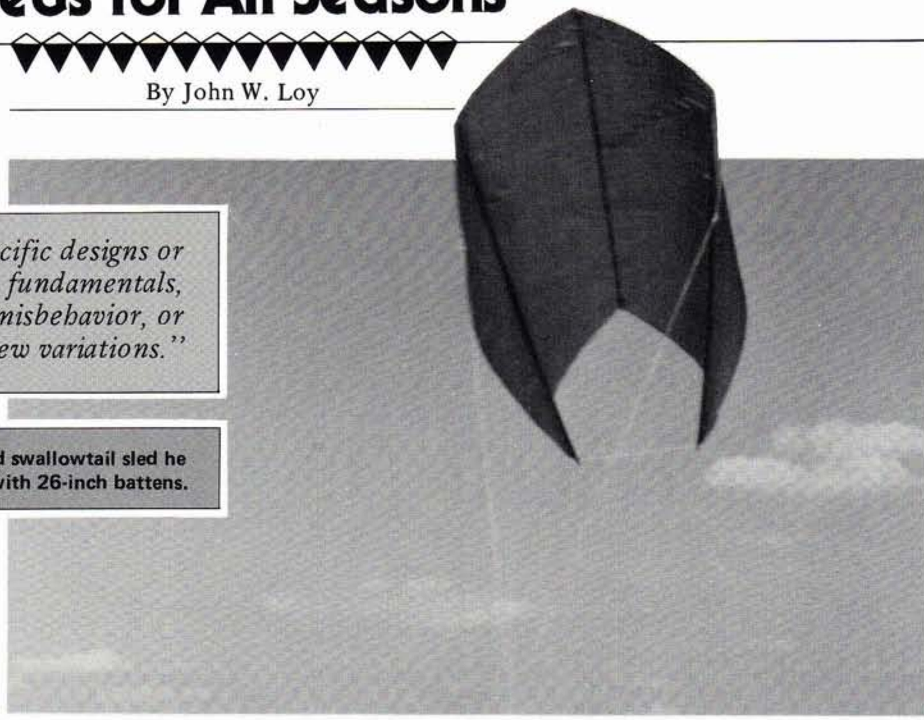
Ultimate Questions

Sleds for All Seasons

By John W. Loy



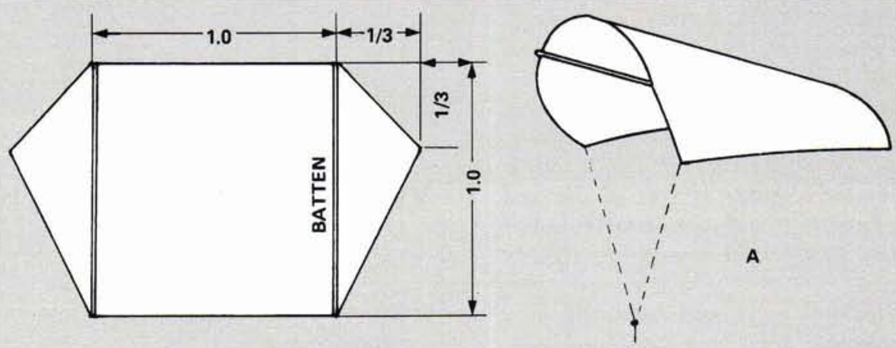
"It is not my purpose to tout specific designs or their originators, but to outline the fundamentals, so that we are able to correct misbehavior, or else come up with successful new variations."

Photograph by Ed Grauel of a haltered swallowtail sled he made of ripstop nylon with 26-inch battens.

All of us kitefliers are permanently indebted to the late William M. Allison for inventing the "sled" kite. Easily and inexpensively constructed, it is ideal for getting youngsters interested in kiting, to say nothing of adults who are novices.

It is important that a newcomer's first construction fly reasonably well. A simple sled will do just that.

Although Allison invented his kite in 1956 (U.S. patent 2,737,360), the design did not become well known until the late 1960s. Figure A (right) illustrates one of the simplest plans and a sketch of the configuration in flight.



