CHAPTER 9

Soft Kites

1 Introduction

The first article I wrote about kites dealt with Deltas, which were identified as "one of the kites which have come to us from 1948/63, that amazingly fertile period for kites in America." (This article has been incorporated into Chapter 7.) The others are sled kites (Chapter 8) and now soft kites (or inflatable kites)[1]. I left soft kites until last largely because I know least about them and don't fly them all that often. I've never made one and know far less about the practical problems of making and flying large soft kites — even though I spend several weekends a year near to some of the leading designers, fliers and their kites.

"Soft Kites" as a kite type are different to deal with, compared to say Deltas, as we are considering a relatively small number of designs mostly by an international group of highly talented designers/makers, rather than by adventurous club fliers. So after a look at some definitions, Section 2 is a chronology and Section 3 examines design features.

The fundamental soft kite is a parafoil (Illustration 1) in which there are no spars and the upper and lower surfaces of the skin of the kite are connected by risers. There is a gap along the leading edge through which wind enters and by pressure inflates and holds the kite's designed shape. The shape flies i.e. produces lift greater than weight plus drag. Such kites have been called descriptively "ram-air". The principles of ram-air inflation, not necessarily from the leading edge, and the kite's flying surfaces being held in position by internal fabric risers (or later by cords), are common to nearly all soft kites.

1. For years I have used the term 'inflatable kite' in commentary at kite festivals. Recently a TV cameraman asked me about the gas that was used and where it was inserted. I now wonder how many spectators believed they were seeing essentially balloons on a line below a small kite (the pilot kite — see Section 3.5).

Illustration 1: the Parafoil

There have been some kites which do not use ram-air for inflation. Of most practical importance has been the Kytoon developed over 60 years ago by Domina Jalbert and used for many years for lifting loads such as timber in isolated sites. Jalbert developed it as a response to the bending of the spars of large kites such as his 5m. triple Conyne which affected their performance. The Kytoon is a snub-nosed gas-inflated balloon with two horizontal and two vertical planes at the rear. The horizontals provide additional lift which helps to reduce a tethered balloon's tendency to be blown down in anything above a medium wind. The vertical fins give directional stability (see Pelham[1], p.87). It is worth noting that in 1909 the airship "Baby" which was designed and constructed at Farnborough had horizontal fins and a single vertical fin. Overall it was a broadly similar shape although the fins were proportionately smaller. It used hydrogen to inflate bag and fins — unlike the Kytoon's single-skinned fin. The aim was to provide directional stability (P.B. Walker *Early Aircraft at Farnborough Vol. 1*, 1971). It was a recognisable ancestor to Second World War barrage balloons but is quite different from the 'bird barrage' balloon kite mentioned in Chapter 3.

At least two toy kites have been marketed which used inflation by mouth to produce the flying shape (a fat Eddy). One, the Stewkie Glida-kite is lost in the mists of the 1970s, the other the American Puffer kite (with an ingenious straw and simple valve inflation system) was still being made in 1997 (Illustration 2).

Illustration 2: the Puffer Kite

The absence of spars is not by itself the mark of a soft kite. Back in 1948 Francis Rogallo patented his flexible kite (see Pelham p.83 and the chapter on Deltas) where the bridles determined the curve of the wing (i.e. no spars but no inflation). First sold by the Rogallos in 1949, the original design was produced commercially as a toy for many years (Illustration 3).

Illustration 3: Rogallo Flexible Kite

Rogallo in his 1948 patent application foresaw that a stiffened keel or spars might be needed in a large kite — he mentioned that they might be inflatable. So Rogallo could argue (see article in *American Kite* Fall 1988) that the key invention

was the idea of the flexible wing and in that sense Jalbert's inflated wing section followed Rogallo's invention.

Ram-air tubes to replace the spars in the sled design were produced — Ed Grauel's Bullet of 1973 is a forerunner, followed by John Verheij's Parasled of 1985. I have memories of monstrous Eddys being produced for record-breaking purposes in the USA which used pre-inflated (i.e. not ram-air) spars. Similarly, gas-filled spars are used in this French high-altitude model (Illustration 4).

