

MICHAEL

HOLZWARTH:

My name is Michael Holzwarth, as Philip said. First and foremost, I'd like to thank you guys in advance for giving me the opportunity to, for lack of better terms, drone on about drones for about a half hour here. Today, I'll briefly be covering the part 107 guidelines, the differences between hobby flying and 107 commercial flying, different policies, procedures, and my experience thus far in the industry.

At any time, if you guys have any questions, feel free to interrupt. I don't mind. And I'm going to leave some time at the end for questions. And if any of you guys want to come up and check out the bird up here, please feel free.

All right. This first slide is going to talk a little bit about my journey thus far in the UAV industry, or UAS. Bought my first drone in 2014 to take with me on a trip to Hawaii, edited up some footage, posted my content to YouTube, and got a little bit of semi-viral success-- about 50,000 views. And then a licensing company actually reached out to me and said, hey, we want to utilize some of your footage. We want to sell it. We like it.

And I just said, man, I just made this for fun. I can make money doing this. This is great. And saw a little side revenue stream there.

After I started making a little bit of money, I was kind of hooked. And when the first round of 107 exams took place roughly two years ago, I told my father at East Coast, I want to be the very first person in the state to take that exam. I passed.

I was the first person in the state of Massachusetts to hold the 107. That reign of terror lasted roughly five minutes till the kid next to me passed his test. And then there was two.

I then had some local success. Next, I made a video, as Phillip was alluding to, on Cape Cod over at Wellfleet. If any of you are familiar with the Beachcomber. I absolutely love that place.

Went and flew my drone there, posted a video. All the local news channels picked it up. And about two weeks later, I received a nice \$1,500 fine from the ranger station in Cape Cod.

They fined me for-- what was it-- some kind of Piper Plover Puffin bird out there. I was flying over a sanctuary. They were not happy with that. And I was operating a UAS over a national park.

I want to stress, though, the FAA didn't fine me. It was the ranger service that gave me the fine. I kind of chuckled at it, because I made about \$4,800 off the footage, and that made the fine kind of worth it.

In the fall of 2016, I basically hit some viral gold. I took my drone up to the Kancamagus Highway during the fall, made a nice little foliage video. Couple licensing companies picked it up. And that very next day, it ran on *Good Morning America*.

I got some national attention to the tune of about 4.7 million views on the video. Still counting-- people still watching that thing all the time. Especially in the fall, it gets a lot of play.

You might be wondering, what does 4.7 million views equate to in dollars? I'll admit, it's not that much. I wish it was \$1 a view, but, unfortunately, is not. I think I made about \$10,000 off that.

But something I was just doing for fun, and I had no intention of it going viral or getting that kind of success. So it was definitely a plus. After I got that national attention, a local production company called Above Summit, here in Somerville, contacted me.

Where you been all our lives? Come work for us. And now I'm a production coordinator and Lead Drone Op over at Above Summit.

Next slide. This slide, basically just provide you with some links to the full text of regulations, introduction material, and any other relevant documents. You guys can take a look at this on your own time.

All right. Next, we're going to talk a little bit about hobby [? versus ?] 107. Let's talk about the difference. Hobby operation is just how it sounds. You want to go out and take some pictures of your kids or do whatever, that's on your own time. That's hobby.

But if your intended use is for anything commercial, you are required to obtain a 107. Some examples-- real estate photos, aerial surveying, thermal imaging, search and rescue, industrial pipeline inspection, things of that nature even. If you're working for or with a non-profit, you still have to obtain your 107.

PHILIP

What are the asterisks there, Michael?

GREENSPUN:

MICHAEL

HOLZWARTH:

We'll get to it. We're getting there. So some basic operating rules are shared by both hobby and 107 operators. You have to keep visual line of site, must follow basic safety guidelines, maintain altitude of 400 feet or below.

Something to note, like Phillip was saying, you'll see these asterisk bullet points on the right-hand side under "107." You can get waivers and exceptions from the FAA to kind of break these rules. We're going to talk a little bit more about that as the slides continue here. We'll circle back to that.

Slide 4 talks about multi-person crew. They don't tell you that you have to have a multi-person crew. Sometimes it's really not needed.

If you're working for, let's say, a real estate company and they want you to take some photos of a residential house, you're standing right in front of the house. You don't really need a visual observer-- someone looking for obstructions or things of that nature. You can pull it off yourself.

But in more of a professional setting, or depending on the scope of your job that you're using your UAS for, having a visual observer is definitely helpful. I have some buddies that work in the industrial sector, inspecting pipeline that's 30, 40 miles long. They actually use 10 visual observers. And they stage them with radios and binoculars along the pipeline, just for added safety. And then they have the operator kind of cruising, walking with the drone, if you will, sometimes.

But my personal experience on movie sets and things of that nature, we operate with a three-man crew. We have a visual observer, a camera operator, and then someone behind the wheel of this thing right here. You will notice this camera on here can be independently operated by its own set of controls. And then the drone can be operated by its set of controls, which allows you to get more dynamic range of shots.

Drone can be going this way. Camera can be panning the other way. Drone can be rising up as camera goes down. So it really brings some versatility to your shots and things of that nature.

