

## Flight: Foils & Angles of Attack pg.1

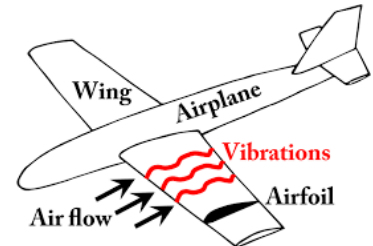
We have two fun flying contraptions for you in this Mod. Before these are passed out, we want to tell you about one of God's wildest fliers—the dragonfly— and how your contraptions are like His bug. We're also going to show how the dragonflies are like a jet is to a stone in how much more complex God's dragonflies are than your two fliers.



**A dragonfly fly demonstrating water adhesion!**

### The Super Fliers—Dragonflies!

Dragonflies are considered to be the aerodynamic wonders of the insect world. They can fly as fast as your car when it accelerates to get onto a freeway! They have four wings with four different muscles controlling them. Their tiny sand-sized God-designed brains can turn them faster and sharper than any drone, plane, or jet on earth.



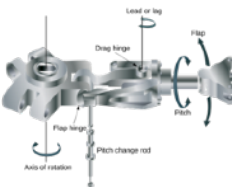
Dragonflies can fly forward and backward and up and down. If the wind blows them upside down, they can easily spin around and continue on their merry way. They are the best gliding objects in the sky. The veins in their wings generate vortices—little tornados— that make them so they can glide elegantly!



Dragonflies can catch the fastest insects on earth by turning their wrap-around-their-head eyes on the bugs, tracking them with incredible speed, and scooping them up with their front feet. Dragonflies are A-M-A-Z-I-N-G!

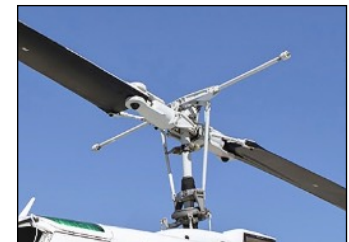
### Airplanes and Helicopters

Airplanes have “fixed wings.” This means they cannot tilt them. Pilots can make the flaps on the wings move, but not the wings. (Some airplanes can move their wings like VTOL aircraft, but it is not in flight, but for flight).



**The rotor turning mechanism of a helicopter.**

Helicopters can adjust their rotor blades. The big blade can go quite fast when they are on the ground getting ready for takeoff. When they are sitting there and spinning their blades fast, the blade is flat, not turned downward like one of the two flyers you'll get today.

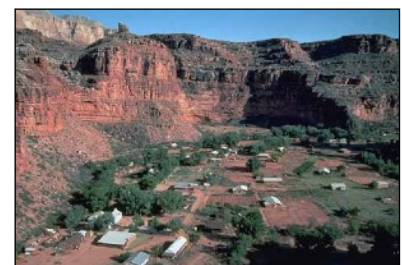


When it is time for the helicopter to lift off, the blades tilt like one of your flyer's blades are tilted, which causes air to shoot down, which causes them to go up. I had a funny experience with this.

### A Flying Whaaaat???

Years ago, we took a group of dads and kids on a backpacking trip to Havasupai Falls, which is in a finger canyon of the Grand Canyon. We drove out into the middle of nowhere in Arizona, then took a left turn on a road that ran another 20 miles north. This road ended in the strangest way we'd ever seen.

After passing nothing for 100 miles, suddenly, we were face-to-face with a cliff— a BIG one. Before the cliff, though, were a couple of dozen parked cars, lots of trucks, a helicopter, a bunch of horses, and a hundred people all busy doing something.



**The village of Supai.**

## *Flight: Foils & Angles of Attack* pg.2



We sized up the situation and realized this was where hikers took off. We parked, got our backpacks, filled up our waters, and headed out for a 9-mile adventure. A few hours later, we landed at the tiny Indian village of Supai, home of the Havasupai people.

The small valley had a few dozen small, simple homes, a store (where we learned there was ice cream!), a tiny hotel, a little church the size of our living room, and all kinds of odds-n-ends. It was incredibly unique, with such happenings as a pack of

horses bolting down the only road, a very dusty dirt road. The horses were eager to get to their feeding station after being relieved of their packs on the other side of town. We learned to get out of their way!

EVERYTHING had to be brought in by helicopter, backpack, horse, or mule. There was no road in or out of the little village. This was the stage for a very unusual helicopter experience not far from the turquoise waters of the river and the waterfalls.



### **A Trip to the Bathrooms I'll Never Forget**

On the second day there, I headed to the bathroom near our campsite, which was nothing more than an outhouse. Just as I arrived, a helicopter appeared out of nowhere

and began blowing everything around me all over the place as it came in close. While still hovering, a rope was tossed from the copter. A man ran out of the bushes, grabbed the thick rope, and began fastening it to the outhouse. I couldn't believe what I was seeing.

The hovering pilot then turned his rotor blades at a steeper angle and about blew me over with the force of wind they generated as it lifted straight up, outhouse and all! Both flew to 100 feet and then took off full throttle to the south. In moments the tie-er man and helicopter were gone, and all was normal again—minus one outhouse that I desperately needed!