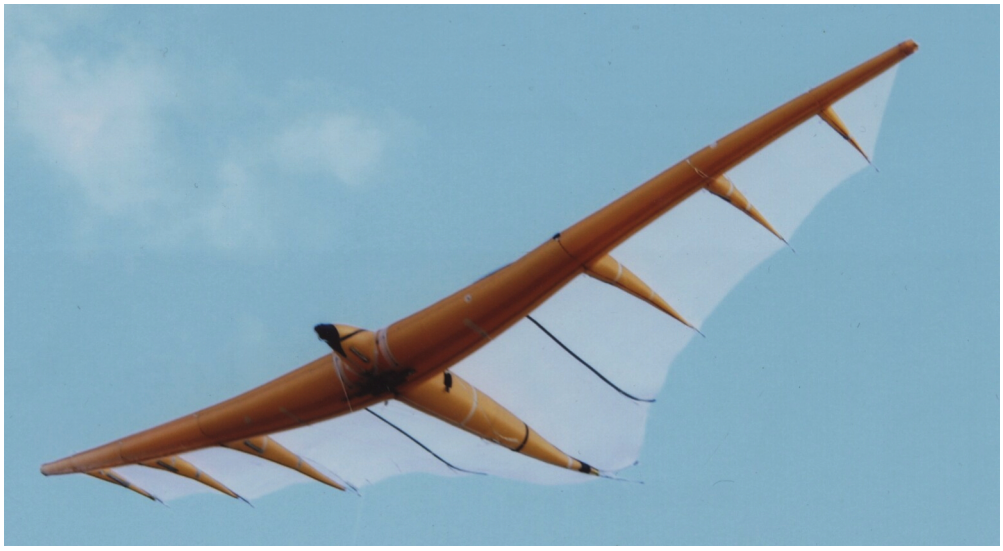

Illustration 3b: A French kite with gas-filled spars

But most see Rogallo's role as being the direct producer of the hang glider and being important in the development of the Delta — all using the single skin canopy. Jalbert is the father of ram-air parachutes and the modern soft kite. Illustration 5 shows the first commercial "toy" kite, the J-7.5 of the 1970s.

v

Illustration 5: the Jalbert J-7.5

Designers have used ram-air combined with spars to great effect. Undoubtedly the leader in this type of kite has been Martin Lester. His shark of 1983 is still a wonderful wriggling creation when correctly sparred (Illustration 6). The bird kite chapter shows his goose. I managed to get a pre 1988 space shuttle at a recent auction (Illustration 7). Few other designers/craftsmen seem to have used this combination although in recent years there have been "toy" kites using air to give a 3D body to aircraft and birds.

Illustration 6: Martin Lester Shark

Illustration 7: Space Shuttle Kite

One last look round before we get down to the chronology — have soft kites existed before or elsewhere?

Interestingly one of the candidates for the earliest European kite (see Chapter 2) was a windsock. I doubt whether it was designed with lift in mind but perhaps the stubby dragon wings helped. Incidentally it is suggested that they had fire in their mouths, which, with smoke, frightened the enemy. Apart from the problem of fireproofing, flames might have been very spectacular as presumably air (and

therefore flames) flowed in and out of the mouth with changes in wind conditions. I don't know of oriental designs which used wind pressure to form a 3D shape — while wind-driven whistles, hummers and mechanical devices are of course common.

2 Chronology

1930s
Domina Jalbert develops the Kytoon.
1948
Francis Rogallo patents the "flexible kite"
1951
Rogallo writes in *Ford Times* "If we could combine the shape of the supersonic air-plane with the unbreakable structure of the parachute, we would have a fine kite indeed!"
1964
Jalbert looks at his Beechcraft plane wing and decides to produce a soft cambered airfoil. He starts by removing the gas tank cover and measuring his plane's wing chord.
1974

Illustration 8: Sutton Flowform

Steve Sutton, a parachutist, having seen trials of the Jalbert parafoil in 1965, patents his Flowform parachute, which in 1979 becomes the Sutton Flowform kite. He claims to have been influenced by realising that a drogue is more effective with a hole at the downwind end. The Flowform (Illustration 8) with its distinctive cut away trailing edge is used at kite festivals as a lifter. It uses a thicker section chord than a typical parafoil with a much larger front edge intake linked with air exiting along the trailing edge. There are also holes both between risers (shared with some

parafoil designs) and on the upper and lower skins to allow air movement in response to local changes in pressure. Claimed to be better in fluctuating winds it has the practical advantage of requiring fewer bridles. (For a history, see *Kitelines* vol. 13 no. 1 (Spring 1999).)

