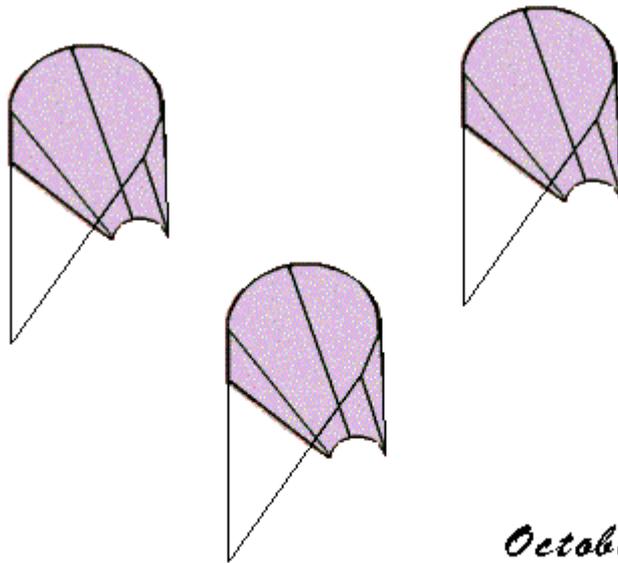


Allison's Flexible Kite

Compiled by Tom Lehane



October 2002

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Scott Sled is a registered title to Ray Holland owner of Airplane Kite Co.

The word **Sled** in the kite world refers to a flexible canopy kite .

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In the world of inventing, glory often goes not to the person who is first with the invention but to he who has the best publicist.

Even to the present day there are some that argue about who was first with powered flight. There is no doubt in my mind that the Wright brothers achieved the first human operated powered flight. They approached the problems in a scientific manner with the building of a wind-tunnel to many test flights with gliders before making their finale powered flight.

Now there is a challenge to William A. Allison's flexible kite, better known as a Scott Sled. An article published on the Drachen Foundation Web site '*Was the Sled Kite Invented in Europe*

http://www.drachen.org/journals/J9_36-48.pdf (download the PDF file)

The publication states that a design using the same basic canopy idea was flown in Budapest around 1904 and was illustrated in an article on *Toys of Children*. The kite is known as a 'Buda'

With William A. Allison's knowledge of flight who at the age of 13 showed great skills and craftsmanship at making model planes, according to kite expert Tal Streeter who has researched the inventor, there is no doubt that Allison is the inventor of the Sled kite.

There are many examples where others have worked on similar inventions totally unknown to the other inventor.

A good example is the Australian Boomerang, it may surprise many that the throwing stick has been found in India, Egypt, Holland, Denmark, Germany and Arizona just to name a few. Internationally the Boomerang is a symbol of Australia and yet it was found as far away as Arizona in U.S. and in prehistoric times when travel across a vast ocean was impossible.

It is unknown what influenced Allison's invention but in his patent application on September 8th 1950 he writes that it was an instant invention.

His flexible kite has a very good weight per square foot rating which make it a light to medium wind kite. According to Leslie Hunt ¹ in his book '**25 kites that fly**' a kites should be about .47 ounces per square foot.

Using his formula, one of my Sled kites with a canopy measuring 11 inches by 18 inches, $11 * 18 = 198$ square inches. $198 / 144 = 1.375$ square feet. The kites weight is .64 of an ounce.

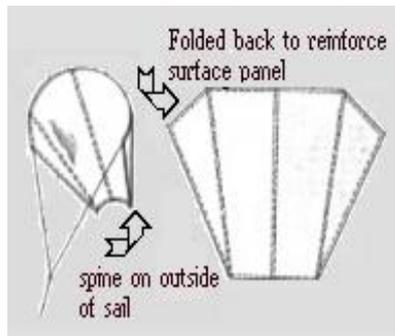
$.64 / 1.375 = .46$ ounce per square foot, with such a favourable rating the kite is easily scaled up or down to make very small kites.

When building large Sled kites care should be take if flown in strong winds as some can have a canopy area of a small sailing boats spinnaker.

Tom Lehane.

¹ *Leslie L. Hunt, kite builder for the United States Weather Bureau and author of a book published in 1929, '25 kites that fly'.*

Allison's Flexible Kite



Allison's Flexible Kite (United States Patent and Trademark Office number 2,737,360)

William M. Allison was born in Canada and moved to the U.S.A. state of Dayton, Ohio in the early 1930's.

At the age of 13 he built model planes that displayed fine detail and craftsmanship for a boy his age, according to kite expert Tal Streeter who has researched the early years of Allison for his book "*Great Kites of the Western World*".

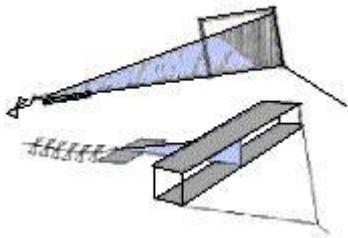
As an adult he worked for the Westinghouse refrigerator factory in Dayton as a mechanic. Allison enjoyed flying kites and helping others in the art of fine tuning and kite flying. He enjoyed experimenting with designs of his own.

