we wanted to get great imagery.

Once we located the first iceberg of the season, after our week-long transit south, the drones came out. Out on the rear deck, all sensors checked out on our two Phantoms; we got "green across the board," as they say. We launched Simon's P4 first, preferring our hand-launch method to keep the aircraft away from the ship's metal. After 30 seconds of some preliminary checks at low altitude, things got weird. The P4 shot off, away from the ship, apparently under its own volition. Simon fought to bring it back, successfully doing so only after a series of unconventional inputs—up was down, forward was back; no input made sense. After a tense couple of minutes, the P4 thumped down on the deck.

Thinking that something was wrong with Simon's P4, we tried one of mine—Eagle-3, which appeared to fly relatively well once it was in the air. After confirming that nothing weird was happening, I flew out toward the iceberg to capture some video of the iceberg and the *Ocean Warrior* together. Reaching the iceberg, which was relatively close at less than a mile away, I lined up the shot I wanted. After I rolled the camera, the gimbal suddenly slammed to maximum rotation in one direction, then the other, and then the aircraft catapulted itself at a blazing 52mph away from us and toward the water. For a heart-stopping few seconds, the aircraft was nonresponsive. Though I had a full-strength signal, I could only watch as the Phantom dragged itself toward a watery end.

As seconds stretched into forever, I became convinced that my accident-free streak was over (90 days and counting!). I went through everything I could think of to regain control—flipping into Attitude mode, making inputs that would counter the current flight path—nothing worked. The drone executed a series of horizontal loops, something that's sometimes referred to as the "spiral of death." I didn't think this phenomenon was possible with this newest generation of Phantoms because of their new redundant IMU system, which helps keep faults like these to a minimum. After executing three loops, wherein the aircraft got progressively closer to the water, Eagle-3 slowly came to a pause, hovering about 20 feet over the water.

Realizing that I had control back, I climbed away from the icy waters and pointed the nose home. Even though my



WE WERE INCREDIBLY CLOSE TO THE SOUTH MAGNETIC POLE (SURPRISE!). THIS WAS LIKELY THE REASON FOR ALL MANNER OF COMPASS WEIRDNESS. THE SOUTH POLE WAS OUR LOCAL VERSION OF THE BERMUDA TRIANGLE, ATTEMPTING TO SUCK OUR DRONES INTO THE VOID.

Opposite, top: A raft of Adélie penguins scuttles toward a small pool on an iceberg. This species of penguin is the basis of the characters in the animated feature film *Penguins of Madagascar*. (Photo by Simon Ager/Sea Shepherd Global)

Opposite, bottom left: Simon Ager holds a Phantom 4, while Gavin Garrison prepares for takeoff. (Photo by Ashleigh Allam/Sea Shepherd Global)

Opposite, bottom right: The starboard life ring aboard the MV *Ocean Warrior*. (Photo by Gavin Garrison/Sea Shepherd Global)

inputs were creating the wrong results, they were at least consistently wrong, so I was able to guide the Phantom back over the deck and into Simon's waiting hands. Breathing a deep sigh of relief, we packed up the drones for the day. Later, I learned two things. First, we were incredibly close to the South Magnetic Pole (surprise!). This was likely the reason for all manner of compass weirdness; even the magnetic compass on the bridge of the ship had inverted itself. Second, Phantoms should not be flown in Polar Regions (in P mode). This piece of advice that came from a Phantom forum, pointing out there's a Polar Region warning on page 40 of the P4 manual.

More research revealed that others were flying drones in Antarctica—one of the U.S. icebreakers, *Nathaniel B. Palmer*, had a research team specifically tasked with finding out whether they could fly their Inspires and Phantoms from the ship. Another guy posted some video of Antarctica taken with a Phantom 2 from his sailboat. So what was with this Polar Region stuff? After several more hours of reading, it was clear that the issue was our proximity to the South Magnetic Pole, because flying in Attitude mode did not resolve the problems. We'd have to wait until we got away from the pole before we flew again. We later decided that the South Pole was our local version of the Bermuda Triangle, attempting to suck our drones into the void.

FROM HERO TO ZERO (PERCENT)

Weeks later, after putting a fair bit of distance between ourselves and the South Pole, Simon and I again took to the skies—or at least tried to. Finding that neither my Eagle-1 nor Eagle-3 would agree to take off (despite endless compass calibrations), I grew frustrated and decided to calibrate their IMUs, which turned out to be an incredibly bad decision. At the time, I thought that anything, even a shoddy IMU calibration, would be better than repeatedly getting the "Cannot Takeoff" message, but I was wrong. Given that we're on a boat that never stops rocking, the IMUs failed calibrating every time—or said that they had succeeded but really hadn't. Without access to a stable surface on which to do a real IMU calibration, which requires that the drone not move for five minutes while it makes sense of the world around it, my Eagles would no longer fly. Simon, however, had success with his P4; on the next flight out, he was able to capture an incredible vista as we skirted an enormous ice floe. He was also able to capture one of the most beautiful drone photos I've ever seen: a bird's-eye view looking directly down over an iceberg.

On another flight, Simon took his P4 out over the ice to look back on the ship, angling to get the sun behind the camera, knowing that this would make for the best photos. After a flight full of ice, penguins, and incredible scenery, at 44 percent remaining battery, he decided it was time to bring the P4 in. Unfortunately, this was precisely the moment he completely lost signal—both video and RC. A challenging aspect of flying from moving ships, especially small ones, is that, at any given moment, a large block of steel, aluminum, or whatever—in this case, the superstructure of our ship—could move between your transmitter and your drone. As anyone who has attempted to fly around buildings knows, any obstacle between your transmitter and your aircraft is bad news for signal strength.

Simon shot up the outside stairs to the upper deck of the ship, transmitter in one hand, turning in all directions to try to reacquire the signal. After a few seconds, the Return to Home (RTH) function chimed in, letting Simon know that the drone was going to do just that. Unfortunately, "Home" was now about a mile and a half behind us, over open water. Quickly canceling that, we realized that Simon was still receiving telemetry: battery voltage, orientation, and altitude. Using



WILLING TO FIGHT UNTIL THE END, SIMON KEPT INPUTTING MORE THROTTLE AND GUIDED THE AIRCRAFT IN OUR DIRECTION. AS HE APPROACHED, THE BATTERY DRAINED FASTER. A FEW OF THE SHIP'S CREW HAD GATHERED BY THIS POINT AND WERE LINED UP ON THE DECK, READY TO CATCH THE PHANTOM AS IT CAME IN.

