

Delta Kites - History, Development and Design

By George Webster

Definition: A definition of a Delta is "A kite with two wings swept back leading edges, each stiffened along a least part of it's leading edge. There is a keel or spine that results in each wing having a conical section in flight. The distance between the outside edges of the wings is determined by a spreader bar".

References

¹Kitelines, Winter/Spring 1981. "You asked what is a Delta". A good account of the history and development of Deltas up to that point. Plans for 6 Deltas. Also the basis of a definition of Delta kites.

²Kitelines Winter 89/90. More on the role of Wilber Green and friends producing the Delta.

³Kitelines, Spring/Summer 1997. Tosa Dako. The ancestor of the Delta.

⁴Mark Cottrell, The Kite Store Book of Kites. Pages 34-36 deal with determining the tow point and the layout of a standard Delta. Pages 8-9 for a swept wing Delta.

⁵Neil Thorburn. Super Kites 3 1991.

⁶Dan Leigh Delta Kites. <http://www.deltakites.com>

⁷American Kite, Fall 1988. An interview with Francis M Rogallo, the man who invented the flexible wing, the hang glider and succeeded in mating a jet with a parachute.

1 Introduction

I have decided to write about deltas because the first kite I made as an adult in 1979 was a Delta and since then they have given me hours of pleasure. They are graceful and they usually fly best in the light winds that I most enjoy. Easy to assemble, just insert one spar. Easy to make too. This article is not written to allow someone who has never made a kite to go out and buy the materials and make one. Rather it hopes, without being "too scientific", to tell most fliers a little more about a kite type which many of us own. Perhaps also to get builders interested in new configuration and new types which they could try.

There are references, listed on

2 History

The origins of the Delta kite are not entirely clear, which is odd for a kite which is less than 60 years old. Most fliers probably think of Deltas simply as one of the kites which have come to us from 1948 - 63, that amazingly fertile period for kites in America, being a descendant of Rogallo's Flex Kite (1948). Other radically new kites were the Allison Sled (1950) and Jalbert's Parafoil (1963). Where would our children's workshops be without sleds? And where would our kite festivals be without soft kites?

Books usually say that the Delta is descended from the Flex Kite and that hang gliders, also developed from Rogallo's work - which advocated that wings should be flexible and allowed to have their shape influenced by airflow, not the rigid structures of traditional

this page, pointers (A-D) which refer to drawings on the Diagram Section plus a set of kite plans chosen to illustrate points made, particularly section 3. I suggest you look at them now as I haven't made detailed references to the appropriate plan as the point arises. Too complicated.

This is a modified version of an article originally published in The Highflier. Thanks to Harry Peart of the North East Kite Fliers. I sent the history section to Valerie Govig of Kitelines - she said she enjoyed it - so at least she didn't disagree.

I wouldn't have been able to write much of this without reference to old copies of The Kiteflier and Kitelines¹. I'm only concerned with single-liners.

aeronautics. Mind you a true Eddy kite has a very curved aerofoil, but that is a different story.

The Rogallos built the first totally flexible kite in 1941, patenting it in 1948. It was sold largely as a specialist toy in the 60s. But unlike Deltas as we know them it had no stiffening by struts at all, just a crease in the plastic along the centre line and it used multiple bridles to hold the fabric in shape (originally 28 lines, later reduced to 4). So don't look at the definition above, because unlike our Deltas it had no keel, no spreader bar and required a tail, probably because of the shiny plastic used.

The closest descendant of the Flex Kite was the Glite, a commercial plastic kite on sale in the 80s which used a solid nosepiece to fix the angle between the keel and the wing leading edges (A).

Delta Kites - History, Development and Design

A nose-fitting to pre-form the dihedral was used later with Peter Powell and Rainbow stunters. The legendary Russell Hall (1964) is a low aspect ratio kite which allows slack wings to take up a conic section but requires a considerable tail, and in my experience a locksmith's delicacy to set the bridle correctly.

Undoubtedly the first commercial Deltas were manufactured and sold by Fantastic Kites (which became Gayla Kites in 1961). Wilbur Green of Fantastic Kites was the patentee in 1945/6 and the main part patented was the keel. He had started in kites by designing Western versions of Oriental kites and saw an illustration of a Chinese bird kite with a keel. In 1963 Al Hartig (known as The Nantucket Kiteman) made a Red Baron, a cloth version of a modified red Gayla kite. Soon one of his friends used rip-stop nylon. Hartig obtained a patent in 1967 and his cloth Deltas became the basis for the kite we know today.