1978

Richard Lewis produces the flexible pocket kite.

1981

Jalbert takes unsuccessful action against the Sutton Flowform on the grounds that it infringes his patent.

1981

The Ferrari Ram (Illustration 9) is advertised in the UK. Still being made, it uses ram-air to stiffen a series of tubes - the bridling makes it clear that this a type of sled.

Illustration 9: Ferrari Ram

1981

Scheveningen — a Dutch team flies the world's largest kite at the time (16m, 550m^2). Illustration 10 shows it at Scheveningen

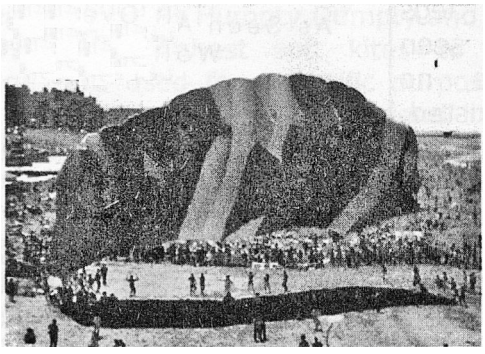

Illustration 10: World's largest kite as of 1981

1983

Martin Lester's Shark created, it is his signature kite and is still part of his logo.

1987

Peter Lynn, a New Zealand designer hitherto best known for his Tri-D box kites, takes up kite sailing using a steerable parafoil parachute given to him by the American John Walters.

1988

Martin Lester's "Legs" kite. The origins of the kite are Martin's response to the advert on the back page of *The Kiteflier* no. 34 (January 1988) (illustration 11, see also www.aeolian.co.uk).

Illustration 11: from *Kiteflier* no. 34 (January 1988)

While Martin's own legs were widely seen at the time, no such kite existed. This, his first totally soft kite, was produced later in the year. Looking at the advert it is obvious that a soft kite was not envisaged and one wonders about the significance of the bridling. This remains, to my knowledge (Illustrations 12a and 12b show legs

and top half), the only kite developed as a response to a joke. Subsequently the "Chorus line" appeared (Illustration 13).

Illustrations 12a and 12b: Martin Lester's legs and top half

Illustration 13: the Chorus Line

1988

Peter Lynn produces the first of his single line soft kites — the Manta Ray (Illustration 14 shows a recent version).

Illustration 14: Peter Lynn's Manta Ray

1989

The German designer Peter Rieleit designs the Superfly (Illustration 14). Flown on two lines for basic control rather than stunting, this is for me, among the very first "radically different from a parafoil" designs, having six legs and shaped bi-plane wings. Peter's other designs of the period included a large, curiously doomed looking bird and an asymmetrical banana (so is a real banana). See his article in *Kitelines* vol. 11 no. 4 (Winter/Spring 1996) and his book [7].

Illustration 15: Peter Rietleit's Superfly

1990s

Peter Lynn has developed the first practical kite powered buggy (but remember George Pocock) and designs the Peel kite to provide traction.

This marks the point at which soft kite design splits to follow two fundamentally different paths. We will follow the largely single line kites designed for appearance or their aesthetic qualities. But sometimes old forms were used e.g. Tal Streeter's artwork "The Flying Red Line" is a Doug Hagaman built 700 sq.ft. red ripstop parafoil with a five mile long one foot wide tail, which I understand has flown at one mile length (see his book *The Philosopher's Kite* [2] p.48).

The other development path, of course, is that of two or four line kites designed for traction. While Peter moved to buggies as being easier for testing traction kites than boats, power kiting in the last 10 years has made spectacular advances in the water-kite surfing which emphasises different kite qualities compared to buggying e.g. ability to relaunch from water. So once more we find kites with preinflated tubes to make relaunching easier.

1990

Jim Rowlands has great success at the Dieppe Kite Festival with his whale (Illustration 16). His frog is a further step away from the parafoil (Illustration 17). Later designs include Humpty Dumpty and the Clown.