The last bullet point here mentions that the drone operator need not be certified, but a 107 operator must be on-site. You might be wondering when this would come into play. I get a lot of requests from wedding people-- wedding people, videographers, photographers, things of

that nature.

They look at the drone as kind of another tool in their bag to utilize when they're doing their gigs and things of that nature. They don't want to get a 107. They don't want the hassle. For them, it's easier to pay me \$100 just to show up and make sure they're doing everything on the up-and-up and supervising.

It always amazes me, too, at weddings why someone would want this loud spinning machine over their ceremony. While they're giving their "I dos," all you hear is [IMITATING DRONE]. Some people actually want it for the video, though, and want it for prosperity, I guess.

All right. Human factors in decision-making-- alcohol and drugs. Obviously, don't operate under the influence, no matter how tempting it is. Have a couple of beers, want to fly on the beach-- not a smart idea.

Let's see here. Crew resource management-- this basically stated, the more people you can bring into the operation, the better. Nothing wrong with an extra set of eyes. Fatigue and stress-- obviously, not a good time to operate.

Here's one of my favorites, talking about attitudes. The FAA, they list five attitudes-- anti-authority, macho, impulsivity and vulnerability, and resignation. The one I see the most out there is anti-authority, all the time.

People want to fly where they're not supposed to. They want to fly longer than they should. They want to fly in no-fly zones, 800 feet by Logan, right by the runway. That's just not beneficial for the hobby, not beneficial for anybody.

That Logan example-- Logan is actually currently doing something about it. The company DJI, which Philip mentioned earlier, they're actually the leader in commercial drone systems. They recently came up with this product called DJI Aeroscope. And what Aeroscope does, whether it's a DJI drone or not, if you fly into Logan airspace, it will ping your bird. And it will tell them your location and serial number.

The serial number is going to go right back to you. You're going to lose your 107. And you're going to get some hefty fines. It's just not smart to fly in Logan airspace or any airport airspace, for that example. Why do you want to mess around with the manned aircrafts?

Let's see here. Next, we're going to get into performance you'll basically find the same

performance issues that you do with fixed wings, but the drone, obviously, is going to be more sensitive to these issues. Things like high-density altitude, humidity, weight, high winds are all examples of items that are going to negatively impact the performance of your UAS. So definitely be cautious of that.

Loading-- I always like talking about this. There is no book yet about how to properly load these things. Now, this drone that I brought in, this only has a limited amount of camera and imaging systems that you can mount here onto the drone. So this camera actually comes off.

This whole entire three-axis gimbal system here can mount off. And you can put interchangeable-- if you wanted to put thermal, let's say-- let's say the police call me, and they've got somebody missing or somebody kidnapped. And they think they're in this area. I can do grid patterns with thermal imaging to find these guys. So that's this type of drone.

But when we're on movie sets and things of that nature, we're using what-- the term we call it is a heavy lift drone. We have a drone that has a wing span of about 10 feet from prop to prop. It's massive. It can hold up about 40 to 50 pounds on its own stabilizer.

And the problem is, is that there's so many different kinds of cameras that this thing could mount. You could mount an Arr Alexa Mini. You could mount a Canon, a Sony,. Cameras that you see people walking around the common, taking pictures with, you can mount on these types of drones.

The issue is, they're all different sizes. They're all different shapes. They're all different weights. And there's no real book on how to properly mount these things.

So what we do is test, test, test. We go out to wide open fields. Here's a good example.

Last month we did a movie called *Knives Out*. If any of you have seen James Bond, 007-- that actor, Daniel Craig. We were doing a movie for that. And they wanted this about \$100,000 camera mounted onto the drone for the job. If that's not nerve-wracking enough, flying \$100,000-- but then we were nervous.

We were like, look, we've never flown that camera before. We've never tested it on this heavy-lift drone. So we actually made the studio give us the camera for a week. We took it to a wide open field.

We played around with it for a while. And we got it dialed in perfectly. The last thing you want

to do is show up to a job and kind of "wing it" with six figures worth of equipment, where you're working around a guy that gets paid \$20 million a movie. It's just a recipe for disaster. So make sure you're always testing all the time, especially if you're loading different things.

You could definitely have fun with loading these things up, too. I was telling Philip a story the other day. About five years ago, when I had my first DJI Phantom, I mounted some Roman candles on the landing gear, chased my buddies around. So you could definitely have some fun there. There's nothing in the book about that.

Moving on, drones at night-- you do need a waiver to fly at night. And we'll get more into how to apply for these waivers and what portals you have to go through with the FAA. The DroneZone is actually for flying at night, and, again, I'll get more into that.

You can, however, operate-- we like using the term golden hour or civil twilight, if you will. The only rule is, you have to have a small strobe or anti-collision lights on there. We always like to mount on this drone right there, just to make sure we're not getting anything in the camera image. Or we don't want the footage to show the strobe, obviously, but we want to play it safe.

PHILIP Michael, hold on a sec. So is there an official mounting spot for a light here? Or you just have
GREENSPUN: to--

MICHAEL Velcro.
HOLZWARTH:

PHILIP Velcro it on?
GREENSPUN:

MICHAEL Gorilla tape.
HOLZWARTH:

PHILIP Interesting.
GREENSPUN:

MICHAEL Let's see here. Regulatory fine print-- don't be careless or reckless. Don't drop stuff. If you
HOLZWARTH: crash and it causes significant damage, which I believe the FAA considers \$500, you do have to report it. Luckily, I've never run into that issue, which is nice.