Sometime in the early 1950's an idea suddenly came to him that maybe a kite could conform to the flow of wind and still obtain lift. As a result he developed a flexible kite, which Allison referred to as a polymorphic kite when describing how the kite conform to the fluctuations of the air stream.

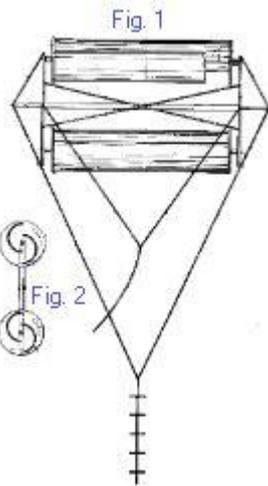
It is unknown what influenced Allison's invention, it may have been a windsock or a sail boat spinnaker but according to his patent application on September 8th 1950 the kite was an instant invention. Allison's invention was basically a semi-rigid canopy kite "***built from any light material, relatively impervious to the passage of air, for example paper.***" (ref from patent number 2,737,360). The reference to paper points to the fact that when Allison designed the flexible kite in early 1950, Polyethylene of the linear low density type (film) was not available until the very late 1950's and early 1960's. Another indication that the original design was made of paper is found in his patent (2,737,360) "***The marginal area of the air foil panel is folded back and bonded to the surface panel for reinforced perimeter.***" Allison's original design was flown with the spines (longitudinal or brace members) on the back of the kite. His idea was to have a smooth passage of wind over the lifting surface of the kite. The patent text makes reference to this. "***Slight resistance to the air flow, being the thin edge of panel, the tethers (bridle) and the small ends of brace members***" (Spines). The Illustrated drawing of his patent shows how the kite appears in flight with the braces on the back. It's shape was similar to a windsock cut in half (along it's length) and shortened, the canopy is only supported in it's longitudinal plan by 3 braces (spines), tapering towards the trailing edge. The braces (spines) are not linked, and the kite can be rolled lengthwise and easily stored without having to dismantled the frame. The bridle which are part of the lateral extremities of the kite and form keels that help the stability and guide the wind over the main surface of the kite. The kite is tailless and requires a long bridle from the keels to maintain it's shape when in flight. Allison applied for a patent not long after perfecting his kite (1950). The patent office withheld approval of his invention for 6 years. The patent appeared to conflict with another patent issued to Francis Rogallo of the U.S.A. In 1948. Rogallo, an aeronautical engineer also invented a Flexible kite. filed 1948 and issued in 1951.

The wording "flexible kite" had the United States Patent examiners look further into his application and the examiner made reference to,

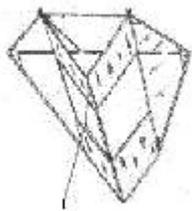
- Wickersham :Patent 1,617,976
- Van Ittersum :Patent 2,107,808
- Wheelwright :Patent 2,386,762
- Bach :Patent 2,463,135
- Rogallo :Patent 2,546,078



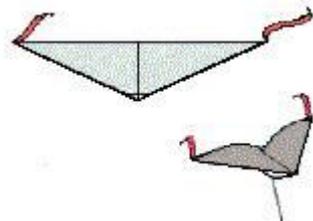
R.D.Wickersham Patent 1,617,976 (year 1927) made reference to a kite that could be un-assembled and re-assembled by unskilled persons.



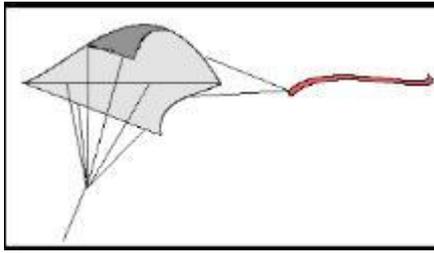
W.A.G. Van Ittersum Patent 2,107,808 U.S. issue 1938. He applied for a patent in France in 1936. The kite has twin cylindrical rotors built of cardboard and mounted in a frame.



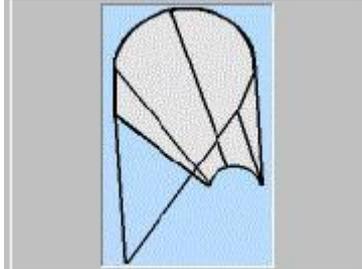
J.S. Wheelwright Patent 2,386,762 issued 1945. The kite's advantage is to be folded into a small package and fired from a life-saving raft and to open once it reached the length of its wire radio aerial. The mention of a kite to be compactly folded by Allison was the reason for the patent office to make comparison J.S. Wheelwright's patent.