Illustration 16: Jim Rowlands' Whale

Illustration 17: Jim Rowlands' Frog

1992

The highest soft kites –to my knowledge– were those used for scientific purposes flying at 11,400 ft. above Christmas Island in the Pacific (*Kitelines* vol. 9 no. 2 (Spring/Summer 1992)). Interestingly, recent world altitude attempts have not used soft kites.

1992

A good year for new designs. Peter Lynn's Octopus is a very popular design, widely seen and widely copied (Illustration 18). Two one-off designs: Wolfgang Schimmelpfenning's Jake the Snake and Jurgen Ebbinghaus's The Frog.

Illustration 18: Peter Lynn's Octopus

1995

Peter Lynn's Trilobite (Illustration 19) — based on the Palaeozoic Arthropod. Developed in size to take the largest kite record at the time.

Illustration 19: Peter Lynn's Trilobite

1996

Martin Lester's top half (see Illustration 12b).

1998

Marco Casadio's Mermaid (Illustration 20). The first glamorous face, plus other attributes which would probably mean it couldn't be flown in the southern USA.

Illustration 19: Marco Casadio's Mermaid

2001

Peter Lynn's Kitty kite (Illustration 21). Look and explain how that shape generates lift. Change the colours and you have a non-specific Malaysia tiger in 2009 (Illustration 22).

Illustration 21: Peter Lynn's Kitty

Illustration 22: Malaysian Tiger

2003

Peter Lynn's flag kite. The world record sized version was launched in Kuwait in February 2005; here is a smaller Union Flag from 2003 (Illustration 23). "Toy" versions are now made.

Illustration 23: Peter Lynn's Flag Kite

3 Some factors in the development of soft kites

3.1 Shape

(1) Early ram-air kite development was largely by the use of new airfoil sections (or chord shaping). Some were obtained through knowledge of technical data about their performance, others were clearly "eyeballed".

Illustration 24 (a) shows "classic" airfoil shape. Often designers (of parafoils) have to use (b) due to the use of a leading edge air intake.

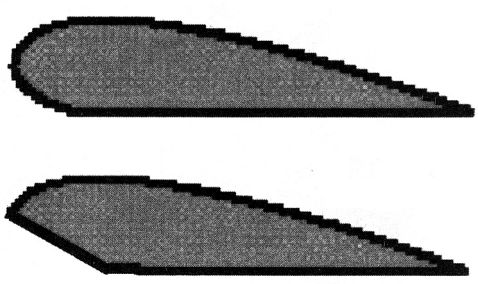

Illustration 24(a) and (b): Airfoil shapes

This changes a vital part of the airfoil. It can be modified by using gauze which holds the shape but still adds to leading edge turbulence. Another approach is to have air vents in the lower surface, allowing an (a) type nosed chord shape. N.B. invert (a) and you roughly have the chord shape of the Flexifoil. Not quite as strange as it seems as the "flexi" is bridled only at the leading edge and shapes (a) and (b) are held to a flying angle by a system of bridles.

(2) Aspect Ratio (defined as span divided by area).
This was also the subject of experimentation together with a range of flat shapes (e.g. pointed trailing edges). Many "ordinary" or club kite fliers who made their own kites and who would happily borrow (say) a delta plan, make some changes and build it, were conscious that ram-air originals were legally protected, required excellent sewing skills and were very time consuming to make.

Magazines had plans –this was pre-internet– and makers then got involved in the other obvious variables as follows.

(3) Location of air intake.
Jalbert had foreseen that this was not necessarily at the leading edge. By 1979 Sean Rawnsley had produced his 'Paraflate' which inflates close to the trailing edge (Illustration 25). Dave Green's Stratoscoop (Illustration 26) had combined keels and intakes.

Illustration 25: Sean Rawnsley's Paraflate kite

Illustration 26: Dave Green's Stratoscoop kite

(4) Use of gauze covered intakes and fitting simple "flaps" to provide valves (pioneered by Robert Ingraham as early as 1970).