Pre-flight-- pre-flight is huge. Just like fixed wing, you want to do pre-flight. You can see all the

pre-flight requirements here on the slide. In my personal experience, I've seen situations go very bad because pre-flight has not happened.

Literally, three weeks ago, I had a buddy who bought this same exact drone. Actually, it was a version before this. This is a DJI Inspire 2. He had a DJI Inspire 1.

It was very cold outside. And he just fired it up and took off right away, did not pay attention to his battery voltage. About eight minutes into his flight, his bird dropped like a rock. And that was about a \$5,000 loss, just going out, having fun with your buddies.

So pre-flight is definitely something that you want to pay attention to. Personally, I double and triple-check before taking off. A lot of times, what I do-- I'll do my walk around the drone to make sure everything's good, make sure connection links are fine.

And then what I'll do, when I take off, I'll let it sit for about 30 seconds right in front of me, five feet off the ground. I'll watch the controls. I'll watch everything, make sure my gauges are right, make sure I have good connection to satellites, make sure it's GPS locked, make sure my Return-to-Home button is readily available and marked.

These are expensive. This setup right here, you're looking at \$10,000 into this thing. So a little extra time pre-flight is definitely worth it.

Also, remember, pre-flight just doesn't include only the drone, as well. If you're working with a multi-crew, double-check your comm systems. Double-check your batteries. Double-check the props. Make sure they're not chipped-- things of that nature.

This reminds me of one story. I actually did have a crash once about three years ago. You guys know what stand-up paddle-boarding is, right? People stand up on the paddle board, and they do this thing.

I had a company ask me to film them at night in Marblehead. And it was this big, open bay with a ton of boats. So we had, like, 40 yards of open water and then nothing but a boat parking lot.

And these guys at night were going to put LED strip lights all over them. They had these spotlights to go under the water on the board. And they were going to do some nighttime black light yoga session out there in the water.

Sure. If your check clears, I'll go film it. No problem. So I say to myself, all right-- I'm looking at

the situation. And I say, all right, there's a bunch of boats out there.

I do not want to hit them. It is going to be night. I will not see them when I'm flying. What can I do?

So I walked up to where I was going to launch from, dip my piggies in the water right there, and said, all right, I'm going to fly the drone out to the first boat. And I'm going to look at my control set-up, and I'm going to note how far away I am from the boats. I think I was 90 feet away.

So I told myself mentally, when it comes time to film this at night, I will not go past 90 feet, or I'm going to hit a boat. What do you think the problem with that is, anyone? Anyone know what the problem with that assessment is? What else moves?

AUDIENCE: Tide.

MICHAEL Thank you. The tide. I was a bonehead. I did not consider the tide.

HOLZWARTH:

So about two hours later when it came time to do the job, I put my piggies in the same water right there. But guess where that water was? About 20 feet out. So I'm thinking to myself, I got 90 feet to play with.

I don't know. I want to say, one of my last shots I wanted to get, I had them all lined up, all the lights. Everything looked cool. They're all doing a "yay." And I wanted to orbit around them.

And halfway around my orbit, I hear "crunch," "splash." I hit a boat mast. Luckily-- very luckily-- the drone hit the mast. The battery came out of the compartment.

The battery is what I heard splashing. The physical drone-- and more importantly, the memory card with my footage-- landed on the boat, which one of the guys ended up getting for me. So that was good.

PHILIP Michael?

GREENSPUN:

MICHAEL Yes.

HOLZWARTH:

PHILIP Quick question-- I thought these drones had sonar anti-collision systems like--

GREENSPUN:

MICHAEL These do.

HOLZWARTH:

PHILIP Yeah, so why--

GREENSPUN:

MICHAEL They most certainly do. And quite frankly, between-- I don't want to endorse this. You should
HOLZWARTH: always fly with your obstacle avoidance on and your vision positioning sensors and things of that nature. For me, personally, it blows my shots all the time, so I turn them off.

PHILIP I see.

GREENSPUN:

MICHAEL If this is a tip of a house and I want to go over the house and reveal what's behind it, but I want
HOLZWARTH: to make it look cinematic and I want to clip that roof real close and then reveal what I'm revealing, too many times I'd try to clip it close-- I'd hear "beep, beep, beep." No, you can't. Your shot's now blown.

So personally, I turn them off. For beginners, I'd recommend, do not turn them off. Fly with them on until you're very comfortable with these things. Again, they're not cheap. They're expensive.

PHILIP So a consumer in that boat situation, the drone wouldn't have hit the boat, because the anti-
GREENSPUN: collision system would have--

MICHAEL If I had it on, correct. If I had it on, correct. You'll notice on the drone, this is obstacle
HOLZWARTH: avoidance. This is obstacle avoidance right there. It's got visioning position system on the back and an obstacle avoidance on the back, as well. So they like to say they're idiot-proof, unless you turn everything off.

Next slide, we're going to talk a little bit about operating locally here in the Boston area. In order to fly commercially in the Boston area, you have to be a 107. And you must obey, we call it, the grid that ATC at KBOS created.