Above: A massive ice floe at the edge of the Antarctic continent shows the first signs of the Austral summer. Below: A bird's-eye view of the icy shore of an Antarctic iceberg. (Photos by Simon Ager/Sea Shepherd Global)



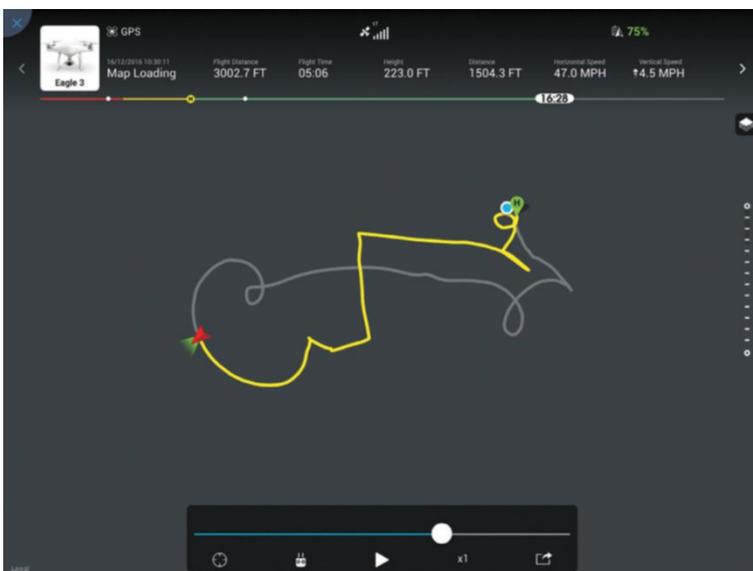
The sun sets over the bridge of the MV Ocean Warrior. (Photo by Gavin Garrison/Sea Shepherd Global)



the orientation arrow, he pointed the P4 in our direction and accelerated at full throttle—only to be told that power output was limited due to the low battery, which was now hovering at about 30 percent.

It occurred to me that we might be able to counteract RTH's forced descent. I suggested to Simon that he input full throttle (up on the left stick, in this mode), and it worked. Instead of plummeting to the ground, the drone actually gained altitude. Now down to about 5 percent, we got an image back on the

Screenshot from the DJI Go app showing the resulting flight path of a malfunctioning compass. (Photo by Gavin Garrison/Sea Shepherd Global)



screen and realized that the aircraft was much farther away than we had thought, but it could see the ship, which was a tiny, glinting speck in the camera's huge 94-degree field of view.

Willing to fight until the end, Simon kept inputting more throttle and guided the aircraft in our direction. As he approached, the battery drained faster: down to 3 percent almost right away. While he was still almost 500 feet away, the battery ticked over to 0 percent and the aircraft was still flying, which I didn't even know was possible (don't try this at home). Undeterred, Simon lined the P4 up over the deck and gave it full down, thinking that at every inch of altitude he might lose power—so the closer the aircraft was to the deck, the better.

A few of the ship's crew had gathered by this point and were lined up on the deck, ready to catch the Phantom as it came in. Antoine, a French firefighter who has endured more stressful situations than this one, leapt in and caught the Phantom by the skids as it plummeted, at 0 percent, onto the deck. He dropped to one knee as he did so, ending in a kind of drone-catch power stance. The crowd erupted into applause. The close call was over, and the Phantom would live to fly another day.

Having learned quite a bit about flying in Antarctica, Simon and I came up with a wish list of items we'd need to knock our flying out of the park, including a new approach that would help us recover the Phantoms intact, even with a water landing. In next month's issue of *RotorDrone*, I'll show you how a few inexpensive tweaks to our setup reinvigorated our flying and enabled us to unleash the beauty of Antarctica in ways that we had never before thought possible. ✈️



NEW YEAR, NEW XPONENTIAL

This year marks the 44th year for AUVSI's annual conference and exhibition, but only the second year of Xponential, a complete rethinking of the previous Unmanned Systems conferences and exhibitions. The theme of this year's show is "Shaping the Future," and AUVSI is focusing on how unmanned systems and robotic technology is transforming business and society.

Xponential, kicks off May 8 in Dallas with a new Startup Showdown competition, an expanded Women in Robotics forum and a new host, the Weather Channel's energetic Jim Cantore.

Brian Krzanich, the CEO of tech giant Intel, will be the first keynote speaker and address how his company's technology is helping push the industry forward.

Krzanich, a general aviation pilot, joined Intel in 1982 and became chief executive officer in 2013. He oversees the company's innovations in unmanned aircraft systems, including tests to fly multiple UAS per pilot and its own UAS platforms. Prior to becoming CEO, he served as the company's chief operating officer, leading more than 50,000 employees from

Intel's Technology and Manufacturing Group, supply chain operations, information technology, and other sectors.

"Unmanned vehicles, including drones, are some of the most dynamic technologies of the future, and well beyond recreation, they have the potential to improve people's lives, create new jobs and industries, and find solutions to real-world problems," said Krzanich.

Two new sessions were added at last year's Xponential: Startup Showdown, where companies described their business plan to a panel of judges to compete for funding, and the Women in Robotics forum. Due to the positive feedback from attendees, these will also be added to this year's Xponential schedule.

The Women in Robotics forum turned out to be wildly successful last year, with around 150 women participating. This year, the event will include more time for discussion and networking.

Big-name players will also have booths on the exhibit floor, including market-leading companies like DJI, Airware, NVIDIA, senseFly and Stampede. Companies will showcase their latest hardware, software, components, guidance systems, payloads, services and more.

Another feature the show offers is pavilions, with both technology and international pavilions featured on the floor. The international pavilions showcase the talent and technologies from China, France, Spain and the United Kingdom. The technology pavilions provide information about different services and technology, including pavilions on air systems, a business services zone, a software pavilion and a startup pavilion.

Theaters on the show floor will focus on business information that is new to the industry, including the solutions theater, which will be a chance for show exhibitors to focus on their new products.

The conference program is divided into three tracks:

- **Policy:** Airspace, local, state and federal government cooperation, international trade affecting unmanned systems, and regulation of unmanned maritime systems.
- **Technology:** Defense technology innovation, drone delivery technology, protecting intellectual property, software development powering unmanned systems and automated vehicle technology development.
- **Business Solutions:** Remote sensing, drones in the wireless industry, mapping and imaging, maritime applications for oil and gas, aviation risk management, and managing and protecting data.

