How Kites Fly—Faults and Actions—George Webster

1 Flying Faults and possible action
- or what to do if your kite won't fly.

The basic approach is from the point of view of a flier on the end of the line of a kite which is not in stable flight. Previous sections have included a certain amount of 'theory' to illuminate what is happening to the kite and therefore what can be done – although admittedly the theory is of more use in kite design. The discussion is largely in terms of a single spine kite with a 2 point bridle such as an Eddy or a Roller (see Drawings 3 and 4). It is easy enough to apply to a sparred kite with 2 or 3 bridles (e.g. Barndoor or a Box). But it doesn't work with a soft kite with multiple bridles – no adjustment is possible in such cases, after checking that all the bridles are tight when the kite is inflated, except perhaps adding or varying the size of the tail/drogue. If you are experienced or skilled enough to handle a 10m gecko or a 2m Edo you don't need help from this section to adjust it.

1.1 Immediate Instability
The first problem is when the kite spins quickly as soon as it has been released or rises a short distance then turns and dives into the ground. I am assuming that either you are launching it from your hand or you have a helper 10m downwind who holds the nose upright and releases it as you give a slight jerk.

I am also assuming that you know the second rule of kite flying. The first is DON'T LET GO. The second is SLACKEN THE LINE BEFORE A DIVING KITE HITS THE GROUND. This seems to run counter to the instinct of many new fliers but you will find

- that a tight-line power dive into the ground can cause considerable damage;
- that if you slacken the line, the kite will sometimes sort itself out or at least drift down nose up and
- that if it does dive the impact will be very much less.

Why slacken the line? Effectively, what you are attempting is to reduce the windspeed over the kite. If your line storage system won't let you do that, then always have spare slack line laid out in a zig-zag on the ground in front of you when you launch. Alternatively you may have to run towards the kite or even, if appropriate, throw the line storage system towards the kite.

If the kite shows this immediate instability, what can be done about it? Unless we are considering an untried design, there are two possible causes.

Firstly, the kite has been incorrectly set up. So check it. The cause could run from spars in the wrong place through to a part of the bridle caught around the frame. The latter happens quite often with multi-bridle kites such as Barn Doors or Roks. One of my finer moments was attempting to launch my son's Rok upside down – several times; at the start of an important Rok fight; and while disagreeing with his choice of language.

Secondly, the wind is too turbulent or just too strong. While the former might be resolved by finding a better launch site, the latter might be coped with by adjusting the kite. On the field there are two things to explore.

- on a 2-leg bridle move the ring or knot to shorten the top leg, moving the bridle point forward. By how much? Only experience will tell you, but for most kites 1 cm is a considerable shift
- adding a tail or adding to the existing one. The limit to 'additional tail' is that the kite rises but can't lift it. The problem is that until the tail is flying behind the kite its full effect will not be known.

Quite often changing the tail requires you to change the bridle e.g. to compensate for the lower angle of attack brought about by the tail's drag.

1.2 Faults in vertical elevation
Consider the situation where the kite is flying so you are looking at the underside of the front but although 'stable' it is not flying perfectly i.e.

a) it is at a lower angle than anticipated
b) it is not quite straight into the wind
c) it is not located straight downwind – often only spotted in comparison with other kites

Examining each case:

a) Of course some types of kite fly at lower angles than others. Assuming that it is stable and not sinking (in which case you might be pumping it i.e. pulling in a few metres of line causing it to rise, hoping that it would stay at its new elevation by willpower or increased windspeed), then the most likely cause of an unexpectedly low angle is that the wind is too strong. In this case, although the kite remains stable, the increased wind speed causes more drag than lift and the drag pulls the kite down-wind. The effect is increased where a bridling system which fixes an angle of attack means that the kite is at a higher angle of attack when low down – increasing the drag to lift relationship. Drawing 2 illustrates this. The solution is to move the bridle point forwards i.e. lower the angle of attack.