And let's just take a look at the grid here. So you'll notice on this grid, this is the local Boston

area. Every little square there has a number. That number represents the height that you can achieve if you obtain the waiver. And you also have to be 107-certified to fly in this grid.

You can do hobby flights if you-- theoretically, you're supposed to call the tower if you're doing a hobby flight and make them aware that you're going to be flying in the airspace. In my personal experience, every time I've called, no one picks up. You leave a voicemail.

But if you are flying commercially and you are 107-certified, you do need to pay specific attention to this grid. For example, if I wanted to fly in Boston Common, you can see right in that area, there's 100 box there. So without a waiver, since I'm 107-certified, I am allowed to fly 100 feet in the Common if I hold the authorization to do so.

And we're going to get more into when do you go through the DroneZone and when you go through LAANC. And we'll talk about that in a second here. Any questions about the grid? Anyone? All right.

AUDIENCE: I have a--

MICHAEL Sure.

HOLZWARTH:

AUDIENCE: So [INAUDIBLE].

MICHAEL Excuse me?

HOLZWARTH:

AUDIENCE: If I'm doing a hobby flight, [INAUDIBLE]-- are they the same?

MICHAEL No, it's kind of backwards, to be honest with you. Theoretically, if you're a hobby flyer, they tell

HOLZWARTH: you you have to be 400 feet or below. So in theory, if you called Logan and said, hey, I'm flying in the Common today and I just wanted to let you know-- I'm just doing it for fun and messing around-- theoretically, you could fly 400 feet.

Is that smart? No, because what's going on around there? Med flights, helicopters, things of that nature. Ton of people underneath.

I see it all the time. I'll walk down the public garden or whatever. And I'll see people taking off their drone, flying around like an idiot, having a grand old time. And I'm just thinking to myself, all it's going to take is for you to hit someone, and you're going to be on every news station

tonight.

All right. Let's get into a little bit of the waiver process. There's two portals for waivers and authorizations. One's called the DroneZone, and one's called LAANC.

The DroneZone is used for night flights, wide-area authorizations, and exceptions, such as those asterisked items that we were looking at earlier, like flying over people, flying from a moving vehicle, flying over 400 feet, flying at night, things of that nature. And also, the DroneZone is meant for wide-area authorization. So I hold a bunch of wide-area authorizations.

That whole grid that you saw, I basically applied for the entire grid. So I applied through the DroneZone, said, hey, FAA, I work commercial in the area. I don't want the pain in the butt of having to go through the LAANC system every time I get a job. Just give me the entire grid. And that's good for two years.

Now, the difference is, LAANC is same-day authorization. So let's say I get a job in Chicago, where I'm not always operating out of. And I notice that the address they gave me in Chicago has a little box around it. It's class D airspace. And they say I can only go 200 feet.

Well, if I don't hold a waiver for Chicago, then I would use the LAANC system just to get authorization for that one box that I'm operating in for that specific day and time. They will give that to you within 24 hours. Now, for the wide-area authorizations, or if you wanted to fly at night or over the grid box-- if they say, hey, you can only fly 100, but you say, hey, the building I want to film is over 200. I need 300 feet or something of that nature. You have to go through the DroneZone.

Now, the problem with the DroneZone is that it's a two to four-month waiting time. So it always behooves you, especially if you're going to work in your local market, to get these authorizations beforehand. I don't know anyone that's going to offer you a job four months in advance.

Hey, in four months, I want you to film this down the street here. Usually, these things happen pretty fast. So it always behooves yourselves to get all your authorizations and get all your waivers kind of in line.

Next slide here, we're going to talk about the certificate. Basically stated-- read the regs. Study up. Take the test.

Personally, with my affiliation with East Coast Aero Club, they have a great testing center, great people over there. So please make sure you go East Coast Aero Club.

Slide 16, certification for traditional pilots-- take an online course. Apply through IACRA and you're off and running, or flying, as they say. Slide 17-- for you guys in this class, you do have a couple options. Any private pilot license holders out here? Anyone?

Hey. All right. Private pilot's license-- no exams really required. If you do not hold a private pilot's license, you must schedule your 107 exam at your local testing center. Slide 18, we're getting back to the hobby and 107. We highlighted some of these asterisked areas here. I can talk about these a little bit more.

This is all about the power of the waiver. For example, about six months back, the Discovery Channel was down here. And they asked us to do-- they had a restored Viking ship.

And they were taking that Viking ship from Nova Scotia and sailing it down the East Coast. And the Discovery Channel was doing this big documentary show about it and how the journey went and the problems that they ran into. But for me, the problem I was running into is, I have to fly from a boat, which is a moving vehicle.

I had to be over 400 feet. And they wanted some of those shots at night. Luckily, we had all these waivers in place. If not, we would have had to tell them, hey, it's going to take two to four months for us to get these waivers. And they would have went to the next company. So it always pays to have these waivers and authorizations in place.

This is embarrassing. Slide 19 is some of the recent accomplishments and projects that I've been working on. Few A-list names up there. What I can say, locally in this market, is, we have seen a major spike in TV and movie productions being made in New England, specifically in Massachusetts.