A simple sled layout. Placing a string halter across the stern, to prevent the battens from flaring outward, substantially improves behavior, but is not mandatory.

THE SLED

A sled is a "semi-soft" kite. A pair of battens stiffens it only in the chordal direction (from leading edge to trailing edge). The surface between the battens we call the canopy. The pair of triangular surfaces outboard of the battens we call the laterals.

Since the leading edge is soft, it tends to collapse—with annoying frequency—in scruffy wind conditions. This fault is easy to correct if we think a bit on why it occurs.

Visualize yourself holding a thin ribbon, stretched taut between your two hands. Held edgewise in a strong wind, the ribbon will not twist or collapse—so long as you maintain sufficient tension. So it is with the leading edge of a sled. A properly constructed sled is as reliable as any other kite, and more so than many. It does not require a tail or drogue.

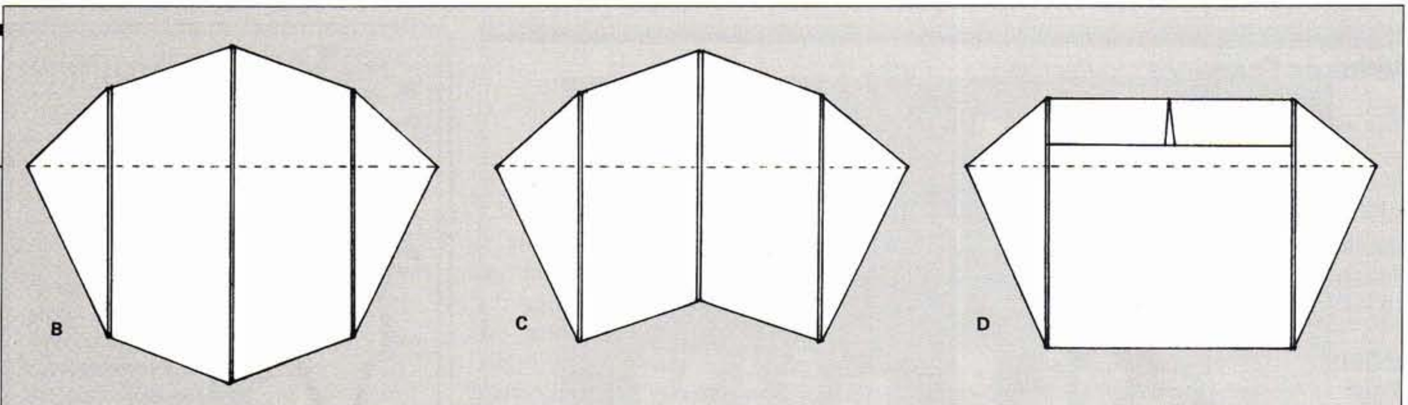
Ed note: The fact that a kite design has been patented does not mean that you cannot make one for yourself—for your personal use or to give to a friend. However, a kite patent, while still in effect, does prohibit the manufacture and sale of the design, unless, of course, it is done by or with the permission/agreement of the patent holder.

THE ATTITUDE

Maintaining tension on the leading edge involves firstly positioning the lateral tips, which represent the bridle points, so as to cause a sufficiently steep attitude of the canopy. (Some use the term "angle of attack," derived from aircraft terminology. Kites don't attack the wind, they obstruct it.)

A safe position for the lateral tips is on an imaginary line such that one-third of the area of the canopy is forward of the line. This results in an attitude of about 32 degrees in brisk wind, which is rather steep, but does tend to keep plenty of tension on the leading edge. This one-third rule thus involves a sacrifice in angle of elevation. Moreover, the steeper the attitude, the greater the obstruction to the wind and the greater the stress on the kite and flying line.

