CHAPTER 3.

SCIENTIFIC STUFF

Earlier, we suggested that scientific principles, expressed through kite designs and features, produce more stable and controlled fliers.

Let's try and say that another way.

> A poorly designed kite is unstable. It doesn't fly or worse, it flops all over the sky. It causes accidents, upsets your neighbors, crashes, and generally makes you frustrated and unpopular.
>
> A well designed kite does what you want. It's safe, goes where you send it, makes you look good and better yet, makes you feel good.

So science is the difference between being frustrated and feeling good.

> *A number of kite enthusiasts obtain as much pleasure from designing and building their kites as they do from flying them, and a great deal of time and effort goes into highly imaginative and well-finished creations.*
>
> *Unfortunately, imagination and craftsmanship alone don't produce lift and stability, so before proceeding with an original configuration it is well to have a grasp of the roots of aerodynamic theory as applied to kites. As in any other field of design, the measure of good design is directly proportional to the amount of information that one has on the problem.*
>
> ***David Pelham***
> ***Penguin Book of Kites***

Stability

We've been telling you that maneuvering fighter kites is based on recognizing, predicting, and controlling stability.

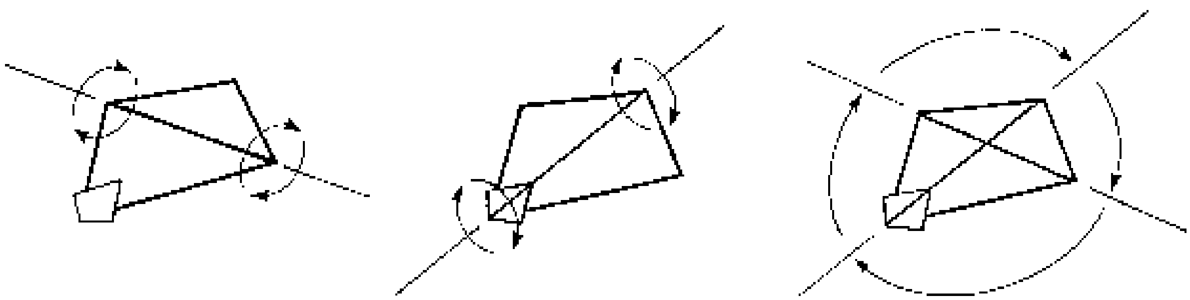
Actually, there are several different types of instability that effect your fighter. Some are helpful and can be used in maneuvering the kite. Some are not.

Let's take a look at the three basic forms of instability in kite flight.

Pitch: Think of a boat dipping alternatively at the bow and stern. That's called "pitch" or movement around the horizontal axis. Your fighter's horizontal axis runs roughly along the cross spar. Pitch shows up as wobbling at the top and bottom of the spine or the kite actually trying to flip end-over-end.

Roll: Now think about that ship turning over on its side. That's called "roll" or movement around the vertical axis. Your fighter's verticle axis is the center spine. When it rolls, the kite leans, wobbles or tries to rotate from side-to-side.

Spin: Finally, imagine a boat caught in a whirlpool and turning round-and-round its center of gravity. Fighters do the same thing. They turn around their bridle tow-point in a way which, if properly controlled, allow us to change direction. Aeronautical engineers call this a "yaw", but we'll just call it spin.



pitch **roll** **spin or yaw**

You're probably real confused now about boats, kites, pitches and yaws. The point is that unstable kites can move in a number of different uncontrolled directions. We need to look for design features which provide stability and control. Three that are particularly important are dihedral, balance, and the kite's angle of attack.

Dihedral — to convert spin into direction:

Earlier, we talked about dihedral as a design feature that helps provide stability and control fighter kites.

We already know that fighters are traditionally constructed with a rigid spine and a flexible cross spar. When you put tension on the bridle line by pulling, increased air pressure on the sail bends the wing tips back.

If you think about it, what you've done by bending the kite in half is change a single flat surface, into two flat surfaces joined at an angle. That's basically the definition of a "dihedral".

Dihedral is one of the most fundamental principles of kite flight and stability.

A flat surface naturally gives way to any pressure from the wind. Two flat surfaces, joined by an angle, move into a position that creates the least resistance. It works like a weather vane.

A flat kite has no way of naturally moving into a position of least resistance so it spins around the tow-point. When we introduce dihedral into the kite, we create a position of least resistance. That stops the spin and helps the kite move.

So as we've been saying all along, by carefully choosing the point in the kite's spin to suddenly create that dihedral, we are able to control the direction the kite moves.

Balance - to avoid roll and maintain equlibrium:

A fighter's dihedral will only work when the kite is properly balanced.

Balance is an important feature of almost all fighters. By balance, we mean that they have equal amounts of sail surface and frame weight on both sides of the center spine.

If the center spine of the kite doesn't divide the kite into two perfectly balanced halves, the wind will exert more pressure on one side of the sail and the kite will roll in the air. It won't actually flip over backwards because the bridle holds the front of the kite towards the flier. So instead, one side of the kite will lean back and it will either pull to one side or begin to fly in larger, uncontrolled circles.

This is something we'll talk more about in Chapter Five.