Deltas are particularly prone to this and may become low angle hard pullers and in extreme cases break the spreader bar. Their bridle point is often fixed by being the low point of a keel. The article deltas does show a way round the problem.

Kite designers specify a bridle point to help achieve the desired flight characteristic e.g. highest flight angle for altitude, a low angle for drag (i.e. pull) or a point between for lift – again see Drawing 1.

For a whole range of flat kites (e.g. Eddys and Rollers)

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changing a bridle point to achieve altitude as the windspeed changes is easy to do – and frequently necessary for good flight.

b) There must be some lack of symmetry if the kite is not quite straight into the wind – although not so large as to produce 'Immediate Instability' (1.1 above). Apart from inaccuracies in the dimensions or the stitching, differences in spar lengths might be the cause – or even spars with uneven flex. Again with a delta, reverse a wooden spreader spar and see what happens. Check carefully that the spreader is perfectly at right angles to the keel of the kite – most easily done by measuring from the spar pockets to the nose.

These sorts of problems occur when a kite has been repaired. Sometimes wear develops different degrees of stretch in parts of the fabric.

c) Relatively few kites fly precisely downwind – look at a kite-filled sky – which is why kite lines cross when fliers are close together. This can aid casual conversation with fliers together but kites apart. Untangling is another conversational aid.

Trying to sort out flying at an angle to the wind involves the actions mentioned in b) above. However, there may be situations in which you want a single line kite to fly stably at a considerable angle 'off' the wind e.g. when the kite is being used to carry fishing lures beyond the breakers and the wind is parallel to the beach. I have a New Zealand fishing delta with instructions that advise fixing a plastic bag on a short line to one end of the spreader at its junction with the leading edge spar.

1.3 Minor movements of a kite in flight

We now need to analyse, in a simple way, possible minor movements which the kite makes when it has achieved its stable altitude. Drawing 3 illustrates the three movements of Pitch, Roll and Yaw for a Pearson Roller. Drawing 4 shows the plans of the kite, the angle of attack and dihedral. A properly constructed kite of good design should return to equilibrium i.e. to be stable, when caused to move in flight e.g. by turbulence.

1.3.1 Relatively few kites **pitch** – I know of two situations. The first is when the kite's airspeed is varied quickly (e.g. by pulling in or letting out line) so that the kite moves from high lift to high drag.

The second is a kite with an over-large tail where in a gusty wind the excess drag in addition to causing the kite to veer may change the kite's flying angle. Sometimes a longer bridle can help.

1.3.2 **Roll** is the result of differences in lift between the two sides of a kite e.g. ABED compared to ABFG in Drawing 4 of a two-sailed kite. The basic problem with roll is that it is associated with sideslip (where the kite moves sideways) and turning (think of uneven lift on the front sails of the Roller).

Roll has been 'designed out' of kites in several ways:

e.g. vertical surfaces (in square flown boxes) and fins (deltas and note the rear fin on the Roller).

e.g. use of dihedral. Drawing 5 shows the operation of dihedral from behind a kite where the horizontal wing has a bigger lift arrow than the other. Dihedral may be achieved in several ways. In Drawing 4 the cross spars at DG and EF will be joined at the centre spar AB by 150 degree fittings.

Another widely used method is to have a line running wing-tip to wing-tip which can be adjusted by a slider to give the desired bend to the cross-spar(s). At one time when many Eddys/Diamonds were non-dismountable e.g. fixed assemblies with string edging the paper kite sail, great play was made of whether better dihedral came from a bent cross spar (e.g. by string and slider) fitting into a slack sail or by the line running wing-tip to wing-tip of a taut sail. I have a small diamond kite where both spars, keel and cross-spar are oversized and tied at right angles to each other. With a slight resemblance to an umbrella, this results in a good flier with curved keel and dihedral.

Some original Eddys were designed with rigid cross spars but flexible spines.

Dihedral may be built into the fabric eg the Sode.

To summarise, many kites

- have dihedral designed in.
- have adjustable dihedral – use of tensioner or slider
- have some 'automatic' increase of dihedral with windspeed e.g. a flexible cross spar or even a flexible joint.