(5) Size of intake. Some early ram-air derivatives e.g. soft sharks, which looked closely related to drogues, had over-large intakes. For most purposes $1m^2$ intake will serve a $15m^3$ kite. I remember Martin Lester explaining that the size of the mouth on his semi-soft shark was as small as possible but had to be big enough to allow a hand to be inserted for assembling the spars.

A fundamental design decision is the location of air intakes and the flow of inward air together with the managed interior airflow to the vents.

(6) Frequency of ribs. Given that fabric ribs were required there was a trade off with more ribs adding weight and building complexity but fewer ribs allowing distortion of the flying surfaces between them (Illustration 27).

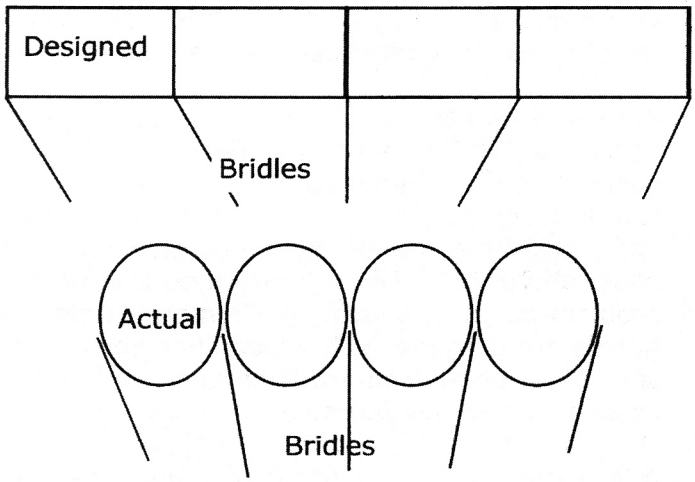

Illustration 27: effect of ribs on soft kites

(7) The use of holes in ribs, i.e. cell walls, to allow air flow between cells to balance pressure and in particular to cope with wind changes.

(8) The size and nature of fins and the number of bridling points required. Whereas originally fins were used not only far lateral stability but to spread the load on the fabric, techniques such as cording helped to allow fins to be "designed out" of the kite e.g. the flag kite.

3.2 Bridles

Apart from the physical difficulties of bridling a large parafoil there was the problem of identifying stretch. I remember Doug Hagaman, a greatly missed builder of superb parafoils, telling us that he might re-bridle every two weeks.

Kitefliers experienced with framed kites knew that it was often possible to sort out flight instability by adding fins, adding a tail or adjusting the bridle. Soft kites however seemed to fly stably for some time before suddenly needing considerable stabilisation i.e. tail. Mare's tails and drogues were both used and a form of drogue is now universal with large kites which have to fly stably in reasonable wind conditions.

It became clear that the bridling was often the key e.g. the Peel's bridle is copyrighted. The reason is basically that bridles (sometimes called shrouds in reference back to parachutes) do not simply hold the kite in its desired angle to the wind as with, say, an Eddy, but determine the shape of the airfoil which is responding to the air flow. Re-bridling to improve flight when all the bridles are tight in the air is a complex job. Recently life has been greatly eased for the fliers of parafoils by Peter Lynn's 'How to design and tune parafoil style pilot kites', *Kiteflier* no. 121 (October 2009). All you want to know including how to do it and why it works. Peter claims that if you follow his advice 'the world will be a better place'.

3.3

Essentially 3.1 and 3.2 covered the type of development up to the late 1980s. Jalbert parafoils were the main type seen, augmented by Sutton Flowforms, marketed as being more stable and with less pull. Dave Green of Burnley's Stratoscoop was the main English variant.

There had, of course, been attempts to use the ram-air principle in more "interesting" shapes. I remember an American hammerhead shark which was a fish body attached behind a Flexifoil head. Martin Lester's legs of 1988 and indeed his top half of 1996 looked at closely, are ramfoil shapes with legs or head and arms attached.

However, the Manta Ray of 1988 is, to me, the first produced-for-sale soft kite which really visually concealed its parafoil origins. Jim Rowland's frog was another example of new commercial shapes which owed little to the parafoil — except the all-important notion that a 3D shape could be inflated by wind speed enough to fly. Complex bridling could be designed to allow stability and at least these new shapes often provided enough depth to achieve sideward stability. About this time asymmetrical (left/right) shapes were produced –I remember a grand piano– but development has settled down to symmetry.