“UNMANNED SYSTEMS ARE TRANSFORMING THE ENTERPRISE,”

-Brian Wynne, President and CEO of AUVSI

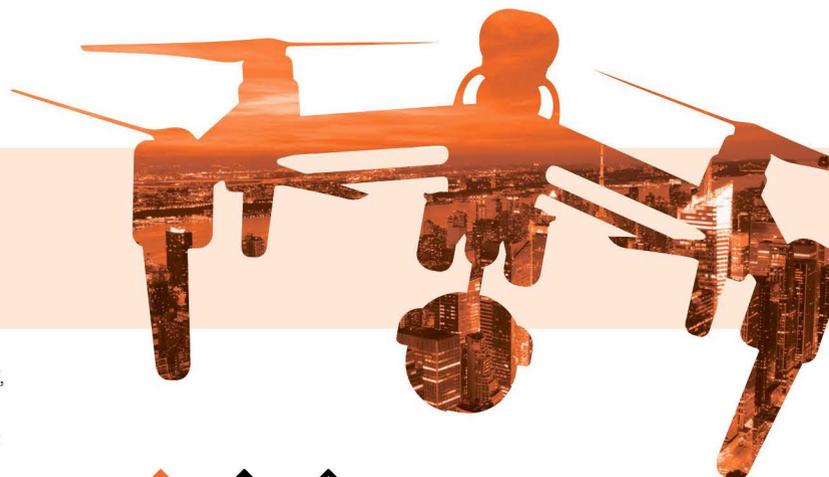
“From energy and agriculture to broadcasting and security, unmanned systems, robotic and drone technology is enabling applications that were previously impossible. The educational program at Xponential is designed not only to showcase these advancements, but to provide attendees with real-world examples, best practices and smart strategies to leverage the power of unmanned systems in their own organizations,” said Brian Wynne.

Xponential is structured to make sure it meets the needs of every attendee. By visiting the event’s website, visitors can pre-plan to make sure they don’t miss out on any viable information. Visitors can also take advantage of event maps that custom tailor the show to their needs.

AUVSI “recognizes that our community encompasses a really broad range of experts with different needs,” says Lindsay Voss, AUVSI’s Director of Education.

With an expected turnout of more than 7,000 people, Xponential will bring the entire unmanned systems community together, from commercial to academic leaders to military officials, all under one roof to learn and network.

Voss says first-time Xponential goers should arrive with an open mind and engage with people who are outside their usual circles. “We have a lot to learn from each other,” she says.



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EYE IN THE SKY

GETTING STARTED WITH AERIAL PHOTOGRAPHY

TEXT & PHOTOS BY JOHN REID

Many drone pilots will begin the process of moving from just flying drones to flying drones with some purpose, and there are two directions you can go. For sports and enjoyment, many will head toward drone racing, while others will want to document their flight through photography or videos. We will save drone racing for another day, so in this article, let's talk about what you will want to look for in a drone to document your adventures from the air.



WHAT IS YOUR PURPOSE?

The first thing you have to decide is exactly what you want to document from the air. Are you looking to have a drone follow you around and document your many adventures? Or are you looking to take some award-winning photos or videos from the air that have a professional feel to them? Maybe you want to make a living by creating aerial videos for commercial projects and advertising.

Because making a living from aerial videography will require the pilot to receive an FAA Part 107 waiver, we will leave that alone for now and talk more about how to create some outstanding images/photos for your own personal use.

THE DRONE

Let's begin by looking at what you will need for aerial photography (still images) as the equipment can be a little different from the camera you need for video. Many multirotors that are designed for video will also work quite well for photography, but there are a few differences of which you should be aware. The drone will not need to have a gimbal system on it to take great photos; the camera can be mounted directly to the rig because the fast shutter speed will eliminate any vibration from the drone. That being said, it is hard to find a ready-to-fly drone that does not have a camera gimbal and that only shoots photos (all of them shoot both video and still images). So plan on getting one with a gimbal, and you will still be able to make good use of this feature.

A drone that is fast and has a good top speed, while not a requirement, will help get the camera from one shot to the other. This is a plus if you are shooting action. Drones that have retractable landing gear are again good to have (especially if you are also doing video), but it's not absolutely necessary. One thing you do want to look for in a drone is one that will lock into position, have a good GPS mode, and not drift. Once



The Typhoon H has a small but powerful video/still camera that can shoot up to 12mp images in RAW and JPEG formats.



Having the ability to add an aerial perspective to your photographic library lets you expand your creative options.

you've established the drone's position for the image you want to make, you don't want to keep tweaking the drone into place while waiting for the shot. A drone that has very little to no drift over the flight time of the battery is good to have for photography.

CAMERA

The camera that is attached to the drone will probably be the most important factor for producing good images. A drone that will allow a variety of selectable payloads by the pilot will be the best choice, but this will come at a much higher cost. Here are some photographic specific features you will want on the camera:

Camera format. Make sure that the camera can shoot in RAW format as well as JPEG. The RAW format will allow more work/corrections to be made in post (working in the computer) to improve the image quality. RAW image format takes all of the information gathered from the photo sensor in the camera and saves it all to the card. JPEG format takes all the information, processes it, reduces the file down to a smaller size by throwing out pixels, and then saves that image to the card.