The name "Delta" seems to have been coined for one of his kites by 1966². So of the three 'essential' features of a Delta; the flexible wing doesn't seem

to have been derived from Rogallo, and Wilbur Green has claimed that Gayla kites were sent to the USAF before military work on the Rogallo wing and hang gliders. The keel came from a rather unusual feature on an Oriental kite (some Thai kites also have keels) and the spreader being loose enough to allow the wing to respond to the airflow might have been no more than the result of requiring a 'push fit' way of setting up a kite which had to be collapsed for marketing.

This account has tried to explain the development of the Delta in America, however, the world wide range and antiquity of kiting means that inevitably it can be shown that features of the Delta exist elsewhere. The most similar kite is the Japanese Tosa Dako³ which is basically a square plan flown on a corner, multi-bridled down the centre line. No keel, and with two or three spreaders set at about the point found on a Delta. The design has the Delta advantage of being easily rolled up with the spreaders removed, unusual for a Japanese kit, but shared by the Rokkaku. Two spreaders might seem odd, but Nishibyashi's aeroplane Delta uses this method. Keels were

also known to Western fliers before 1946. I am not sure when Brookite first used a keel on a kite but I remember seeing a plan for a Malay type kite with a keel in a pre 1914 model maker's magazine (an old copy). Woglams (1884) pleat down the centre line of a slack covered Eddy type kite produces a keel in flight.

Delta kites were being experimented with and developed, initially by American fliers through the 1970s and perhaps the most fruitful time when Delta variants emerged was the decade from the mid-70s. But it is interesting to note that Wagenvoords well known book of 1968 doesn't mention Deltas by name though it has a photograph of a Hartig Delta in Central Park, New York, but it does refer to 'dart shaped floaters'. Delta kites are of course in Pelham (1976) where it is recommended that they should have an aluminium spine to cope with them being temperamental in tricky ground winds. And I have met a flier who tried to build a Delta from Pelham in the 70s, didn't notice that the wing spars did not extend to the nose and found it wouldn't fly.

3 Delta Variables

In this section I'll look at the components of a Delta, e.g. Keels and wing shapes.

Materials and construction methods. First a few thoughts about materials and construction methods. The first (Gayla) Deltas were, of course, made of plastic while the first Hartig did-

n't use Ripstop nylon because it wasn't generally available. Many Delta designs still use plastic, partly because it is cheap (free, when reusing plastic carrier bags) and partly because it can be light and colourful. Ultralight designs can be made using aeromodeller's materials or even silver survival blankets. Another advantage of plastic is that both wings can be

cut at the same time ensuring symmetry.

Delta designs now use rip-stop nylon or similar which enables wonderful patterns to be created, however, life can get complicated with material which has two different surfaces, but where in order to control stretch each wing must be cut with the grain at right angles to the

Delta Kites - History, Development and Design

leading edges. There are some good printed fabrics, rarely used nowadays, which would make interesting kites.

Fliers who design their own Deltas might well encounter the two main problems. Deltas with long leading edge spars and with spreaders near the nose tend to glide and over fly. Deltas with a high-aspect ratio are prone to slide off the wind. Both might be helped by using a porous material.

Regarding size of Deltas. I have never seen a Delta of below 6 inch wingspan flying well without a tail. I've seen a 42 foot span Hardec. I've seen plans for an American 29.5ft plastic and bamboo (terrifying) and I have understood from The Kiteflier, October 2000 that the world single kite altitude record was broken by a 30ft, 18ft high Delta.

For a long time spars in Deltas were exclusively wood, except for drinking straws etc in the small/lightweight versions. The only spar which usually comes under great strain is the spreader bar and it has to flex evenly. Some designers claim that a wooden spar which flexes and breaks in heavy winds is a safety feature. Apart from safety problems caused by a shower of broken spreaders under a flock of Deltas caught in a sudden burst of wind there are ways of reducing problems from wildly flexing spreaders.

If you have designed the kite so that normally there is, say, 6" between the centre of the spreader and the top of the spine, then you can incorporate a 6" loop into the top of the

spine sleeve to control how that spar bends. This still allows the spreader to flex fore and aft. If required this also can be controlled by fixing a fin to the top of the spine with a hole to take the spreader at 6". (A possibility would be to develop this "dorsal fin" to provide directional stability needed, to omit the usual keel and to bridle directly to the spine).