3.4 Size

From 1978 there have been small pocket kites on the market using ram-air effects to allow unsparred kites: often sleds, sometimes foils. One market is to enable hikers/walkers to "climb the peak and fly your kite off it". There was an attempt at one time to claim that such kites would be useful in an emergency, hence Day-Glo orange, but mobile phones and GPS availability stopped that. Initially many club fliers were attracted by larger kites and for a period amateur kite wrestling was a feature of festivals.

However, the major implication of soft kite development was that extremely large kites were now possible and they were easily transportable as no cumbersome spars were involved. As a result 10m.+ kites have become common in the last decade. Essentially this is possible because multiple bridles spread the load over the material. Simply put, a four-celled, five-walled ramfoil is bridled from each wall and can increase size by extra walls with no increase of bridle pull on the material.

Size did bring problems with the material used. Before the widespread availability of ripstop, makers used fabrics designed for other purposes. For sparred kites lack of stretch is often very important and ripstop is treated in such a way that porosity and stretch are reduced but at a cost of weakened fabric. Material with some stretch is desirable for large soft kites, partly because designs involve curves and because strength is helpful when a large kite hits the ground at speed.

Peter Lynn discusses the problem (see bibliography) and has moved to, as far as possible, specifying the material which meets his needs, given that even he is a modest buyer by the standards of his Chinese and now Korean suppliers.

Other things that Peter discusses are:

- Using cord rather than fabric ribs to fix the wing's cross section.
- Most importantly, adapting techniques used by makers of sails and balloons to use spectra line stitched to the fabric to reinforce points of stress and to spread load diagonally across the weave of the fabric.

3.5 The current situation

The development of very large soft kites has transformed many kite festivals in recent years. There is great popular appreciation of large, invariably colourful and often ingenious designs which being 3D are visible from all angles. However, size has created safety issues for single line kites — obviously the issues are still greater for those involved in kite traction. Although there are no spars, big soft kites can easily knock over a spectator and being caught and lifted by a bridle line has led to death in the USA. Large kites need space and have pushed at the limits of some kite venues. Designers and fliers have responded by using header (or pilot) kites (Illustration 28). These are relatively small ram-air kites which are used to stabilise the flight of the main kite and may help wind intake in unsettled or low wind conditions, for example by holding up the top surface of the air intake.

Illustration 28: a soft kite with pilot kite and drogue

Because the pilot (or lifter or header) gets up onto relatively calmer air the use of such kites enables the big primary kite to fly lower, thus increasing the size effect for the spectators. Some kites will not normally fly without a pilot kite. Some 'kites' won't fly at all: are they drogues (or line laundry, line trash or line candy)? I've met fliers who are really exercised by this point. Just to add to the debate: what about a situation where the pilot kite by form or colour is linked to the lower kite so that it could be argued that 'the unit' is flying?

4 Conclusion

A remarkable designer/maker over the last decade is Rolf Zimmerman of Germany. The sea seemed to be his theme and the lobster his signature kite (Illustration 29).

Illustration 29: Rolf Zimmermann's Lobster

While the lobster is one of the all-time outstanding inflatable designs, his seahorses are great, as are his witty starfish (Illustration 30). It took him some years but he has finally perfected the striking dragon (Illustration 31).

Illustration 30: Rolf Zimmermann's Starfish

Illustration 31: Rolf Zimmermann's Dragon

As usual as I get nearer the end of one of these articles I start to think more of the short comings and omissions. In this case I'm very aware of the Eurocentric selection of the kites mentioned. I'm even more aware of creative kite makers who have been omitted. So here is a set of photos of great kites not otherwise mentioned.

I don't know the name of Team Vulandra's designer. Here a shot of the 15m. spacecraft, the centrepiece of one of their displays, showing the steps down which a little green man (allegedly) comes to earth (Illustration 32).