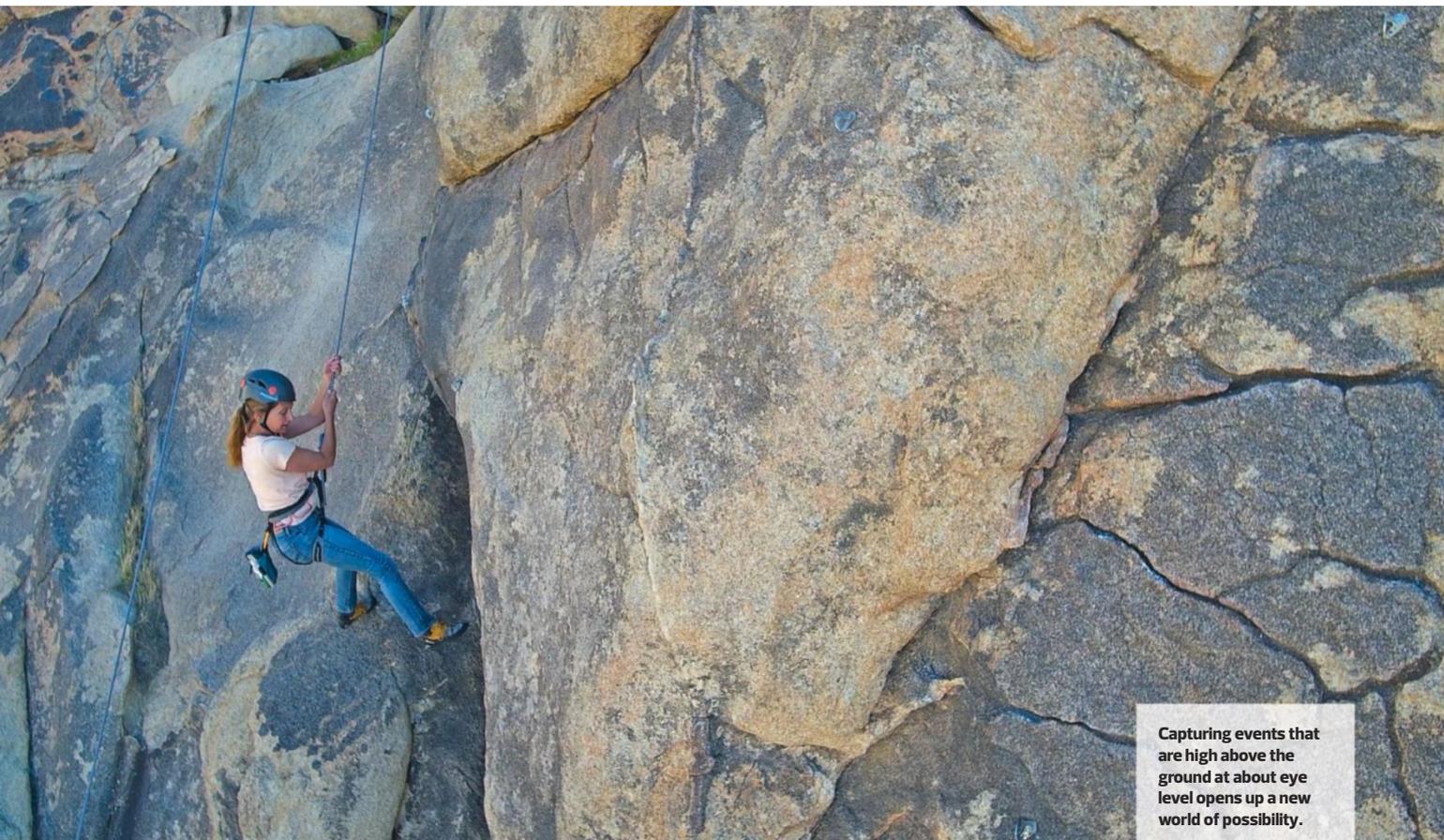
Larger image size. Look for cameras that can create images that are at least 12 to 16 megapixels as this will create a sharp image when enlarged



The camera on this DJI Phantom 4 will shoot 12.4mp images in RAW and JPEG formats.

to 8x10 or more. The more pixels there are in the sensor, the more image detail will be in the saved file.

Shutter/aperture control. Will the camera allow you to have control over the shutter, aperture, or both? Having control over both is best, but it will, most likely, be manual control over the shutter speed, which is the minimum you should have on the camera.



Capturing events that are high above the ground at about eye level opens up a new world of possibility.



The camera-control menu allows you to adjust the ISO (sensor sensitivity), shutter speed, and exposure compensation.



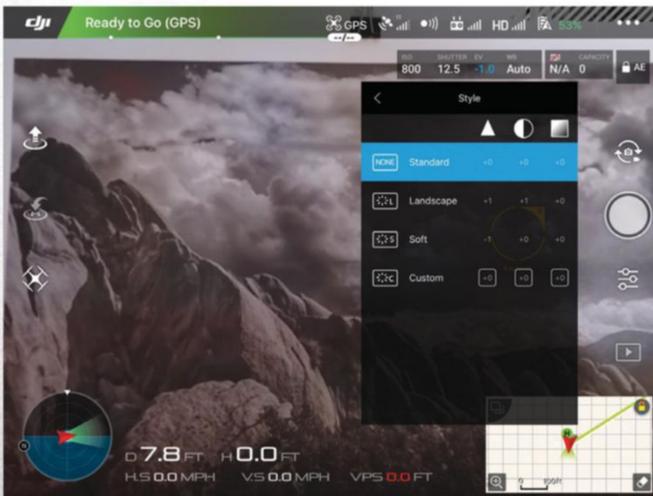
The image-format menu is where you can change from JPEG (default setting) to RAW or JPEG+RAW.



Change the photographic settings in the menu to achieve the image you want. This is where you can create timed shots for selfies.



The color menu lets you create different looks for the image. For more creative freedom, change the image color in postproduction.



The style menu allows the pilot to fine-tune the final look of the image.



The white-balance menu is used to adjust the sensor's color balance for the type of light the camera is shooting in.



Get the drone in the right position, and start the interval timed shots. Then strike your best selfie pose.

Selfie Tip If you want to get a selfie shot without having the transmitter in the shot, set up the quad camera to take interval images two to three seconds apart. Get the drone in position so that you're where you want to be in the shot. Press the shutter button, and let the camera shoot every two to three seconds. Set down the transmitter within reach but out of the shot. Get in your best selfie pose for 10 to 20 seconds, then land the drone and check out the images. If you have what you want, you're done; if not, reshoot.

The AiRScouter allows the pilot to watch the drone while at the same time see what the camera is focused on.



FPV for Photography

On higher-end aerial productions, a dedicated camera person controls the camera gimbal while watching the screen. In most cases, I find that I am both the cameraman and pilot. This is why I started using the AiRScouter by Brother USA (brother-usa.com). The AiRScouter is a head display; it's like wearing glasses because it hangs out in front of one of your eyes. The display is attached to a headband that secures the unit around your head, and it's easy to adjust the location of the eyepiece display so that it lines up in front of your eye.

A key advantage of using this is that it allows me to see the screen (camera view) but still have both eyes on the drone when I need to position it in the right location. This also allows for better depth perception, which is very much needed when flying. There is never a need for me to take my eyes off of the drone at any time while flying. In addition, I wear glasses but find it easy to see the screen even in bright daylight, which can be a problem with some flat transmitter screens.

Setup is just a matter of plugging in the HDMI cable to the HDMI outlet on the transmitter or video receiver of your drone. This will relay the camera signal to the headset. The unit's onboard battery lasts about four hours, which I found to be more than enough time for all of my flights. It has become second nature for me to look at the drone while flying and getting it into position, then to shift my eye to focus on the eyepiece when composing the shot and while shooting.