You might, of course, decide to move to fibre glass or carbon fibre, the latter with no flex removes the compensation of a flexed spar in high winds, but it will save weight in kites where performance is worth achieving even at considerable extra cost.

Construction. Apart from getting the grain right, the only interesting construction method for Deltas has been how to attach the spreader bar to the wing edges. Recently, purpose built fittings have become available which have rather spoiled the fun and are considered by some to hold the wings too firmly and to interfere with flexibility. You will get some idea of the variety of methods used if you look at the plans available. I have fond memories of Jon Bloom's Stacked Delta which used curtain hooks pushed through punched brass eyelets, and also Earnest Barton's aluminium tubing beaten out flat at one end, pierced and sewn via a leather patch.

Keel. The keel of a Delta is seen as providing both directional stability and the appropriate tow point. It is thus determined by the size and form of the wings. Keels also serve to spread the pull of the kite across part of the length of the

spine (so if it was decided not to have a keel because directional stability was being gained in some other way, then a stronger spine spar would be needed). It is generally accepted that keels should be 8 – 10% of the sail area, probably less if the spreader is quite slack, more if the kite is to fly in string winds and so some Deltas have keels that extend aft of the sails.

If you are sure of the bridle point then the keel is usually made to have a 90 degree angle at the bridle point (bottom point). The keel is made of two pieces to allow the grain of the fabric to be at right angles to each edge (B). It is possible to calculate precisely the best size of keel for any Delta plan⁴ but if you are doing it by trial and error you might find (C) of value as this enables the tow point to be varied while still keeping the keel taut, you can also use the Fred Broadhead solution, Kiteflier April 1999. Although the effect of moving between tow points on the same keel (customarily three) found on some kites to allow for different wind conditions may be useful, an unsightly, flapping keel can result.

Variations of the standard single keel include:

Helen Bushell's Tre-foil Delta. The bottom line of the keel has a straight spar with a single tow point. In some versions the top of the keel is stitched to provide an aerofoil shape to the wings.

Having no keel: The Owl Kite is keel less and gets directional stability from the central arch and slotted apron.

Delta Kites - History, Development and Design

Having a double thickness keel: Invented by Dan Leigh and now called, I think, a Pop Fin, the keel has an open front edge which gapes when the wind drops, fills with air and reduces the kite's tendency to glide.

Twin Fins: I found my Owl kite's stability much improved by adding two fins along the lines of the V central spars.

Tunnel Keels: Various designs of tunnel keel have been produced, some rather like sewing together the two fins above. Others are tunnels which may taper to the front or aft.

It is probably possible to provide directional stability without using a keel, e.g. by the use of a drogue, a tail or by using a swept wing plan, but only the last solution avoids lost efficiency through increased drag.

Plan. The plan of a Delta includes not only the wing shape but also the length of the wing spars and the position and tightness of the spreader bar.

It is possible to set out the range of different dimensions of a Delta with a nose angle of about 90 degrees (Ref 4 again). Briefly the wing spars should be about 70 - 80% of the wing length and the spreader should be set 35 - 40% of the distance from the nose along the wing leading edge.

There is an almost bewildering array of plan shapes which have been used at one time or another for one purpose or another. Bi-plane and even quadraplane Deltas have been built. A good collection of plan types, with notes concerning their characteristics can be on the internet⁶ Dan Leigh is the maker of 'Dan Deltas', for many years the acknowledged leader of craftsmen made Deltas in the UK.

Generally, high aspect ratio kites are slower and provide more lift than low aspect ratio kites. (Here I am using aspect ratio in the crudest sense of: Width (height) of the wing centre line divided by the distance

from wing tip to the centre line).

Wings with swept forward trailing edges use less spar length for a given wing area, but I'm not sure about lift. Many American Deltas use slipped wings with trailing edge flaps and wings with concave cut trailing edges. Kite can also be found with 'frilled' edges, V cuts from the spine to give a butterfly look etc. But remember that even in rip-stop the trailing edges need to be finished if it is going to do a lot of flying.

The range of wing shapes seems to be endless. I'll say a little about two of them. Firstly there is a very rarely seen swept wing Delta design (Ref 4). Secondly there was at one time an unofficial competition for the highest aspect ratio Delta (early kites were about 1-1). My best was 2-1 but I have seen 3-1 with a batten in the wings. More than that would, I think, need a drogue. Finally a Delta can be rectangular (D) Very quickly from the mid-

4 Delta Variations

seventies designers combined the Delta characteristics of a spreader, which allows wing flexibility with older 'Kite Body' designs: Here are some of them.