It's been great for us, which is fantastic. Keeps us extremely busy, which is great. Hiring gigs are fun.

They are lucrative, as well. The problem is, there is a lot of pressure. When I was doing the *Equalizer 2* movie, we're flying-- we actually used this drone right here.

And they wanted me to fly the thing over Denzel Washington's shoulder. And I'm saying to

myself, man, one gust of wind or mistake, I could slice this guy's face open. So there is a lot of pressure associated with it.

Directors and DPs-- Directors of Photography-- they want things done the first time. Time is money. Imagine if you were-- there's one time where I was chasing a motorcycle, and there were some explosions going off. It took six hours to rig those explosions. They're only going to go off once.

If you mess the shot up, it's going to cost them another \$6,000 to rig up. It's going to take half a day of time to do it again. So there's a lot of pressure to get it done right the first time.

But generally, these jobs are few and far between. The primary jobs that we usually do-- marketing and promotional videos, documentaries, things of that nature-- can be a little less pressure. But once you get into the upper epsilon of doing feature films and things of that nature, be on your A-game.

All right. A little bit about life on set. Higher end productions, you can expect about \$2,000 a day per operator, which is lovely. Even the visual observer, making sure that we're not hitting power lines or things of that nature, the guy's just looking up and paying attention. He's making a great day's pay there. But again, there is a lot of pressure.

That \$2,000 per day-- I need to note, too-- that's not including gear rental insurance and media rental and everything else that comes along with it. So I work for a company called Above Summit, as I mentioned, here in Somerville. They're usually charging \$20,000, \$30,000 a day when we're on a movie. That's just a little piece of what the operators see.

We generally work in a three-man crew. When you're on TV and movies, it can be extremely humbling, as well. A lot of times we'll nail a shot.

The director will love it. Everyone will say, oh, that's great. You did such a great job.

Then the TV show comes out, and you're like, where's my footage? They don't use it sometimes. And you get kind of bummed out about it. So it can be a humbling experience.

You could spend weeks and hours on set, flying, creating footage, getting them content, and barely any of it will be used. I was talking earlier about the *Equalizer* movie with Denzel that I did. Seven days on set-- got them roughly two hours of raw footage. And about seven seconds made the final movie. I love the seven seconds, but wish there was a little bit more.

PHILIP Michael, what was the 12 days on set to 12 seconds in the final cut? Which movie was that?

GREENSPUN:

MICHAEL Oh, I think-- yeah, that was the *Equalizer* one. Maybe it was 12 seconds, not seven.

HOLZWARTH:

PHILIP And why bring a book?

GREENSPUN:

MICHAEL I'm getting there.

HOLZWARTH:

PHILIP OK, you're getting there.

GREENSPUN:

MICHAEL I'm getting there, buddy. The bring-a-book thing-- don't literally bring a book, because you'd just look pretty silly. The main point of the bring-a-book thing is, it can be extremely boring. You got to remember, the whole movie is not made with this thing.

HOLZWARTH:

They're generally doing action sequence with the drone, tracking shots, establishing shots, top-down, where you're high up and the camera's pointed straight down-- things of that nature. But there's about 30 other camera equipment and people out there that are also getting their shots-- their ground shots and things of that nature-- which does take up the bulk of the movie or TV show or whatever. So I have found there have been times that I've been on set 12, 14 hours, and I've only flown this thing maybe 10, 20 minutes. So there is a ton of downtime, hence the Bring-a-book

And sometimes it can be disappointing. Last year we did a pilot TV show for NBC called *Suspicion*. It was a very fun shoot.

They had a stunt guy getting dragged on the back of a Cadillac Escalade. And we got to track it and film it. And we just got some incredible footage, some incredible shots. Everyone was super happy.

The show wrapped. The first couple episodes of the pilot-- it gets sent off to NBC. A bunch of guys in suits were there. And they said, yeah, we hate this, and it just got scrapped altogether. And the good part is, their check still cleared, but we're not seeing any of that work.

That's about it for me. How do I click this link to get it to work? Phil asked me to string together some footage that I've taken personally, so you guys can kind of see the drone in action.

All the footage you're going to see here actually was not done with this drone. This is more of a professional drone. This was all done with a DJI Phantom. This is a drone that you could literally pick up at Best Buy for, like, \$1,000.

I like having it, just because you can throw it in the back of your car and have around. If you ever see something fun to go out and film, you have it there.

PHILIP Questions, questions?

GREENSPUN:

MICHAEL Yeah, guys. Hit me with some questions while this thing is playing. Anybody got any questions
HOLZWARTH: for me? If anyone wants to come up and play with this thing or take a look at it, feel free.
What's going on, man?

AUDIENCE: What is the endurance of the drone?

MICHAEL This drone right here-- dual battery system. So you'll notice, it's got two. Cool thing about this
HOLZWARTH: particular system-- self-induced heating batteries, which is great in the wintertime. Cold equals bad battery voltage. So with these things, heating and going, that's great.

In regards to range, if you're wondering about range, this can go a mile up and four miles out. Do I want to do that? No.

AUDIENCE: [INAUDIBLE] time?