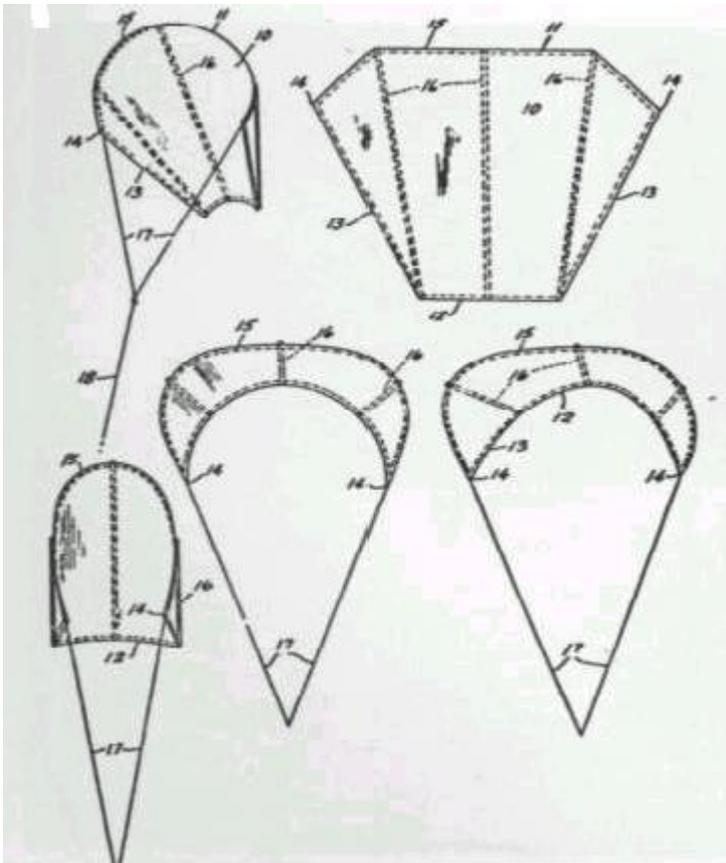
R.F. Bach Patent 2,463,135 issued 1949. The kite is referred to as a 'FLYING WING' which is flexible in performance. The word 'flexible' was the reason the patent was compared to Allison's. It's of interest to note that the application was applied for in May 1947 and Francis Rogallo filed his patent in 1948.



Francis Rogallo Patent 2,546,078 issued 1951.
 This is considered to be the most significant contributions to the development of the truly modern kite. The patent filed in 1948 and issued in 1951 was the reason Allison was not given approval for his flexible kite for six years as there was a possible conflict with Rogallo's flexible kite.



W. M. Allison Patent 2,737,360 issued March 6, 1956
 Application September 8, 1950.



Patent drawing for Allison's flexible kite, 1950

Webster's dictionary :

The word *polymorphic* : *Poly* : meaning, many.

Morphic : pertaining to form : a combining form meaning characterized by a (specified) type of formation. *Polymorphic* : having or occurring in several distinct forms.

Allison reference to his flexible kite as a polymorphic appeared to be a prophecy of things to come, as the word poly meaning many, which there have been of his design.

Morphic : characterized by a (specified) type of formation. His concept has taken on other forms.

Frank Scott's Version

Allison's patent was approved on March 6th 1956. The kite languished in this form with the possibility of the use of plastic film for the sail, from 1956 until about 1962 when Frank H. Scott of Ohio noticed an advertisement in a model aircraft magazine.

As with many advertisement of a small nature, no photographs appeared only line drawings as the cost for print plates of photographs were usually high.

With only the image of the sketch to go by Frank built one of his own design.

Frank been a kite enthusiast soon found ways to improve on Allison design.

A vent was added to the lower half of the kite and the sides were made parallel instead of the windsock taper that Allison incorporated in his design, Scott retained the three spars in the original design. Scott's modifications made the kite more stable and efficient flyer.

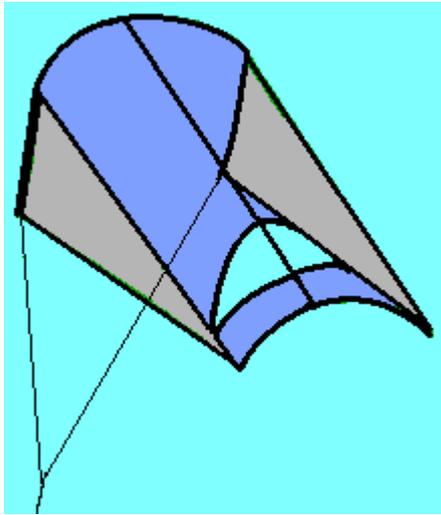
Because of the kites' simplicity to build and requiring no tail to lengthen or shorten to tune for stable flight and no bridle adjustments needed, a novice could have one in flight from the first try. Frank's father, Walter Scott was so enthusiastic about the flexible kite that he built many and sent them to friends in other parts of the world. He sent one to Bob Ingraham, founder of Kite Tails: The Kiteflier's magazine,

A short article in the magazine by Bob Ingraham in 1964 put Allison's concept and Scott's design on the world stage.