When a properly balanced fighter faces straight into the wind, the dihedral causes both halves of the kite to receive equal wind pressure. Then, if the kite leans to one side, that half of the kite exposes more sail surface to the wind and is quickly pushed back into equlibrium.

In other words, the greater surface area exposed receives greater wind pressure and tends to get pushed back into balance at the position of least resistance.

Let's take a moment now to rephrase our basic instructions for fighter flying. In a properly balanced kite, when you put tension on the line, you create a dihedral. This creases the kite along it's center spine and creates a position of least resistance — at least from side to side — which establishes both stability and direction. If the bridle and tow-point have been set to the proper angle of attack, the kite will naturally move off in the direction it is pointed.

Balance refers, not so much to the weight of the kite, as to the amount of sail area and how it is disbursed about the kite's frame. If the sail is even slightly larger on one side of the spine than on the other, the kite will favor or lean to that side. Even sail decorations such as applique can create wind resistance which effects this kind of "balance"

The traditional method of adjusting sail area on simple paper or plastic fighters is to cut or burn small holes in the sail. But I recommend you try something different.

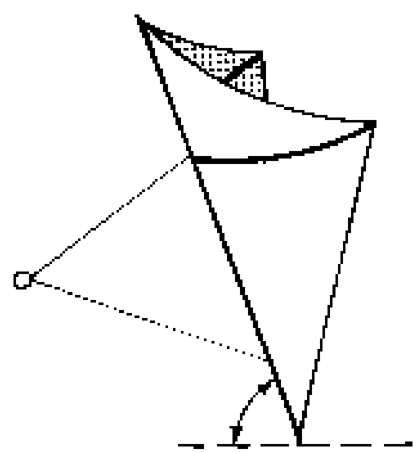
Kevin Shannon
Carlisle, Pennsylvania

Angle of Attack - to control pitch and increase response:

The “angle of attack” has nothing to do with diving on another fighter during a kite battle. Instead, generally speaking, it's the angle that the surface or spine of the kite faces into the wind.

The attack angle is formed by the bridle and flying line. Where these two lines come together at the tow point is probably the most critical part of your entire kite. An improper setting will cause instability that may prevent even the most perfectly constructed fighter from getting off the ground.

As we’ll see in the Tuning Chapter, even minor shifts will effect speed and performance.



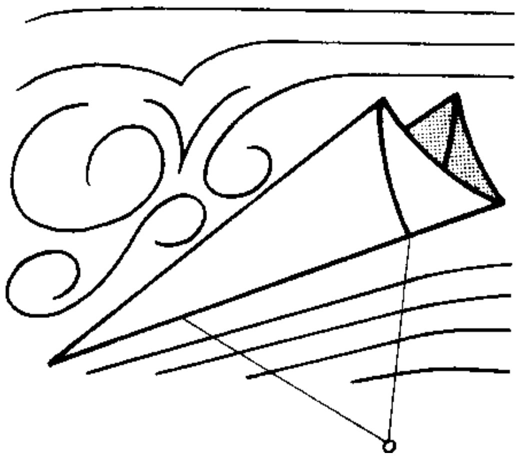
Angle of Attack

If the bridle is set too low, the kite may have a tendency to pitch or flip over so the back of the kite faces the wind. Usually, the bridle gets tangled or the flying line goes slack, and the kite dives uncontrolled and sometimes dangerously to the ground. If the bridle is set too high, you won't get any lift at all. You'll try to launch and the kite will keep settling lazily back down to the ground, tail first.

To test your bridle setting, hold the kite by the tow point. The spine of the fighter should be at an angle of between 20 and 30 degrees from the ground. Then test it in the air. Only small changes should be needed.

So What Makes the Kite Fly?

The wind, the design of the kite, and you holding on to the line from the ground, together create the conditions needed to generate flight or lift. And if you think about it, all three of these factors come together through the angle of attack.

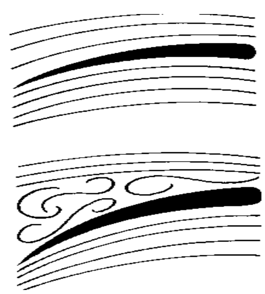


If the flyline and bridle hold the kite in the wind at an appropriate angle, then wind pressure is exerted against the sail. Lift results from this pressure being deflected across the face of the kite.

Wind moving over the top of the kite is traveling faster because it has a longer distance to cover. This creates a partial vacuum or low pressure area along the back of the kite which actually pulls or sucks the kite upward.

An aerofoil at a low angle causes air to accelerate over its top surface, decreasing pressure and causing lift.

An aerofoil at an extreme angle causes the airflow over its top surface to break up into turbulence, and lift is decreased.



David Pelham
Penguin Book of Kites

What this all means is that, if the wind speed increases or if you tug on your flying line to simulate an increase, your fighter will move faster and pull harder. If winds decrease or you let line out, the kite will slow down, fall back, or become unstable.

In higher winds, the edges of the kite may actually be pushed back in a way that creates a dihedral even when you don't want one. This makes direction much more difficult to control - especially when the kite is already moving faster.

Let's take a more indepth look at wind and how it effects fighter flying.