MICHAEL Time? Estimated time, 22 minutes to 24, depending on load and how aggressive you're flying
HOLZWARTH: it. This thing has something called Sport mode or Ludicrous mode-- whatever you want to call it-- that you can get this thing up to, like, 80. And it's going to suck the juice out of the batteries real quick if you're thrusting full throttle for a while. But if you're just hovering, it could get 25, 26 minutes.

Back to the range thing, yes, this thing can go a mile up and four miles out. I never like to do that. I look at this thing as a big bag of money. You want your money close to you, or you want it four miles where you can't have your eyes on it?

You'd be surprised, though. A lot of people do like doing that. They call it "range testing." I call

it stupidity. Let's see how far we can send the thing before it has a battery failure or before it auto lands-- not something I like to screw around with, personally.

PHILIP Should be up now.

GREENSPUN:

MICHAEL Anyone else? Sir.

HOLZWARTH:

AUDIENCE: I actually work in [INAUDIBLE]. And this fall, we had our first drone. Should we require a 107 pilot for this?

MICHAEL For what?

HOLZWARTH:

AUDIENCE: For wedding photography?

MICHAEL Wedding photography? Yes. Anything you're going to make money or promote yourself-- 107.

HOLZWARTH: Just think to yourself, if I'm just out having fun, I don't need a 107.

AUDIENCE: We have photographers coming in. We have a \$50 fee to use [INAUDIBLE] photography. And you try to tell them [INAUDIBLE]. So the photographers don't want to pay [INAUDIBLE].

MICHAEL They do need to be 107, or a 107 operator has to-- you can hire a guy like me to just be there
HOLZWARTH: and say, hey, you're doing everything on the up-and-up.

PHILIP Make sure to read back the question, because--

GREENSPUN:

MICHAEL Oh, I'm sorry.

HOLZWARTH:

PHILIP For the video. Yeah, no, it's fine.

GREENSPUN:

MICHAEL Got it. Anybody else?

HOLZWARTH:

AUDIENCE: You mentioned that you often don't see most of your footage in the final cut.

MICHAEL Sometimes, yeah.

HOLZWARTH:

AUDIENCE: Are you allowed at all to publish that footage? Like, hey, this is what we didn't use in this movie [INAUDIBLE]?

MICHAEL
HOLZWARTH: So this is what we do. So in a lot of our contracts, when we get initially approached by Columbia Pictures or Lionsgate or something of that nature, they'll send us a volume of their contract and what we're allowed to do with the footage, what we're not. It's almost like an NDA, as well. You can't post behind-the-scenes stuff. You can't blow yourself up on social media or things of that nature.

Sometimes we put verbiage in there that says, hey, after-- we say we want to use the footage for our own personal promotion. What they generally come back and say is, you can do that after the movie's come out. They don't want you promoting something that they don't get first dibs at promoting first.

So after the movie is released, usually you give it a month grace period-- that in-between period before it's on Netflix or DVD, but it's out of the theater. Then we usually feel comfortable to kind of self-promote with that footage. Anybody else? Are you guys all mesmerized by the drone footage?

PHILIP Come on. [INAUDIBLE] video. Look at that.

GREENSPUN:

MICHAEL That was actually Big Island, Hawaii right there. That's local. That's in West Boylston.

HOLZWARTH:

PHILIP
GREENSPUN: I tell people that my dream is to get as good footage out of a \$400,000 helicopter as a person can get out of a \$400 drone.

MICHAEL
HOLZWARTH: The helicopter guys absolutely hate us. We are stealing their market share exponentially. Are the movie studios-- they have to hire the photographer, the pilot, the fuel, the time, the cost, all that, or they want to hire us at a third of a cost.

And we're going to get better, more dynamic footage. So doing it out of helicopters is going to the wayside. And everyone's kind of going to these machines now.

PHILIP GREENSPUN: Yeah, so Michael said this was about \$10,000, including the camera. There is just a piece of metal that's FAA certified through a supplemental type certificate called the Tyler Mount. And you just connect this to your helicopter, I think, landing gear or something and then put the camera on this piece of metal.

And I think that piece of metal-- the cheapest ones I've ever seen are about \$12,000. So just a piece of metal that has been through the approval process and all the paperwork costs more than the entire drone system. And the camera balls can be in the \$400,000 or \$500,000, \$600,000 range that go underneath helicopters.

Robinson actually makes a cool news copter. It's all FAA certified right from the factory. I think it's in the million-dollar range that has the ball and the camera and the transmitter back to the TV station. But as Michael said, do we really need those in the drone age?

MICHAEL HOLZWARTH: Yeah. No.

AUDIENCE: For the engineers [INAUDIBLE], what sort of features or capabilities would you like to see in the next generation of drones?

MICHAEL HOLZWARTH: The next generation of drones, what capabilities would I like to see? I'm currently, right now, talking to a bunch of people-- I guess not capability, but they're doing a lot with augmented reality. And I think you're going to see a lot of that coming out.

I'm sure you guys have heard of-- and I'm going to sound really nerdy here-- but Pokemon Go on your cell phone. And you can see the little Pokemon guys running around. Now, imagine if I wanted to train somebody on how to properly fly a drone. Then I could put these rings or circles or maybe directions on the screen when they're flying to go through the hoop and make a figure 8 or things like that. So I think we're going to see a lot of augmented reality stuff coming in and things of that nature.