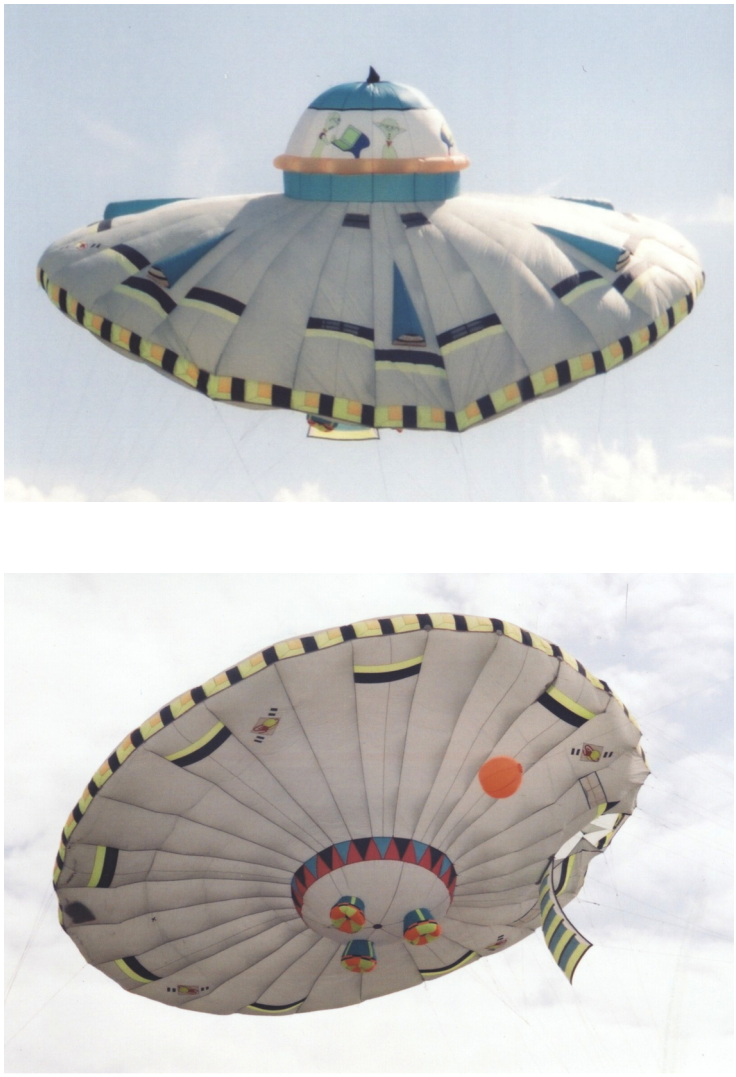

Illustration 32: Team Valundra's UFO

Wolfgang Schimmelpfennig's Basking Shark (Illustration 33) has the sucker fish (or remora) as a wonderful asymmetrical touch.

Illustration 33: Wolfgang Schimmelpfenning's Basking Shark

The hand appeared at Bristol 2003 (Illustration 34).

Illustration 34: Hand Kite

Kevin Hodgson's first kite was Bertie Bassett — which was best kite at Weymouth 2003 (Illustration 35).

Illustration 35: Bertie Bassett

Dave Holt's thunderbird kite keeps the English tradition of semi-soft kites flying (Illustration 36).

Illustration 36: Dave Holt's Thunderbird

Illustration 37: Peter Lynn's new Ray

Interest in sting rays and such like has led to two new recent designs. Firstly, Peter Lynn's ray (Illustration 37) which is designed to move its wings realisitically in flight and with a smooth tail which enables it to be launched from water. Secondly, the highly realistic German 'devil-fish' or manta ray (Illustration 38).