Dihedral to compensate for roll, sideslip and turning is so successful that it accounts for so many flat kites having a central keel. Imagine from Drawing 4 trying to fly a Roller bridled from D, G, E & F. Box kites are exceptional (see Drawing 6). Flown square – with no dihedral – they can be bridled from A and B. The same frame flown on one corner could have a single bridle at A and more lift.

The value of some form of dihedral from a centre line bridle reinforces the view that the first kites were a leaf which would naturally flex each side of the stem.

Roll may well be a design problem, simply that the kite cannot cope with turbulent wind. On the many kites where some sort of tensioner is used in changing dihedral with higher/lower windspeed may be very effective. A few kites allow choice of cross-spar flexibility in accordance with windspeed.

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1.3.3 **Yaw** (see Drawing 3) is our third movement.

Assuming a smooth wind flow, then a kite will usually yaw as a result of some imperfection or lack of symmetry. Kites usually have yaw designed out with a fin or fins, or vertical surfaces which will normally damp down the initial movement. A few kites hunt for equilibrium at a very high angle (see Drawing 2) in a way which includes yawing. WauBulan and similar Malaysian kites are designed to fly at the highest possible angle and are famous for flying in a horizontal figure-of-eight at the top of their flying angle.

If your kite yaws a tail might help. You could try fitting additional bridles across the kite.

1.4 Combinations
A major complication is that (for example) lack of symmetry can well cause roll and yaw at the same time and that such a combination may well produce instability. For example a rolling kite with dihedral might well become steadily less stable as the wind gives a sideways force to the upraised wing. One of the lessons which pioneer aircraft designers had to learn was that aircraft turned much more easily when roll and yaw were combined in a banked turn.

Pitch and roll can also combine with serious effect when, as the angle of attack increases, stalling might occur on the upward pointing wing – giving stall plus turn.

Writers on theory agree that a kite is more likely to deal with these shocks if it is light compared to its size. A more precise measurement would be weight/wing area. Nicholas Wadsworth has some good data on wing-loading and its effect on kite stability (see Bibliography). However excess weight is not something which you can normally rectify on the kite field.

Using some of the analysis of small movements let us now consider more serious problems which you might face very soon after you have got your kite in the sky.

1.5 Unstable Divergence
The term is found in Wright's book, the description is that of a kite which rises apparently to an equilibrium height but then moves sideways and dives. Assuming you know the kite to be symmetrical – what can be done? Certainly treat it as a kite in too strong a wind – therefore move the bridle point forward. Remember you can vary windspeed yourself by walking up and down wind or winding line in or out to see what happens when you do. Try more dihedral if this is possible. Try a tail or drogue.

1.6 Major instability
A term covering a kite which zig-zags as it rises, then develops wider and wider swings until 1.3.3 above occurs or it spins. Try moving the bridle point back. Consider reducing dihedral. With any luck your problem is the wind – if not its speed then it may be gusty or rolling.