The fields we prefer for kiteflying frequently generate updrafts. In that case, the kite senses the wind as coming from slightly—or even much—below level. The kite necessarily maintains the attitude set by the bridle points, but aligned to the perceived wind direction. This may or may not result in overshooting the zenith. More likely, in gusty or erratic thermals, the updraft ceases for a moment. The sled is trapped momentarily in a level wind at an attitude much too shallow for the new wind direction. The tension on the leading edge drops to below critical and the canopy collapses. It may or may not reopen.



Three variations of canopy layout: (B) Rokkaku, (C) Swallowtail and (D) Hooded. A conservative ratio for canopy area forward of the dotted reference line between lateral tips is 0.28 (28%). All varieties should have a halter across the stern (see text).

THE COLLAPSE

When a sled collapses, the forward tips of the battens close inward while the stern tips briefly flare outward, then slap together as part of the total event. Since all this may occur in no more time than a second or two, it is no wonder that we don't always understand what is going on up there.

Moreover, the converse of the action just described is a significant source of failure in conventional sleds. Turbulence can cause the stern tips to flare outward, which simultaneously results in the forward tips closing inward, hence collapse. The cure is very simple, requiring about two minutes to install.

THE HALTER

Simply tie a string "halter" across the stern tips of the sled, the length being roughly 50-58% of the flat width of the canopy. The idea is to keep the battens approximately parallel in flight. (The concept is covered in my U.S. patent 4,243,191 of January 6, 1981.)

An additional and important advantage of the halter is that it assures reliable flight at significantly shallower attitudes and, therefore, better elevation.

THE CANOPY

We don't have to be locked into rectangular canopies for sled kites. Think of the canopy area forward of the bridle points as a proportion or percentage of the total area of the canopy. If the wind conditions are not downright vicious, I have found that a haltered sled can tolerate a ratio as low as one-fourth (25%). The outcome is a shallower attitude, roughly 23 degrees, better elevation, and less stress on both the kite and the flying line.

Sleds tend to be not very pretty kites, although I personally rate reliability above beauty. However, we can at least employ formats other than a rectangle for the canopy. Figures B and C (above) offer two variations—the "rokkaku" and the swallowtail—which have been tested thoroughly.

To be on the safe side, I recommend that the canopy area forward of the dotted reference lines be about 28% of the total canopy area.

For the flier who likes to experiment, it is easy to install a ratio of 25% in the original construction. Then, if the kite shows a tendency to collapse, simply trim off 10% of the canopy area at the stern and thus modify the ratio to 28%. This can be done on the field.

Apart from aesthetics, the "rokkaku" version possesses two distinct advantages. One is the "plow effect" of the pointed nose. The airstream on the lee side of a sled is a turbulent mess. The snout helps to maintain symmetry of airflow over the lee surface. The other advantage is that the rokkaku canopy will usually reopen if adverse wind conditions happen to collapse it. The snout continues to catch the wind.

If, instead of installing a matching triangular section at the stern, you cut out a triangular section, the result is a swallowtail (my U.S. patent 4,272,394 of July 21, 1981). Of course, the position of the lateral tips must be adjusted.

The "hooded" sled (Figure D, above) is made for really awful wind conditions. From the same material as used for the canopy, cut a flap of the same span but one-fifth (20%) the height of the canopy. Tape, sew or glue the leading and lateral edges of the flap to the top of the canopy. Leave the trailing edge of the flap free. Cut a slit chordwise in the flap along the centerline. Overlap the edges of the slit and fasten them together so that the flap is made narrower roughly three or four percent. (For example, if the span were 20 inches, the overlap would be 5/8 to 3/4 inches.) In flight, the trailing edge of the flap will not touch the canopy. The gap provides a small beam effect, but, more importantly, the surface of the flap has a slightly higher attitude than the main canopy. Tension on the leading edge is amplified and kept that way.

I have never observed failure of this kind of sled in any wind that I myself could endure.

Some sleds which I have seen had one or more "vents" cut out of the canopy. These kites likely will perform better if the holes are replaced with a swatch of surface material and a halter tied across the trailing edge. I suspect that the holes compensate for misplaced bridle points.