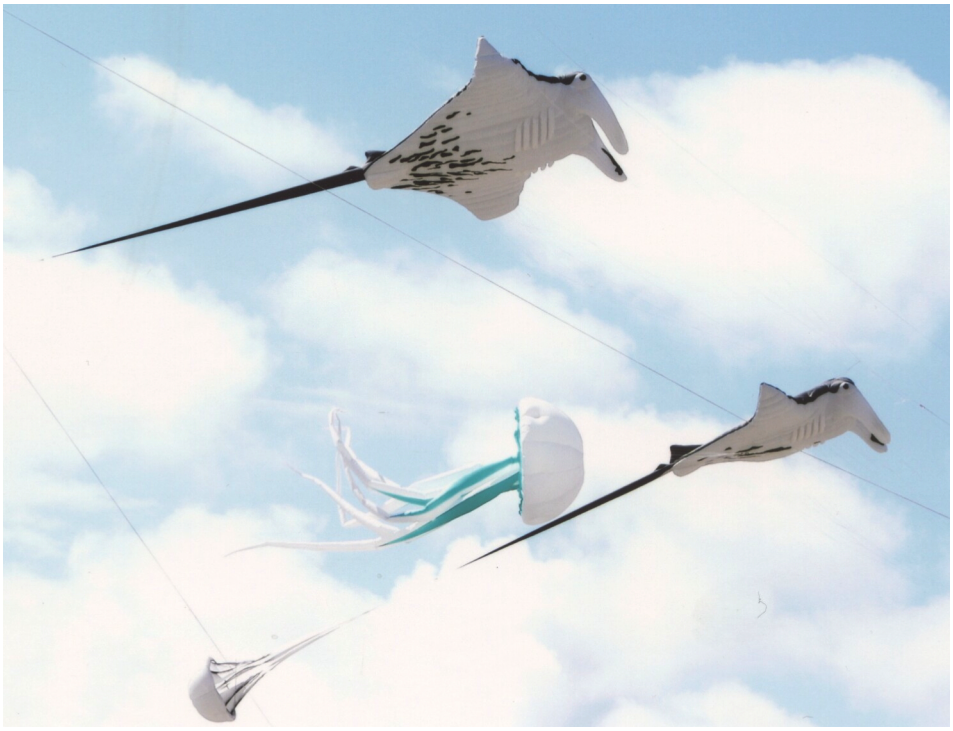

Illustration 36: Gerrman Manta Rays

Soft kite flying is moving eastwards and Illustration 39 shows a very effective Indonesian kite of 2008 (with a Cambodian kite in front).

Illustration 39: Indonesian Kite

So many types of artist/designer have been attached to the development of soft kites since the J-7-5 (six bridles on such a small kite!) — while some have primarily been interested in efficiency and lifting ability, many have been 3D designers. Here I think of Peter Lynn who combines invention with the most profound technical knowledge operating today. Then we have Martin Lester, in some senses nearer to the "pure" designer who is fascinated by the 3D shape of the kite. But how do you respond to someone who produces one of the best designs of recent years (Zimmerman's Blue Owl — its wings shake) from a toy bought at Cleethorpes? And none of this is meant to denigrate essentially 2D designs of those such as Stretch Tucker, who have appliqued great designs to foils (Illustration 41).

Illustration 38: Zimmermann's Blue Owl kite

Illustration 41: Foil kite by Stretch Tucker

5 Bibliography

Much of soft kite development has been too recent to be included in the sort of book published recently — check the internet.

Pelham [1] and Maxwell Eden [3] both have plans of a Rogallo Flexikite and a Jalbert Parafoil. Pelham has the better brief history.
Jim Rowlands - His best book [4] has the widest range of soft kite plans and building instructions. [5] also has plans.
Peter Lynn - Three important articles were "Current Trends" *Kiteflier* no. 45 (October 1990), "Cording and No-Rib Construction" *Kiteflier* no. 68 (July 1996), and "Future and Power Kiting at the Start" *Kitelines* vol.8 no.1 (Summer 1990).

Plans may be found in Cottrell's book [6] and in articles by Stretch Tucker - (Famous for excellent parafoils) - *Kitelines* vol. 9 no. 1 (Winter 1991/2), Martin Lester "The Top Half", *Kitelines* vol. 12 no. 2 (Fall/Winter 1996) and Fred Broadhead "Fredform", *Kiteflier* no. 90 (January 2002). Also detail plans for Bernhard Dingwerth's 'Robbe the Seal' are in *Kiteflier* no. 118 (January 2009).

[1] Pelham, D. (1976*) Kites.*
[2] Streeter, T. (2002*) The Philosopher's Kite.*
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[4] Rowlands, J. (1992*) Kites and Windsocks.*
[5] Rowlands, J. (1988*) Flying Modern Kites.*
[6] Cottrell, M. (1988*) The Kite Store Book of Kites.*
[7] Rieleit. P. (1993) *Lenk Drachen* (in German).