Gadzooks! What a sight to see. A helicopter flying over a side canyon of the Grand Canyon with an outhouse dangling on a rope behind! You couldn't help but laugh. This was the craziest thing I've ever seen in the air! It even beat the balloons and the house in the movie UP! But then I realized that if I had come just a couple minutes earlier and gone into the outhouse, the tie-guy could have roped me inside and it

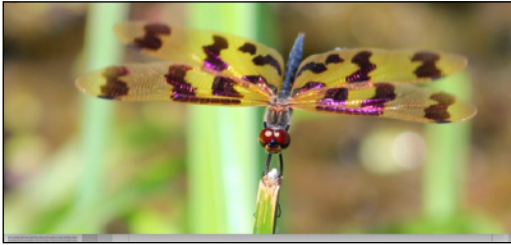
would have been up, up, and away in the flying outhouse for me! YIKES,

### **Helicopters vs. Dragonflies...NO COMPETITION!**

I learned that day how helicopters lift themselves up instead of just hovering. They tilt their rotor blades, and boy, does this increase the force of the wind downward! This shoots them up into the sky!



## Flight: Foils & Angles of Attack pg.3



You have two fliers for this mod, the Spin Copter and the Light Flyer, both have “rotors.” One rotor set is bent at an angle, and the other is not. The “Light Flyer” is propelled upward by a rubber band. It doesn't need to generate lift. This is why it gets by with a flat rotor. The spin copter, however, needs lift. That is why it has angled rotors. These shoot air downward and cause your spin copter to go up, just as the toilet helicopter did. Planes work very

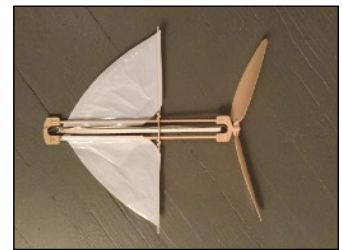
differently. They have a foil that generates all the lift as they go forward.

Dragonflies seriously outdo both our planes and helicopters. They have four wings with four separate muscles that their mini-onboard super-brain controls. Dragonflies can move their wings up and down together or by themselves. They can tilt each of their wings at different angles, too! It gets hugely complex when they fly, but their God-designed sand-sized brains control it all with mind-numbing elegance, making God's little dragonflies the aerial wonders of the world!

### Foils vs. Angle of Attack

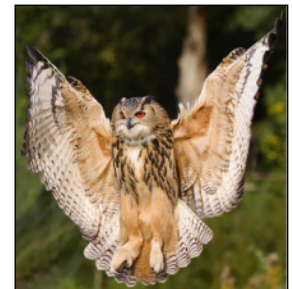


Watch the video below in just a minute. It shows how the Wrights played with a toy a little like your flyer and how they built a bent wing with an idea they got from it to get lift for their airplanes. Then the video talks about “wing bumps” –foils – and gives you the scoop on how they are used in both air and water.



*The Wright's toy copter.*

The critical thing to understand is that for birds, flies, bees, helicopters, planes, or anything else to rise in the sky through powered flight, all of them must have a way to get “lift”. The foil, which involves a curved surface, is a different way to get lift than altering the angle of attack of a blade as a helicopter does. (A simple way to think of the changing “angle of attack” is to think of flying from horizontal to various steeper angles like jets do all the time.)



When birds land, they often move their wings from horizontal to almost vertical. This changes the “angle of attack” of their wings. If a fighter jet goes from a gradual slope and climbs at a very steep angle, this changes the “angle of attack” of its flight. If a fighter pilot goes too steep in flight, the air will stop clinging to his jet's wings, and his jet will “stall” and begin to drop out of the sky! Pilots are now trained to deal with this very dangerous situation which has cost many pilots their lives.

It's essential for all pilots to monitor their angle of attack. We want you to begin noticing it—especially in bat, insect, and bird flight!

Watch this video now: [WRIGHTS AND FOILS](#). Then grab your flyers and try them out!

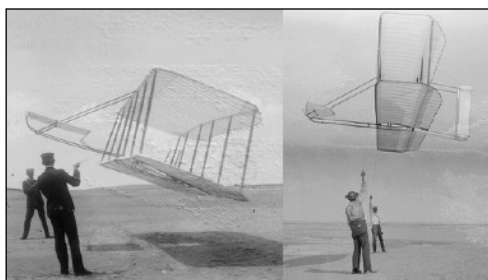


### Experiment: Flyers and Lift

20 min

#### SUPPLIES:

- ☐ 2 Flyers (Pak)



The [Wright brothers](#) testing their gliders in 1901 (left) and 1902 (right). The different “angles of attack” probably at different [airspeeds](#) are providing the wanted [lift](#).

#### PROCEDURE:

##### 1. Have fun!

There is not a lot to do for this part of the Mod, but just have fun with your two flyers. Build the light flyer correctly and use the rubber band shooter to get it up in the air. Notice how the “Light Flyer” has no angle of attack with its rotors, and the spin copter does. This is because the Light Flyer doesn’t need lift and the spin copter does.

##### “Light Flyer”

Fold your flyer as shown and insert the rubber band in exactly as shown. If the “rotor” comes off, carefully insert it as shown in the photos. (We use different flyers for WT based on availability; these photos ought to help with any of the flyers we use.)



##### “Spin Copter”

To fly the Spin Copter, put your copter stick across your left palm. Take your 3 middle fingers on your right hand and put them on the stick in your left palm. With your left hand frozen, rub the stick across your palm by the 3 fingers of your right hand. DO NOT MOVE YOUR LEFT HAND. This will get your spinner spinning fast and it’ll take off. If the rotor begins not spin when the stick spins, add some toilet paper around the stick end and jam the stick through it as you insert it into the rotor section. The toilet paper will make the stick firm into the rotor.

Here are a few articles and videos that might interest you:

[Astonishing acrobatics—dragonflies](#) Dr. Jonathan Sarfati

[How Helicopters Fly](#)

[V-22 Osprey Tilt-Rotor Aircraft In Action](#)

[First F-35B Vertical Takeoff Test](#)

[Airfoil](#)

[Understanding Aerodynamic Lift](#) VVG