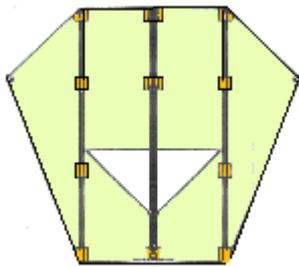
Frank Scott called his modified kite a sled because it flew well and was flexible making it a Flexible Flyer a brand name for a snow sled that was popular with children that was blessed with snow in the winter months. It never occurred to Scott to call his kite a sled because of the shape of it's keels while in flight. If the airborne shape had influence him he may have called his creation a Bonnet Kite, as the shape resembles an early pioneers' bonnet that were worn by the ladies of that era.



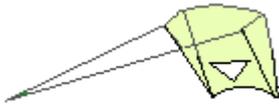
Flexible Flyer sled, the brand name that influenced Frank Scott to call his improved version of Allison's kite.



Scott retained the three spar (spine) of the original design. The centre spar was used to stiffen the flexible canopy to prevent the the leading edge of the canopy from folding and causing the kite to collapse. The sides were made parallel instead of the windsox taper that Allison incorporated in his design. A triangular vent was added, this force high-pressure air from below the sail into the turbulent airstream above the sail, serving to stabilise the Sled's flight.

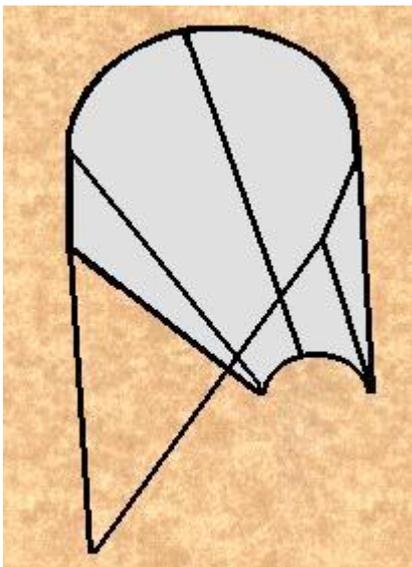


Frank Scott designed a flexible kite for Ray Holland to manufacture in 1967. The name Scott Sled is the title for the kite, registered to the company. The original size 40 inches by 35 1/2 inches. Three spars and a triangular vent are used. Colour of Polyethylene sail is yellow.

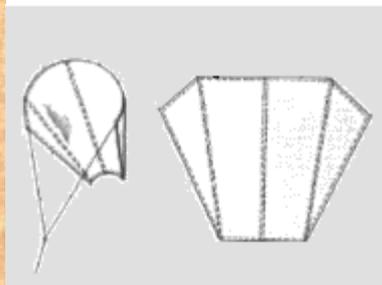


Bridle length 70"

Original Scott Sled Width when spread flat 40" Length 35 1/2"



Allison's design in flight.



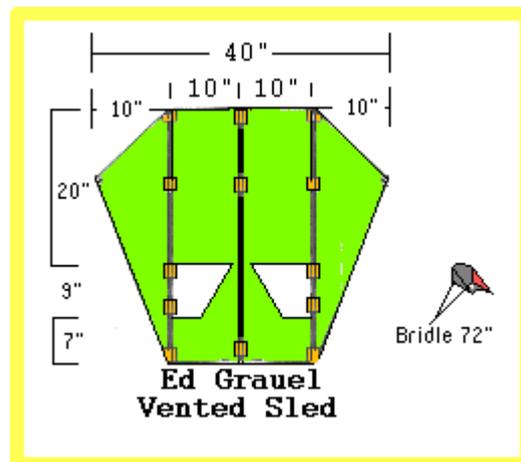
Allison's basic layout pattern.

Ed Grauel's Further Improvements

Twin Trapezoid Vented Sled

[trapezoid] (quadrilateral, four sided) with no parallel sides.

Ed Grauel applied his experience and skills to Allison's / Scott Sled kite and improved the vent design that Scott had utilised. The use of twin trapezoid vents refined the kite and made it much more stable. The Sled relies on the wind pressure to maintain its shape and can collapse if hit by cross-winds. The twin vents force high-pressure air from below the sail into the turbulent airstream above the sail, serving to stabilise the Sled's flight.



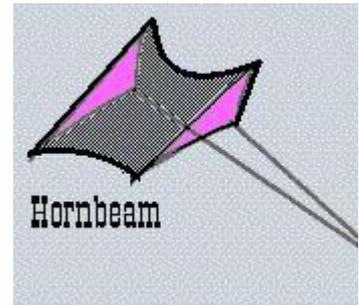
Guy Aydlett's Hornbeam (Sled Kite)

Because of the Sled kite's simplicity it captured the attention of many kite designers. The original design by William M. Allison had a tendency to collapse with wind change and 'wobble' as the air flow left the trailing edge.