Before the AiRScouter, I found myself concentrating on the camera feed and fighting glare from the screen while trying to capture the shot. This would also take my attention away from flying the drone. This is a great accessory to have, and I recommend it to any pilot.



Shooting straight down on action scenes requires good flying skills and good timing.

Filters. Does the camera allow the use of filters, or are filters available for your drone? Although they aren't necessary, filters will enhance many images if used correctly. They can also be used to creatively show movement by blurring the parts of the image that has movement (for this type of image, you will need a good-quality gimbal to keep the camera steady). Filters can also intensify the colors in the photos and add contrast. Filters offer a lot of creative options and are available for a number of drones, so consider getting a drone that offers a good selection of available filters.

ISO range. This determines how sensitive the camera sensor is to light or the amount of light needed to make a proper exposure. Some of the best images are produced in low-light situations, and a camera that has an adjustable range of ISO will allow more creative freedom. A camera with an ISO range of 100 to 3200 is good, but a range of 100 to 12800 is better. When the ISO goes up, we introduce noise into the image, which is where individual pixels in the sensor create data that is erroneous. This, in turn, gives a grainy texture/look to the image and degrades its quality. Higher-quality cameras will help reduce this effect at the higher ISO settings.

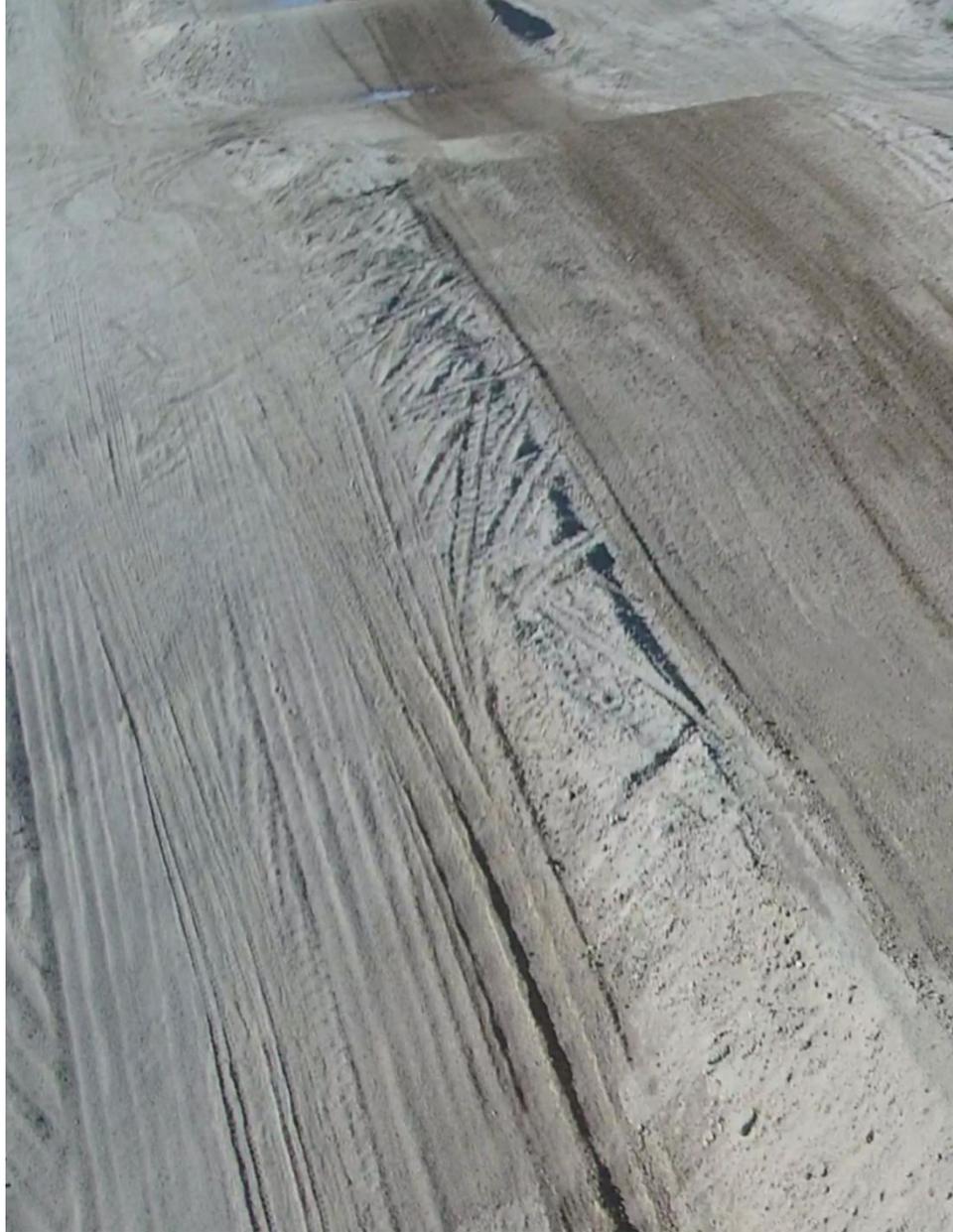
Shooting modes. Cameras that will only allow a single shot to be taken each time the shutter button is pressed on the transmitter will work for most shots. But if you are trying to capture something that is moving fast, like a motorcycle making a jump, you will need to time your shot just right. Cameras that have burst-mode settings will allow you to take a number of frames one right after the other. In this mode, you press the button as the motorcycle approaches the jump and the camera shoots a number of images throughout the entire jump. You can then pick the best photo after the jump is complete. This feature is really important if there is any "lag" time in video transmission from the camera, on the drone, to the transmitter screen. Common burst modes are three to five frames per second, but some go up to 14 frames or more.

Another shooting option that is desirable to have is interval mode. This is where the camera is set to shoot an image every two or three seconds and will continue to do so until the pilot gives the command to stop. These images are used most of the time to create time-lapse movies by combining single images in post to create compressed-time videos. For this type of photography, you will need a good gimbal and a drone that does not drift for the entire length of the flight.

Exposure adjustments. Cameras that have a way to manually control the exposure are a big plus. This could be referred to as "exposure compensation" or "exposure value bias." Along a similar line is auto exposure bracketing. With this setting, each time the shutter button is pressed, the camera takes three to five images. When set to three, one image will be at the exposure recommended by the camera meter, another image will be at an exposure lower than recommended, and the final image will be over the recommended exposure. How much over and under will be determined by your settings. Bracketing will go a long way toward guaranteeing that you get the correct exposure.