Bibliography

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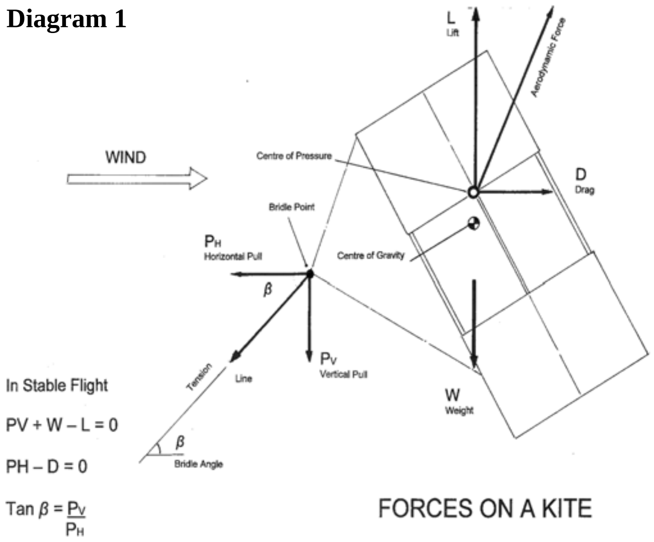
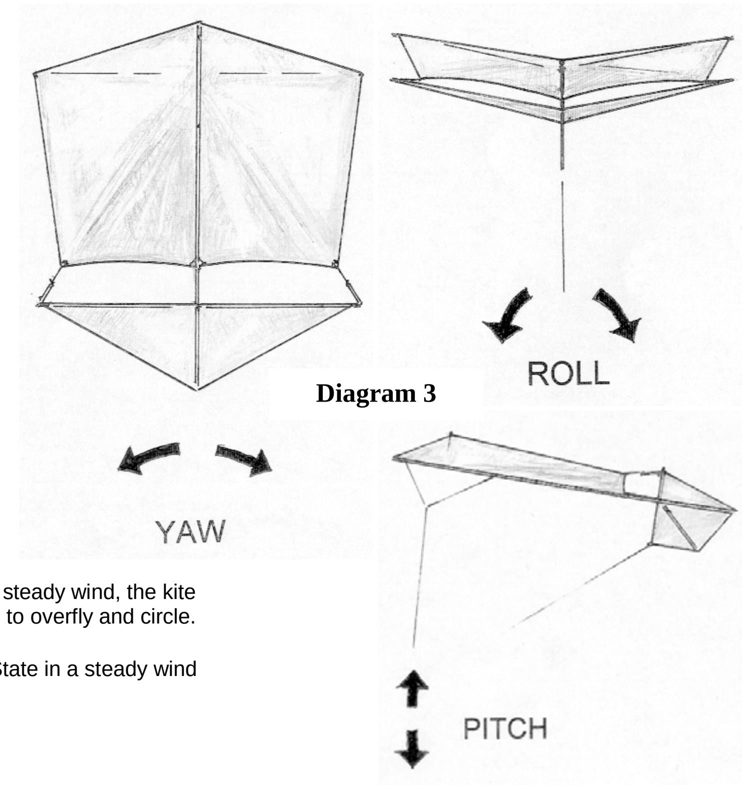
A Physical Description of Flight by D Anderson and S Eberhardt. http://www.aa.washington.edu/faculty/eberhardt/lift.htm