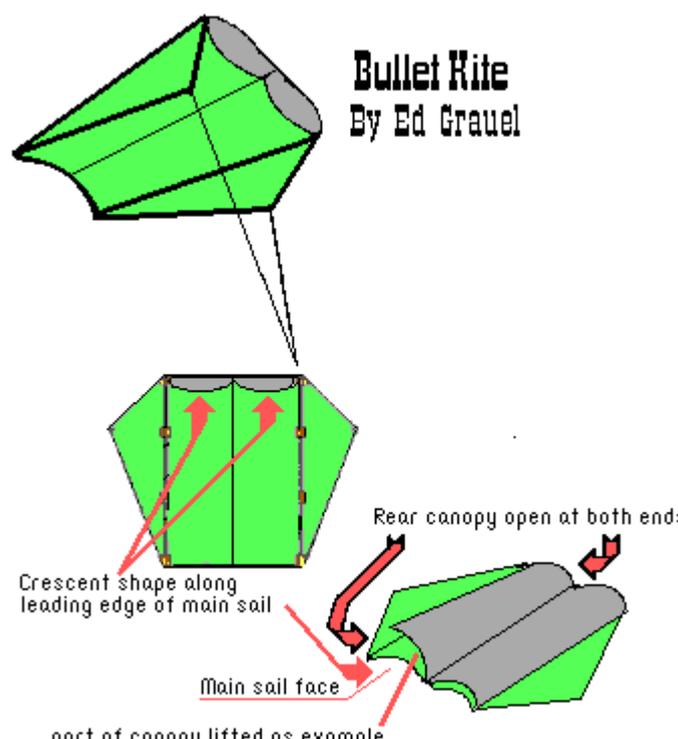
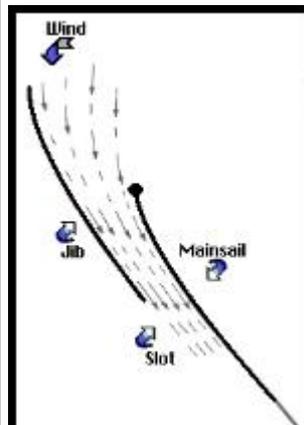
Frank Scott added a triangular vent to the lower half of the sail and made the kite more stable. Ed. Grauel introduced two trapezoidal vents to the lower half of the sail which improved the kites performance.

Guy Aydlett turned his attention to the Sled's tendency to collapse and introduced a curved leading edge instead of the straight edge of other designs. Air is equalized over the curved leading edge and improved stability.

This kite is known as the **Hornbeam** and has no vented sail.

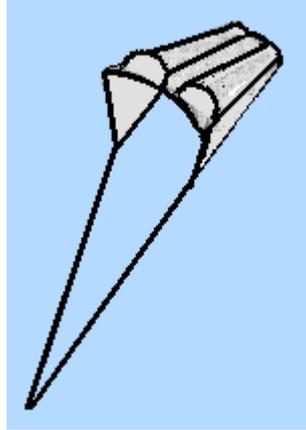


Ed Grauel's Bullet Sled

 <p>Bullet Kite By Ed Grauel</p> <p>Crescent shape along leading edge of main sail</p> <p>Main sail face</p> <p>part of canopy lifted as example</p> <p>Rear canopy open at both ends</p> <p>Spars are used on the sail the same as the Scott Sled.</p>	<p>Kite designer Ed Grauel in the early 1970's was not content with the Sled kite's performance even though he contributed greatly in making a much stable kite with the introduction of twin trapezoid vents.</p> <p>The kite still had a tendency to wobble and yaw. He tried different types of vents with not much success. He then tried placing a canopy behind the main sail of the kite.</p>  <p>This is similar to the slot effect of the jib on a sailing boat that concentrates the airflow over the leeward side of the mainsail and causes it to accelerate.</p> <p>This produces a drop in pressure which results in an increase in drive.</p> <p>The canopy added to the Sled didn't improve the kite's performance. An idea came to him to sew the canopy down the centre from the top of the kite to bottom. This produced two air scoops instead of the single canopy.</p> <p>This improved the kite's performance to the point that it eliminated the wobble and made the kite a stable flier.</p> <p>The two scoops made the kite accelerate it's ascent after releasing to the wind. This rapid climb led Ed Grauel to name the kite a 'Bullet'.</p> <p>The kite is covered by a patent but like Allison's original design Ed Grauel's creation sowed the seed for many variations.</p>
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Richard Lewis Flexible Pocket Kite

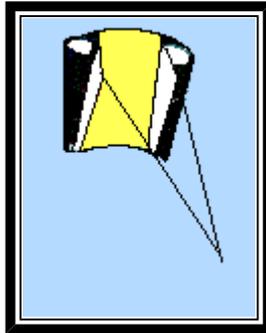
In 1978 a new Sled arrived based on Ed Grauel's Bullet kite that featured two air scoops at the rear of the sail. The design by Richard Lewis was sparless with two conical tubes to the rear of the sail. With the wind flowing into the conical tubes helped the kite to maintain it's shape and provide stability. A completely sparless kite it could be rolled up and placed in your coat pocket.