FLYING TECHNIQUES FOR PHOTOGRAPHY

When shooting for aerial photography, most of your flying will be getting the drone in the right spot and waiting for the shot. Speed will help with that when you have to go from one location to another while tracking



fast-moving action. But as mentioned before, a drone that doesn't drift will be the biggest plus. GPS flight mode will be your friend, and you will most likely be flying in this mode most of the time. Now, that is not to say that when shooting images, you will not need to track your subject. There are times when this will be absolutely necessary. But because you are only capturing brief moments in time, it will not always have to be as smooth a flight as you would need for video.

Maximize the use of the gimbal by changing up the shooting angles on your subject. Take some at a low angle. Move the drone to a higher altitude and shoot from a 45-degree angle. Then, if safe to do so, point the camera straight down and take an image from directly overhead. By maximizing your gimbal movement, each image will have a completely different look to it.

You will find that, with still images, many of your photos will not require the drone to be that far from you. So if you can take the shot with the drone closer to you, do it. It will be easier to control and place in just the right spot. But always be aware of your surroundings, and be sure that you are in a safe spot; this is very important when working around moving subjects.

BOTTOM LINE

Although shooting photos from the air might not require as many flying skills as shooting a complicated flying scene for a video, you still need to have the ability to know where and when to place that drone in just the right spot for that great aerial image. The only way to master it is to get out there and shoot...and shoot...and shoot some more. ✨



Burst mode is perfect for capturing fast-action shots at just the right moment.



When setting up for close-up shots, like this one, be sure to stand close to the drone so that you can see the amount of space between the drone and your subject.

Propel *Star Wars* Battle Drones

The perfect drone for any *Star Wars* fan!

BY JOHN REID PHOTOS BY CHERYL MALTBY & JOHN REID

There are times when two passions just seem to collide to create the ultimate must-have products, and Propel has just made this happen for me. Its *Star Wars* battle drones are just about the best aircraft for anyone who likes science fiction and technology.

HIGHLIGHTS

The first thing you see when opening the shipping box is a sheet describing the collector's edition box with instructions on how to break the seal and reveal the display platform that the vehicle is mounted on. When you open the box, the display comes alive with lights, music, and sound clips (each time that it is opened, a different clip plays!).

There are three different *Star Wars* drones available, and each is hand painted (so no two are exactly the same) and has a unique serial number. The models are the Tie Advanced X1, 74-Z Speeder Bike, and the T-65 X-Wing, and each comes with the appropriate transmitter and two unique battery packs. Also included are a charger, a protective training cage (for new pilots), extra propellers, a propeller multitool, spare parts, and a nicely written manual.

The first thing I did was to start charging the battery packs, then I installed the props onto the drones. Each drone comes with a faux battery cover that is used when it is in the collector's box; this will be removed and replaced when the battery is ready. I had time to read the 37-page manual, and I recommend that everyone read it before flying as it's loaded with lots of tips for flying and how to perform evasive maneuvers. With that out of the way, all that was left to do was to get another pilot and start my combat missions.

AERIAL RECAP

If you've never flown a quad before, you will want to snap on the protective cage for your drone and turn on the T-mode, which is intended to help ease new pilots into flying. When the drone is in this mode, it is governed by an invisible ceiling of approximately 6 feet and a "floor" that prevents the ship from touching the ground. The drone will also take off and land by itself (when instructed to do so). This is a great mode for anyone's first battle flight.

With the T-mode disabled, the drone can perform some radical moves with speed. Your controller has two buttons that allow the drone to perform either a clockwise or counterclockwise roll. In addition, you can speed the drone up three levels for some quick and fast flying, especially indoors.



T-MODE IS INTENDED TO HELP EASE NEW PILOTS INTO FLYING. WHEN THE DRONE IS IN THIS MODE, IT IS GOVERNED BY AN INVISIBLE CEILING OF APPROXIMATELY 6 FEET AND A "FLOOR" THAT PREVENTS THE SHIP FROM TOUCHING THE GROUND.





Each battle drone has its own unique flying characteristics and look. In addition to these three, the Millennium Falcon will be coming out in the spring of 2017. a

AT A GLANCE

-  **MODEL**
Star Wars Battle Drones
-  **MANUFACTURER**
Propel (propelsw.com)
-  **TYPE**
Mini battle drones
-  **SIZE**
80mm
-  **ASSEMBLY TIME**
10 minutes
-  **FLIGHT DURATION**
5-7 minutes
-  **CAMERA QUALITY**
Not applicable
-  **PRICE**
\$199.00 each

WE LIKE

-  Display case
-  Hand-painted designs
-  Easy to fly and great flight performance
-  Battle tallies on the transmitter

Star Wars fan or not, you will have a blast flying these quads.



Let the Battle Commence!

After learning how these birds fly, you will, of course, want to head into battle. After all, isn't that why you signed up for the rebellion flight school? First things first: Protect your belly! The infrared receiver for each drone is located on its underside. Practice maneuvers that allow you to drop behind and slightly lower than the enemy. To help, each manual has a number of different maneuvers for each vehicle. In most cases, you will score a hit if you are two to three meters away because the transmitter sends a wide signal. When you fly outside in bright sunlight, the signal distance is greatly reduced, so you will have to fly closer to your enemy. When flying inside, however, the signal will bounce off walls, especially white ones. The plan of attack here is to stay close to the center of the room so that there is less chance for your opponent to score a hit. Hopefully, you will be able to push them to the outside of the room so that you can score the ricochet shot from the wall. Now that you're armed with that knowledge, get out there and attack those battle drones!

Throughout, *Star Wars* music plays from your transmitter for that little bit of extra inspiration.

The object is to get three hits on your opponent before he or she can score three hits on your aircraft. When you score the first hit on an aircraft, it will rock back and forth. The second hit will cause it to rock back and forth a little longer and with a bit more intensity. The third and final score will cause the aircraft to auto-land in a spiraling downward direction. After 10 seconds of no activity, the ship will reset and be ready to fly again. All three *Star Wars* battle drones have solid flight performance in the air and respond well to stick inputs. Pilots of all skill levels will enjoy flying these drones.

BOTTOM LINE

Having battle drones that resemble *Star Wars* vehicles is very cool, but add in the sounds, music, lights, and the maneuverability and flying speed and you are going to have a great time with these drones. Whether you are a new or veteran pilot, into *Star Wars* or not, these drones are a lot of fun to fly. Be sure to get at least two! ✨

Each unit has a matched transmitter that plays the appropriate movie sound clips for the vehicle.