Also, they're making them smaller. That's another big thing. And they're making them more diverse with image systems. What you can mount-- being able to mount something smaller, more powerful.

They have cameras now that have hundred-time zoom on one end of the camera. And then on the other end, they have thermal. So you can switch back and forth between the two on the same drone. So things of that nature-- kind of making them more efficient.

And battery time, as well-- that's a big thing. People want drones that are going to fly for hours, not minutes. So I think you're going to see a big push in that. Sir, go ahead.

AUDIENCE: Sort of in the same vein, in terms of controlability and autonomy, what does the standard control look like? Is it just two sticks?

**MICHAEL
HOLZWARTH:** Yeah, sticks [INAUDIBLE]. I've got a couple right up here. This is it. These are controllers.

I'll level with you. If any of you guys have ever played first-person shooter games on Playstation, it's about the same. One remote for the pilot, one remote for cam op.

PHILIP It's the same remote, basically?

GREENSPUN:

MICHAEL It's the same principle if you're playing a first-person shooter, left and right on the joystick.

HOLZWARTH:

PHILIP But camera operator and drone operator get the same physical remote?

GREENSPUN:

MICHAEL Correct.

HOLZWARTH:

PHILIP OK.

GREENSPUN:

MICHAEL Correct. Does that answer the question for you?

HOLZWARTH:

AUDIENCE: Well, the follow-on question was, in terms of where do you see things going or capabilities wanted by customer, in terms of autonomy, would it be better--

**MICHAEL
HOLZWARTH:** So thank. You thank you for reminding me. The keyword there is "autonomy." So there are different programs.

Now, I don't use them personally a lot, because my application is more cinematic and doing things of that nature, which I like to fly manually. There's more feathering and kind of finesse

to that. But a lot of people that are doing industrial, like surveying and things of that nature-- this thing is as powerful as it gets.

There's a program called Litchi that you can attach to this drone that you can run off their operating platform. You can put waypoints in and say, all right, go to point A at 50 feet. Snap a photo.

Then go 20 feet up. Go to the right 100 feet. Then take a video, and then go down.

So you can pre-program these things. A lot of my buddies do it. They make great money.

And all they do is, they program the grid into the drone, they hit Go, and then they sit back, and they watch the thing do the job for them. And there is-- there's great money in the industrial sector with these things-- with autonomous flights and things of that nature. The only time I've ever used waypoints is to do something called a hyperlapse, if anyone knows about photo or video.

A time lapse is something where you take a photo, then you move the camera, take a photo, move the camera, take a photo. A hyperlapse is when you include motion in something like that. Waypoint feature is great.

We put a waypoint at point A. And then 300 feet away, we put point B. And we say, every two seconds from A to B, take a photo and go to this straight line. Then we string all the photos together, and you get a cool, little hyperlapse effect.

So sometimes we use the autonomy. Honestly, the enjoyment, for me, is flying manually. I don't want to just enter in a bunch of data and say, OK, go do your job. I'd rather be on the controls and having fun with it. So hope that answers your question. Sir.

AUDIENCE: Yeah, I was going to [INAUDIBLE].

**MICHAEL
HOLZWARTH:** Some guys in the studio, again, who do the industrial kind of stuff-- yes, they'll utilize the functions for autonomy. But again, personally, I just don't. I like flying manually.

**PHILIP
GREENSPUN:** Over here, Michael.

**MICHAEL
HOLZWARTH:** Sir.

AUDIENCE: How much flying experience do you need to [INAUDIBLE] and do the close shots that you--

MICHAEL
HOLZWARTH: That's up to you. That literally is how comfortable you are with it. Some people I know never take the obstacle avoidance off. They think it's there for a reason.

They don't need to get that really tight, close-in shot. A lot of people just do what we call high and wide. You just fly the thing up 300 feet. You get a nice landscape view or whatever you're looking for, and you have the collision on for that or whatever.

But again, you probably saw some of those close shots I had in that video. You can't obtain that with the avoidance system on. Me, personally, I think within three weeks I turned them off, man.

I was like, this is not for me. I just wanted to jam on the thing and get some great footage. So the safety was impeding it a little bit for me.

PHILIP
GREENSPUN: Behind you.

AUDIENCE: I just wanted some more clarification about [INAUDIBLE]. You said 400 feet was the maximum height that I can fly [INAUDIBLE].

MICHAEL
HOLZWARTH: Well, not that-- it can fly well over 400 feet. But you're only allowed to fly up to 400 feet.

AUDIENCE: Can I be flying in my neighborhood's backyard?

MICHAEL
HOLZWARTH: Sure. The funny thing is, why do you want to, though? Why do you want to be three feet off the ground, risking your couple thousand-dollar piece of equipment when you can just take a handheld camera and walk?

AUDIENCE: [INAUDIBLE]

MICHAEL
HOLZWARTH: Oh, yeah. Oh, yeah. You saw in some of the shots there. I'm skimming waves at a foot off the waves, skimming them. So yeah, you can fly really low. Again, you have to have your sensors off for that, though.

The sensor systems that are on these things will say, what are you doing, you idiot? Don't fly me like this. So in order to achieve it, you have to shut them off.