Nick Morse (Sled Special)

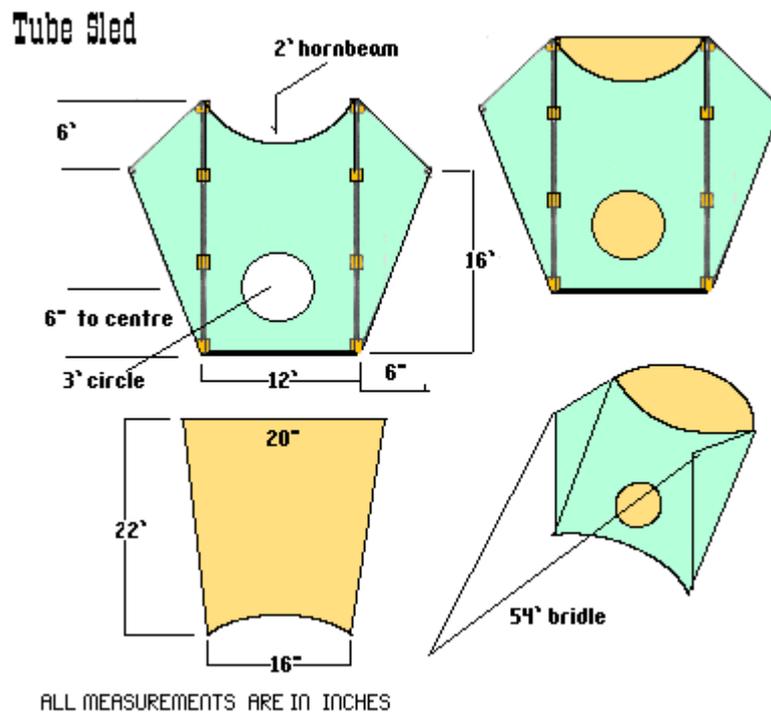
The Sled Special by the English kite designer Nick Morse also makes claim to a sparless sled (pocket type kite). Unlike Lewis's Pocket Kite also a sled where the conical tubes are placed on the back of the sail similar to Ed Grauel's 'Bullet Kite', who started the ball rolling with the introduction of two air channels to the rear of the Sled .

Morse placed his conical tubes to the side of the twin keels which are attached to the long bridle.



Tube Sled (Takeshi Nishibayashi)

It is assumed that the Japanese kitemaker Takeshi Nishibayashi is the designer of this particular type Sled kite. He made numerous visits to England, bringing with him many new and simple ideas for kites. This Tube Sled is very similar to the original early development of Ed Grauel's Bullet (Sled). Takeshi made the main sail shape like the Hornbeam with a large round vent then attached a single canopy to the rear to form a air channel.



Hooded Kite

Invented by John W. Loy (U.S. Patent 4,243,191) issued January 1981.

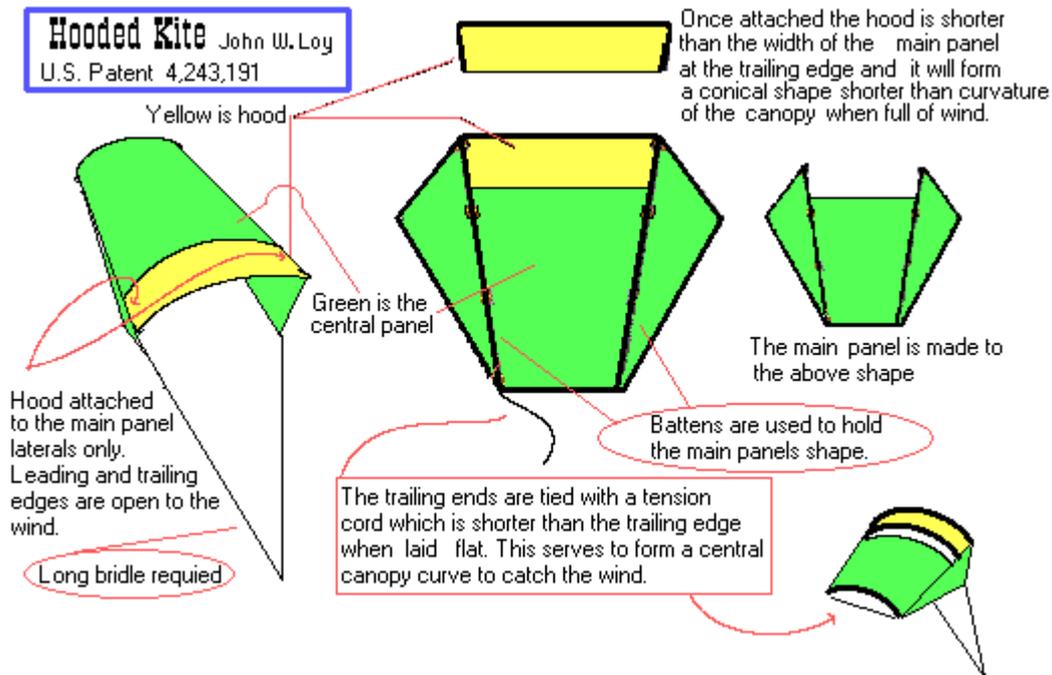
The design of a hood is to minimize and to prevent the collapse of a soft leading edge, customary to flexible Sled type kites without departing from some of its features. When the hood has air between it and the canopy it resists collapsing even if there is a short period of wind loss.