THE BRIDLE

The length of the bridle legs is important, but not critical, just so they are long enough. A handy rule of thumb is five times the width of the canopy. Each end of the bridle, of course, connects to a

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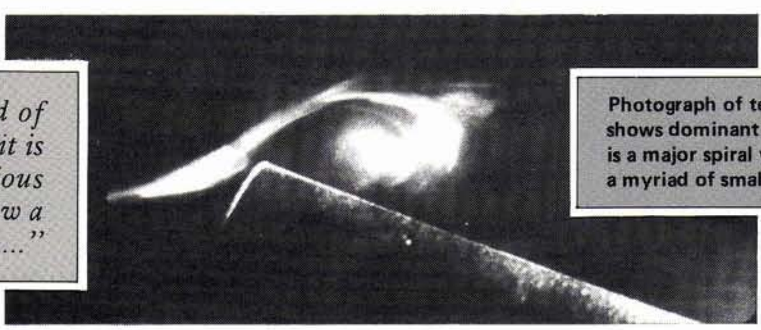

Photograph of test sled in wind tunnel shows dominant vortex at centerline. There is a major spiral vortex on either side, and a myriad of small, random vortices.

lateral tip. A shorter bridle tends to draw the lateral tips inward, which may adversely affect flying. A longer bridle tends to make launching awkward.

CONSTRUCTION

There are more than enough books and other publications dealing with construction materials and techniques. My remarks will be very few. One of these involves my distaste for stretchy surface materials, especially low-density polyethylene. This is the stuff used for garment bags, trash bags and the like.

Contrary to logic, the tension in the leading edge of a rectangular canopy is not necessarily uniform. The reason is that, with only a tiny bit of stretch, tension transmitted from a lateral tip to the leading edge bypasses in part the area in proximity to the forward tip of the nearest batten. With binoculars, we can often see the stress wrinkles in the canopy. They tend to be aligned between a lateral tip and the central portion of the leading edge. This explains why collapse of the leading edge is initiated by a folding over of a segment between batten and centerline.

The use of grommets in the lateral tips also can result in tension bypassing the leading edge of the lateral and, hence, the leading edge of the canopy. The bridle legs should lead directly from the very tips of the laterals, with appropriate reinforcement by way of overlying gussets.

In the case of a sled specifically constructed for high wind, a cord should be attached to the very edge of the lateral for a suitable distance forward and aft of the tip, leaving a small loop at the tip. The bridle leg then ties to the loop.

A "snouted" design—the rokkaku for instance—helps to transmit and maintain tension more directly to the canopy's leading edge. In fact, if the flier wants to fiddle with geometry of a triangular foresection, the leading edge of the lateral can lie on the same straight line with the connecting leading edge of the canopy. I did not draw Figures B and C this way because I did not want to mislead readers to supposing that a straight-line layout is necessary. It's just a technical nicety for severe wind conditions.

THE TAIL END

Most kiters will readily agree that a wealth of technical knowledge is not a prerequisite to successful kiteflying. Thus, I am not suggesting that you rush right out and buy or build a wind tunnel of your own.

However, here we are at the tail end of the 20th century, and it is about time that serious kitefliers understand how a kite maintains its position in the absence of a pilot or instrumentation.

Young children are not interested in talk about attitude, tension, towing points and all that jazz. On the other hand, if a child asks you, an adult, why his or her kite does not fly, you had better have a good answer.

JOHN W. LOY (left, with double-canopied sled) writes from Bartlesville, Oklahoma: "While living in Tokyo (1968-73), I became interested in the fundamentals of why kites fly and why they don't. During 1974-77, I was posted in India and made some headway on the technical side; likewise in Hong Kong in 1977-79. After retiring as an executive with Phillips Petroleum (1979), I finally got around to constructing a rather capable wind tunnel and, after three years of operating it, have compiled a large amount of quantitative data on behavior of a wide variety of kite forms. In the process, I learned some things that astonished me."