THE OBJECT IS TO GET THREE HITS ON YOUR OPPONENT. THE THIRD AND FINAL SCORE WILL CAUSE THE AIRCRAFT TO AUTO-LAND IN A SPIRALING DOWNWARD DIRECTION.



Be a Drone Advocate

One of the greatest things about a democracy is that we the people are the bosses (at least in theory), and our elected officials are required to represent our interests. But how do our elected officials know what our interests are? Congress at the national level and state representatives at the state level have interns and staff lined up to speak with constituents who call in regarding their issues of concern. Your voice matters. And as a member of the drone community, your voice is needed—right now—to advocate for the future of our industry. Whether you are purely a hobbyist or are also a commercial drone operator, you are no doubt aware of the rising tide of (what I have been resigned to calling) “stupid drone laws” in states and local governments across our country. In this article, I ask each of you to consider doing your part.



Jeffrey Antonelli
Antonelli Law

With a legal background in corporate outside counsel, civil litigation, insurance defense, and intellectual property and drone/UAV law, Jeffrey began flying radio-controlled aircraft several years ago, which lead him to research new technologies, including first-person viewing (FPV) and drones.

Disclaimer: None of this article constitutes legal advice. Please consult an attorney if you have legal questions. Associate attorney Amelia Niemi assisted Jeffrey Antonelli with this article.

Federal Advocacy: Express Federal Preemption Is Needed

This is the big one. Express federal preemption is vitally important for the drone/unmanned aircraft system (UAS) industry. What is it? Express federal preemption in a statute basically says, “In this subject matter here, federal law is exclusive and states and their political subdivisions (i.e. local government) cannot interfere by putting forth their own laws or regulations, regardless of whether state/local laws or regulations complement or further the federal objectives.”

CC Most hobbyists and small drone companies cannot afford to hire a law firm to challenge the state or local drone law in court. This will lead to a chilling effect in the industry as bad law after bad law goes unchallenged.

I believe that to stem the tide of harmful and inconsistent state and local drone laws, we must have Congress include *express* federal preemption in the 2017 FAA Reauthorization Act. Without it, any challenge to a state or local drone law would have to be on the basis of *implied* preemption (as opposed to *express* federal preemption). That would mean lawyers on both sides “arguing the law” to judges, which will undoubtedly lead to bad and inconsistent decisions. Furthermore, since most hobbyists and small drone companies cannot afford to hire a law firm to challenge the state or local drone law in court, this will lead to a chilling effect in the industry as bad law after bad law goes unchallenged.

To challenge local and state drone laws effectively and quickly, we need express federal preemption in the

FAA Reauthorization Act so that when a legal challenge is filed against a state or local drone law, there is little to no discretion by the judge hearing the case. The phrase “Your local drone law is clearly preempted by the express federal preemption clause in the 2017 FAA Reauthorization Act” is what we want to hear the judge say. Express federal preemption will also make it much easier to get rid of these laws without litigation. With express federal preemption, when a drone lawyer like me shows up and gives the local government a copy of the express federal preemption clause in the 2017 FAA Reauthorization Act, it will be much easier to force the local governments to back down because they are certain to lose. While we’re at it, let’s throw an attorney-fee award in the FAA Reauthorization Act. This would allow those who challenge a state or local drone law and win to reclaim their attorney’s fees and costs. That way, more people would be able to afford to fight bad state and local drone laws. (A lawyer, of course, would suggest this.)

Currently, Congress has not given the Federal Aviation Administration (FAA) specific express preemption authority in the field of aviation as it relates to drones/UAS. So this is the fight that counts. Otherwise, we will have a patchwork of inconsistent state and local drone laws across the country that are not easily defeated.

The drone industry—and possibly your drone job—hangs in the balance. I encourage you to call your U.S. representative and senators, asking them to include an express federal preemption clause in the 2017 FAA Reauthorization Act.

Advocacy at the State and Local Level

Many states, counties, and cities have passed legislation relating to drones: where they can be flown, by whom, penalties for injury, prohibitions on privacy invasions—you name it. Some of these laws will be in direct conflict with federal law and regulation, and will almost certainly end up in court over preemption issues. But as I said previously, fighting these cases in court takes time and resources that many people cannot afford.

Consider visiting your elected representatives during their office hours or setting up an appointment to meet with them to discuss drones in general and/or to change



EE Show your elected representatives the good side of drones. They might only be aware of the misinformation and fear floating around the industry.

or eliminate state and local drone laws that are bad. Tell them we need laws that aren't subject to preemption lawsuits and that are good for business in their district. Take the opportunity to show your elected representatives the good side of drones. They might only be aware of the misinformation and fear floating around the industry.

Notice of Proposed Rulemaking for Flights over People

The next "big thing" for drone regulations is expected to be an FAA announcement of a proposed rule related to flights over people. The FAA held meetings in the spring of 2016 with a Rulemaking Advisory Committee regarding safety standards to conduct these options. In December 2016, a Notice of Proposed Rulemaking for a supplement to Part 107 was expected to be released but has not been as of February 2017, when this article was submitted for publication.

When it does come, please do your homework and then submit your public comment about the proposed rule. Be prepared to take some time to review the proposed rule and think about how it will affect the types of operations you want to do. Do so whether you support the document in its entirety or even if you oppose certain

sections of it. You may find it helpful as well to look to industry leaders, including the Academy of Model Aeronautics, the Association for Unmanned Vehicle Systems International, and the Aircraft Owners and Pilots Association, for their take on the proposed rule.

Contacting Your Elected Representatives

There are many levels of elected representatives to whom you can reach out. At the federal level, citizens can communicate with their U.S. representative and senators—or at least their staff. At the state level, you can contact your governor, state officials, and state reps. On a local level, you may have a mayor and city-council officials with whom you get in touch. The website usa.gov/elected-officials can provide contact information for each office.

Many of us, including me, were not yet active in the commercial drone world during the time the 2012 FAA Modernization and Reform Act was being developed. That was the law that gave us Section 333 and, eventually, Part 107. But now you *are* a part of the industry as a hobbyist and/or a commercial drone operator. This is your chance. Please do your part now. ✈️

Asked **AND** Answered

Expert solutions to common questions / BY TEAM ROTORDRONE

What's the best type of case for traveling with drones and accessories?