Delta Conynes

Why triangular Conyne centre sections work so well with Delta wings I don't know, but they do even though Conynes were developed to fly at a different angle in stronger winds. The Marshall Delta Conyne was a famous high performance Ameri-

can kite of the late 70s. Instead of the usual two cells the Dunton Delta Conyne has a single open ended triangular centre section (more Bells than Conyne?) and has an excellent record in altitude sprints.

Stacked Deltas

Perhaps the most inventive combiner of Deltas, boxes and sleds was Neil Thorburn⁵ whose Stacked Delta used a Conyne centre section, has become a classic and has been modified to be many things, from a Christmas Tree (graduated wings from small to large) to

weird monsters.

Delta Boxes.

These are not often seen but there have been boxes flown from one corner with Delta wings added looking rather similar to Edwardian jibbed wing boxes.

Delta Sleds

Again, Thorburn has done it but the most sophisticated combination of just Delta wings with sled is Stormy Weathers "Winged Victory" also with a fine sprinting record. Would we classify the Washington Friend-

Delta Kites - History, Development and Design

ship kite as a winged delta?

Yacht Delta.

Before we come to kites where the Delta principle is used with a modified plan and wing shape we should mention this kite. Think of a Delta triangle as being a side view of a yacht hull and sails then add a fringe across the whole trailing edge width to suggest the sea.

Bird Kites

While even in the west "Bird Kites" pre-date the development of the Delta, it is true that the ability of delta wings to flex and move are admirable qualities for a good bird kite. Stan Swanson's 10ft Condor remains on the edge of Delta design. Joel Schultz's Parrot kites are wonderfully colourful yet simple and easy to fly. More than one design of Seagull claims to have fooled the real birds. George

Peter's birds somehow manage to combine vibrant colour, grace and being massive.

Aeroplane Kites

There have been one or two aeroplane kites based on Deltas. A plan by Nishibayhashi is included. I scaled mine up to 51" long by 88" span and am still waiting for there to be an ugliest kite in show competition for me to win.

5 Delta Plus

Somehow it seems that more than any other kite of kite Deltas lend themselves to being 'messed around with'. I am a founder member of SPCD (Society for the Prevention of Cruelty to Deltas) the main form or cruelty is to fly them in high winds. In America, from my limited experience, Delta also have spinning drogues added (1 off the spine and 1 off each wing tip). However, one of the most effective changes of

recent years has been French, where the basic, rather floppy Delta, has been transformed by a 20ft or longer painted training edge to each wing, done in a light trailing fabric.

Deltas can be flown in train, this is slightly complicated as unless a no-keel design is chosen there needs to be a slot in the spine to allow the line to go from one keel point to another.

You can also fly several small Deltas as a 'flock'. I have done

this with six small (3ft) kites attached by 12ft lines at 25ft intervals on a main line with a 6ft Delta leader kite.

You can also piggyback. Done correctly, you need a slot arrangement required for a train but if the difference in size is large enough (eg from 3ft to 8ft) you can simply attach a short line from a small kites keel to the centre of the spreader bar of the large kite. It reduces the flying angle but it can look interesting.

6 Using Deltas

1 Kite workshops for children quite often use simple deltas although it has to be said that getting symmetry can be a problem and sleds do now seem to be more popular.

2 Lifting, although soft kites can be more powerful in anything more than a light wind and a high flight angle can be a problem, the fact that big Deltas are easy to use and deal with a wide range means that they have been widely used for lifting cameras and fauna drops.

3 Fishing. Using kites for fishing is widespread throughout the Pacific. "Benny's Kites" of Auckland, New Zealand make a fishing Delta. It has plugged hollow spars so that it floats. Users are advised how to get the kite to fly at an angle to allow the hooks to be pulled out to sea even with a wind parallel to the beach (attach a shopping bag on a line to one end of the spreader bar).

4 Stunting. While I'm not dealing with the whole line of sports (or stunt) kites which are said to be Delta based it should be mentioned that 10 years or so ago there were specially con-

figured and bridled deltas (eg Gryphons) which were slow and graceful 2 line fliers. Glites could also be set up for 2 line flying.

5 Falcon training. This is the most unusual use of Deltas known to me. The birds are kept fit and learn how to fly higher following a lure fixed below the kite⁶

6 Highflying. According to the Kiteflier, October 2000, Richard Synergy on 12.8.00 flew his Delta to 'not less than 13,600ft' breaking a disputed record that has stood since 1898. Not bad for a 'dart shaped floater'.