When the hooded kite is flying the canopy takes on a concave curvature.

The hood at its trailing edge is shorter than the width of the canopy, it forms a conical shape, of greater radius than the canopy, extending beyond the canopy surface.

The trailing edge of the canopy at the battens are tied with a tension cord which is shorter than the trailing edge when laid flat. This serves to form a central canopy curve and assist the kite to catch the wind when the velocity is low.

The patent lists two hooded kites, one with a tapered canopy and the other with parallel sides.



Swallowtail Kite

Patent issued to John W. Loy, July 21 1981
U.S. Patent 4,279,394

John W. Low filed two patents on May 29 1979, one for a Hooded Kite which is another version of a Sled type kite that incorporates a hood, the other took a completely different approach. With all previous designs with the exception of the Hornbeam, Sled kites had straight leading edges and trailing edges.

Most of the Sled kite designs had a problem of been sensitive to collapse in turbulent wind. John W. Low claims to have overcome these limitations to the Flexible Kite design by making several important modifications to the basic design of the Sled type kite. The central panel has been altered from a rectangle, to one which is the shape of a swallowtail.

To archive the required shape, three longitudinal stiffening battens are used.

The central batten is moved forward by about 20% of the two side battens to form a triangle leading edge.

If the wind condition changes and causes the kite to collapse the triangle leading edge catches the wind and reopens the canopy.

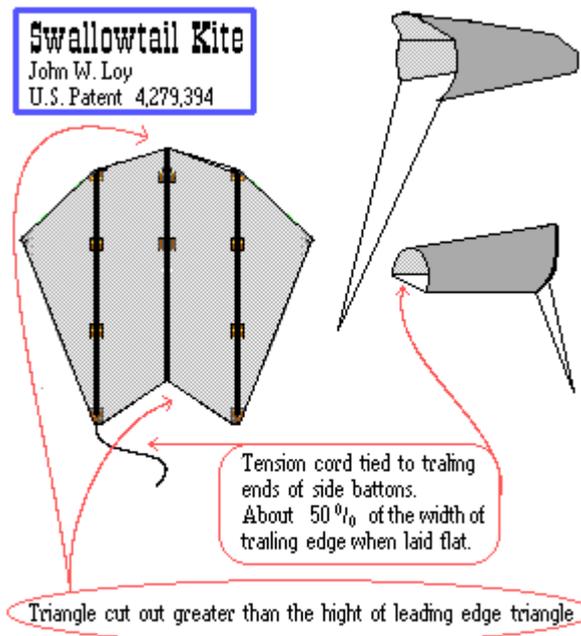
The trailing edge is cut away to form a isosceles triangle, the height of the triangle is greater than that of the leading edge.

The trailing edge shape provides the wind inside the canopy to spill from the kite before completely leaving the kite, providing additional stability.

The design of the trailing edge also uses a cord tension across the two outboard battens, this holds the canopy at that point to form a trough.

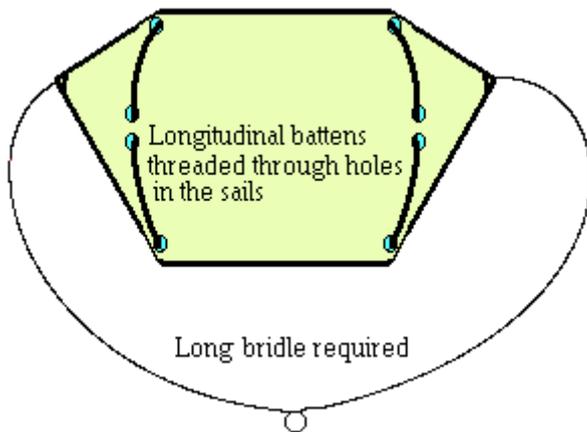
Even with the slightest wind, the held shape provides a strong reaction at low wind velocity.

The design requires a long bridle as do all other flexible Sled type kite.

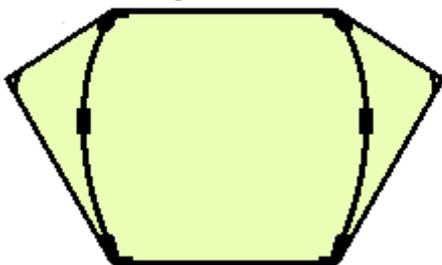


The canopy is of light weight material such as paper or thin plastic film.