Answer: A hard-shell, polyethylene case is superior for both transit and shipping. Look for name brands with strong replacement warranties in the event of freak failures in the handles or otherwise. Also look for optional or included locking mechanisms and ergonomic features, such as wheels and comfortable handles.

Look for small-cell, low-abrasion foams. They have the best durability and will minimize or eliminate the scratching of your lenses and equipment. Small-cell foams are able to hold the shape of the interior cavities as time goes by. Lower-quality open-cell foams will collect dust and won't repel water, and micro-cell foams can be so dense that they chip and dent over time.

For larger drone cases, look for removable trays that are well balanced in terms of placement and weight. It is important that item cavities are crafted and placed so that the weight distribution does not cause the trays to flop or warp.

Also look at the way the foam is cut. Waterjet-cut foam has the smoothest edges, and allows for the placement of the most number of cavities while maintaining weight balance. The process itself allows for maximum usage of space, which provides for the smallest case compared to die cutting.

Purchasing a case can be an afterthought, but it should be given the same consideration and research as the purchase of your drone and equipment.

Beth and Rick Bohlman
Go Professional Cases, Inc.



Rick and Beth Bohlman originally established Go Professional Cases to provide rugged cases for GoPro HERO sports cameras but quickly found a market in the drone industry.



This innovative case is capable of carrying the Yuneec Typhoon H and many other accessories that are needed on a shoot.

What recommendations would you give to an aspiring drone operator who has a Part 107 certification and is looking for commercial work?—Mike Christensen, via email

Answer: Having the certification is a good starting point, but there is a lot more to becoming a competent commercial drone pilot. Prospective pilots must have additional training in the various platforms, payloads, and missions that they will have to use in their work. The most important traits that professional drone-service companies are looking for include being scientific, disciplined, reasoned, and able to follow the rules for operating the drones safely and having the ability to learn—and be comfortable with—a variety of platforms, payloads, and missions. The bottom line is that the industry is very new, and potential pilots must be willing to tailor their training to their own goals and competencies.

We post job listings on Craigslist, with Facebook groups and advertising, on our own website, and in industry publications. Our contractors find us through our advertising in niche publications and online. As a rule, it is not the kind of work that lends itself to people walking into the office looking for work.

On a résumé, we like to see the types of drones and payloads/missions the prospective pilot is comfortable operating. Along with certification

and proof of insurance (\$1 million liability available through the Verify app or other short-term providers or long-term policies), companies need to know the type of work that the individual is comfortable and competent carrying out. Commercial work requires a great deal of discipline and focus to make sure the operation is safe for all involved. This means that pilot job candidates need to be fully aware of their strengths and weaknesses and can identify further training they might need.

While not necessarily a requirement, any additional information or demonstrations of competence are a good thing to bring to a commercial drone company. At ABJ Drones, we would not hire someone without examples of their work in the field. Providing information and examples of past work makes it easier for the company to know what training and guidance the pilot might need in the future. It is also important for the company to have confidence in a pilot it is sending out into the field. The more secure the company feels about the pilot, the better the chance for the pilot to get assignments and make money in the industry.

Vip Jain
CEO, ABJ Drones



ABJ Drones CEO Vip Jain stands next to the latest drone models at his office in Cranbury, New Jersey.

An article in the "Getting Started" section at RotorDroneMag.com noted that you should use thread-lock on all of the bolts and screws when you're assembling a multirotor. I've seen several types of thread-lock at the hardware store; which is best for our drones?

—Derrick Clarke, via email



Paul Stenberg, Zap distributor

Answer: Thread-lock, as the name implies, keeps threaded parts from coming apart under most conditions. There are two types: mechanical and chemical. Mechanical thread-lock includes split washers, star washers, and nylon-insert nuts. Chemical thread-lock can be both anaerobic and non-anaerobic.

Anaerobic thread-lock will cure when oxygen is not present. It also has a chemical component that cures in the presence of iron-based raw metal (typically not alloys). Non-anaerobic thread-lock is typically hybrid cyanoacrylate-based and does not rely on a metal component. A non-anaerobic

product will, therefore, lock both metal and nonmetal fasteners.

Most people are familiar with mechanical thread-lock but have never used a chemical thread-lock. The prime advantage of a chemical product is that it not only locks the fastener in place but also seals the threads, which, in some cases, prevents air and liquid leakage through the parts.

Both anaerobic and non-anaerobic thread-lock is produced in varying viscosities and bonding strengths. Usually identified by color, blue thread-lock is most common and allows the parts to be disassembled with basic hand tools. Red thread-lock is typically more permanent and usually

requires heat to disassemble the parts. Green thread-lock is typically a non-anaerobic product and has a very thin viscosity, which allows the chemical to wick into the parts once assembled.

In most cases, you should use blue thread-lock on all of a quadcopter's bolts so that they can easily be replaced. If you forgot to use thread-lock and everything is assembled, green thread-lock can be a big time-saver with its wicking capabilities because it can seep down inside the threads of the nuts and bolts. ⚡

Paul Stenberg
Distributor, Zap



Here are two of the most popular thread-locks: blue (medium strength) and red (permanent).

SEND IN YOUR QUESTIONS! RotorDrone is your magazine, and we enjoy answering your questions. If you have any drone issues you'd like solved by our experts, please email them to: RotorDrone@airage.com. If we feature your question, you'll receive a free one-year subscription or extension to RotorDrone magazine.



Treasure Hunt

Location: LKQ Pick Your Part, Denver, Colorado

Pilot: Andrew Coop (SkySpryte)

Equipment: DJI Inspire 1 Pro Black Edition

Camera: Zenmuse X5

SEND US YOUR PHOTOS If you have an image that you've taken with a multirotor that you'd like to see showcased in *Over the Horizon*, please send your high-resolution image, your Instagram handle (if applicable), and information on the location and the drone you flew to capture the image to rotordrone@airage.com. If we use your photo, we'll give you a free one-year subscription to *RotorDrone* magazine.

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Fully integrated into this machine is the flight controller, full-graphic OSD, and 40-channel video transmitter.



FULL GRAPHIC DISPLAY WITH EzOSD

The full-graphic On Screen Display (OSD) on-board provides a real-time interface with artificial horizons, fighter-jet style displays and an exchange of flight parameters.



WIRELESS VIDEO CONTROL

New "Tramp" 5.8GHz video transmitter with Touch-n-Race includes 40 channels with variable power levels from sub-1mW to >600mW that can be selected from a Spektrum Transmitter.



CUSTOM V-SPEC MOTORS

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