Diagram 1





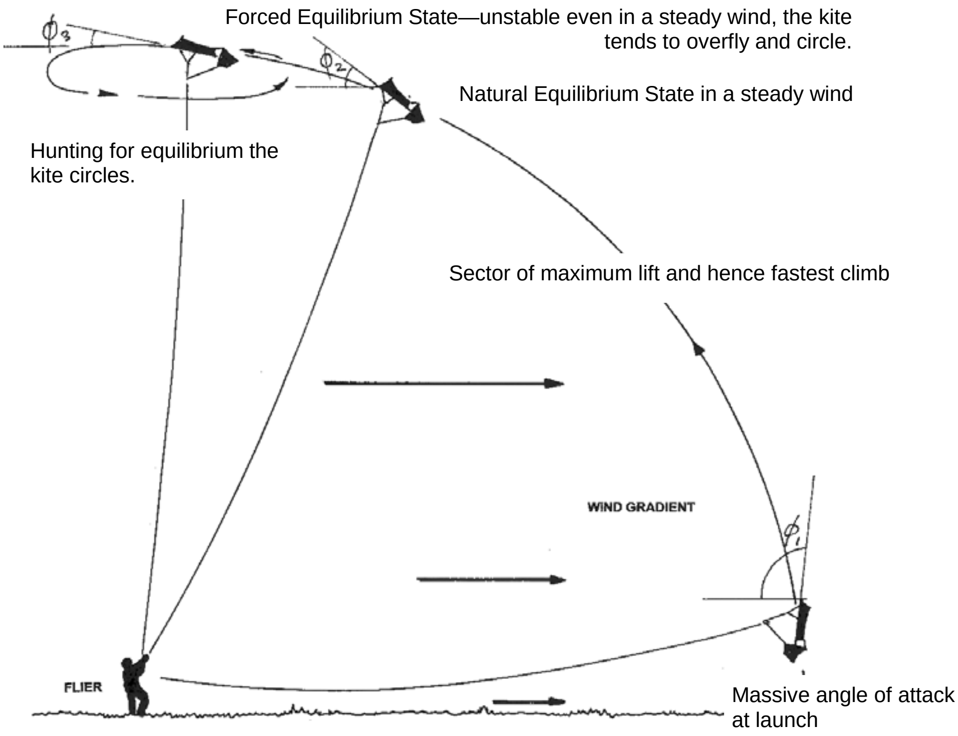


Diagram 2 Kite Behaviour in Ideal Winds

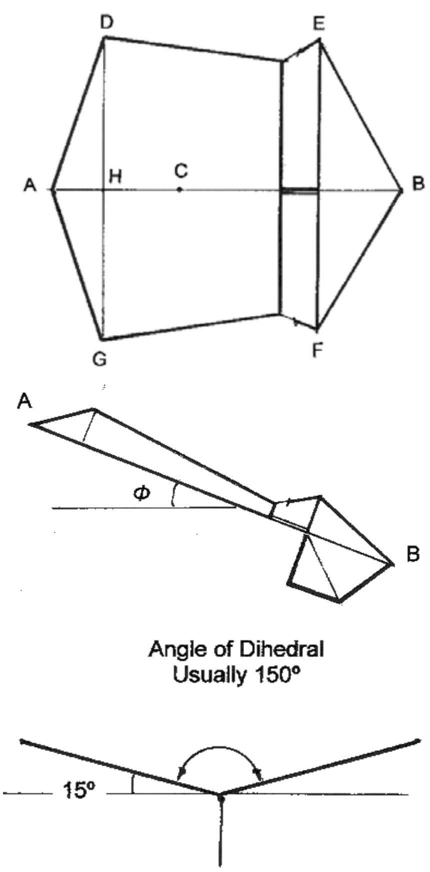
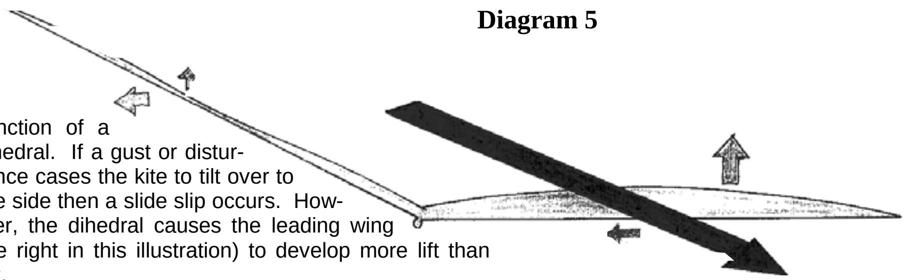


Diagram 4

Diagram 5



Function of a Dihedral. If a gust or disturbance cases the kite to tilt over to one side then a slide slip occurs. However, the dihedral causes the leading wing (the right in this illustration) to develop more lift than left.

Both wings develop drag as shown. The combination of these forces tends to restore the kite to an even keel. It will be apparent that a highly angled wing tip dihedral is more efficient, than a uniform straight dihedral but this is more difficult to build into the structure. Certain SE Asian kites are bowed back only at the tips and flat in the centre.

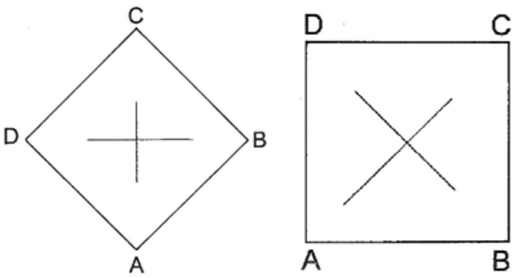


Diagram 6