AUDIENCE: [INAUDIBLE] So if you're three feet off the ground in your neighbor's backyard, is that considered your neighbor's property? Are they allowed to not let you--

**MICHAEL
HOLZWARTH:** Yeah, that's a slippery, slippery slope-- the privacy laws and things of that nature. A lot of the bad press that drones get-- like, oh, I was sunbathing in my backyard, and I saw a drone way up in the sky. And they're invading my privacy.

And it's just like, well, really think about that. You look like a little ant. How much privacy am I really invading? Hand-held cameras with telescopic lens are going to invade more privacy than this thing is.

**PHILIP
GREENSPUN:** So I think it's an evolving legal area. The classical law has been that the airspace belongs to the public. Only the FAA can regulate it.

But that's been eroded. I think a few states have been passing anti-drone laws--

**MICHAEL
HOLZWARTH:** They've been trying.

**PHILIP
GREENSPUN:** --of various kinds. So I don't think it's a-- I think it's an untested legal area. There was a question over here.

AUDIENCE: So the main aviation has the ADS-B by 2020. Did drones have the upgrade [INAUDIBLE]?

**MICHAEL
HOLZWARTH:** They're talking about it.

**PHILIP
GREENSPUN:** Repeat the question, please.

**MICHAEL
HOLZWARTH:** I don't know the acronym. What's the acronym again?

**PHILIP
GREENSPUN:** ADSB.

**MICHAEL
HOLZWARTH:** Yeah, fixed wing has to have ADSB installed by 2020. So the question was, are drones going to have to have them? The problem with it right now is, they don't make them lightweight and

small enough to equip on these things. When they do and the technology is there, I'm willing to bet you're going to see it. Yep, absolutely.

The problem is the weight. You can't throw that extra weight in and get any kind of viable performance out of it with them right now. But as the technology gets better and they make those things smaller, I'm willing to bet you're going to see them on every single one. Yep.

AUDIENCE: The guy sitting to your right [INAUDIBLE].

MICHAEL Can you do that [INAUDIBLE] really slow for me? Anybody else? Sir.

HOLZWARTH:

AUDIENCE: When you're piloting, how much are you looking out at the drone versus looking--

MICHAEL Great question. Great question. I've seen so many people crash their drone because they are--

HOLZWARTH: - I call them screen warriors. They got their control here, and they got their iPad mounted.

And they can see everything. And they're, oh, my god, this is so great. Boom, they hit a tree.

Why did they hit the tree? Because the camera-- now, this drone is a little bit different. When this drone takes off, this landing gear actually raises up above the body here. So this camera down here can spin 360 without getting the legs in the footage or anything of that nature.

But your general consumer drone, when you're looking at your iPad when you're flying, you're seeing what the camera sees, which is great. But what you're not seeing is your peripheral. You're not seeing that your props are out this far.

And if you're just sitting there, looking at the screen, you'll end up clipping something. You'll end up doing something. My general rule of thumb, if I'm flying by myself-- I set up a shot. I look at the screen.

A lot of times, though-- and this just comes with experience-- I can look at the drone and know what the camera's seeing. In a professional setting, that's why you have a multi-person crew, why you have a visual observer, because a lot of the times when you're getting paid and you're under pressure and time crunched to get the shot, your head needs to be dug into that screen. And that's why you need radio communication with a visual observer to say, hey, you're clear. No obstruction 25 yards. Have at it or whatever the case may be.

But flying for fun by yourself, my advice would be, look up at your bird every now and again.

I've also had people that have flown and then been like, well, wait, where is it? Because, again, these things can go a mile up and a mile out. And all the sudden, they're like, wait a second, where'd my drone go?

Now, luckily, for lack of better terms-- and excuse my language-- I call it the "oh, shit" button. But there's a button right here. So when I turn the drone on, what it does is, it communicates to satellites. It marks a GPS home point.

Now, if I'm being an idiot and I'm sending it out a mile away, the drone is smart enough to say, hey, I only have enough battery percentage to get back to your home point. And it will kick me off the controls altogether, and it will fly itself back and land right where you took off.

Same function as, where'd my drone go? I can't find it. If I really needed to, you hit that button, and the thing will fly itself back.

Now, if you utilize that function-- this is getting back to the sensors and things of that nature. If you have your sensors turned off, you're in trouble, because what the drone is going to do is take its most direct path back to your home point. If there is a building in the way, it will hit the building if your sensors are off.

Now, if your sensors are on-- I actually have this set up to where if Return-to-Home function kicks in, the sensors turn on. And then I also have it set up to where if it meets an obstruction-- let's say there's a building here. Oh, no, I don't know where my drone is.

I hit Return-to-Home, and it comes towards the building. It will sense it, and it will raise altitude until it clears it. And then it will clear it and continue on back to the home point.

I never like to rely on Return-to-Home, though. Never. I don't feel comfortable with it. I like knowing-- again, using the bag of money situation, I like knowing where my bag of money is at. I don't want it to get away from me.

You guys can come up and pick this thing up. It has some weight to it. If this thing fell 400 feet and hit somebody, they're in trouble. You're in trouble. So it behooves you to always have a set of eyes on it and pay attention to everything you're doing there.