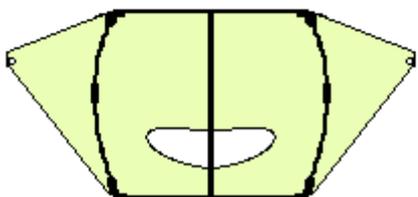
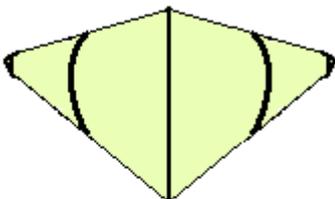
Ray Holland's Curved Spar Sled



Spring-like battens prevent the leading edge of the canopy from collapse.



Other alternative forms included with the patent



Patented October 1973 (3,767,145) On October 29th 1971 Ray Holland, Jr. filed for a patent of an improved version of wind-formed flexible kite of the general type known as a "Scott Sled", which is a registered trade name that is held by Ray Holland.

The one problem with this kite was it's tendency to collapse but designers are attracted to it's simplicity and area to weight rating.

As Ray Holland explained in his application for a patent (No 193,875). 'The kite design was hampered by the tendency of its fully billowed form to collapse at the leading edge in gusty air'.

One of the reasons the original 'Scott Sled' retained the three batten design of Allison's flexible kite.

Ray Holland's improvements solves the problem of collapsing and produces a flexible kite that stays open in the wind even when it is gusty. The design provides the ability to build flexible Sled type kites of varied sizes.

The design incorporated longitudinal ribs that are elastic or spring-like which straighten out when the kite is in a flat position. The choice of suitable material for the ribs requires careful selection to suit the flexible kites size. The designer Ray Holland suggests slender birch dowels for small kites.

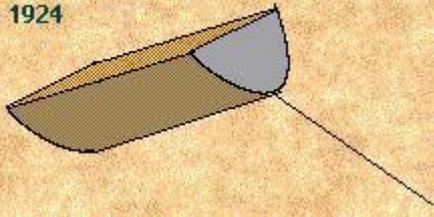
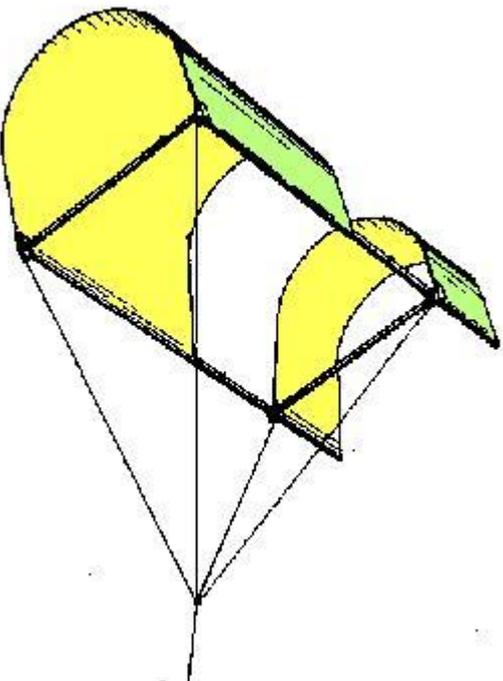
When the kite is in flight and billowing full of wind the curved ribs causes the upper leading edge and trailing edge to be raised relative to the mid-section.

The action of the curved ribs further improves billowing, holding the mouth of the kite open which prevents the collapse of the leading edge that leads to the kite folding in upon it's self.

The patent 3,767,145 covered many variations of the design, some are shown here. The use of a pressure-inflated tubes for the longitudinal ribs is also mentioned in the patent.

Concave Parabolic Arch Kite

Peter J. Pearce; Toby J. Cowan
Patent number 4,018,408 (April 19th 1977).

<p>A. B. Wilder's Kite. Patent number 1,498,356 April 15th 1924</p> 	<p>A patent filed on July 15th 1975 by Peter J. Pearce and Toby J. Cowan and granted on April 19th 1977.</p> <p>Patent number 4,018,408, consisted of two arched sails.</p> <p>Each sail is separated, forward and aft similar to a box kite arrangement only the forward sail has a larger area than the rear or aft sail. Their concave shape face downward in flight like a flexible sail of a Sled kite.</p> <p>Pearce and Cowan made reference to Allison's kite in their Patent application filed on July 15th 1975 (596,015) stating that it had a concave surface facing downward and that the sail is flexible.</p> <p>Their kite includes two sails attached to a rigid frame.</p> <p>The sails form a parabolic arched surface and form a shape of a trough with their open, concave shape facing downward in flight.</p> <p>A kite designed by A.B. Wilder in 1924 (Patent No 1,490,356) and reference cited by the examiner of the Arch Kite patent. A.B. Wilder almost had the concave kite concept, only his invention was flown with the curved surface facing down. (See drawing above)</p> <p>The kite also incorporated a paper webbing between its curved bowed members which the patent referred to as a top plane or wing.</p>
	

American Sportsman Keeled Sled

Designed by Harry Sauls

The American Sportsman is a kite design all of it's own as the kite differs from the basic

Sled. The kite has a central keel that provides added stability and assists to keep the kite

pointing into the wind. There is a series of triangular vents that provides a balanced airflow

over the kite's sail. A four legged bridle also provides lateral stability.

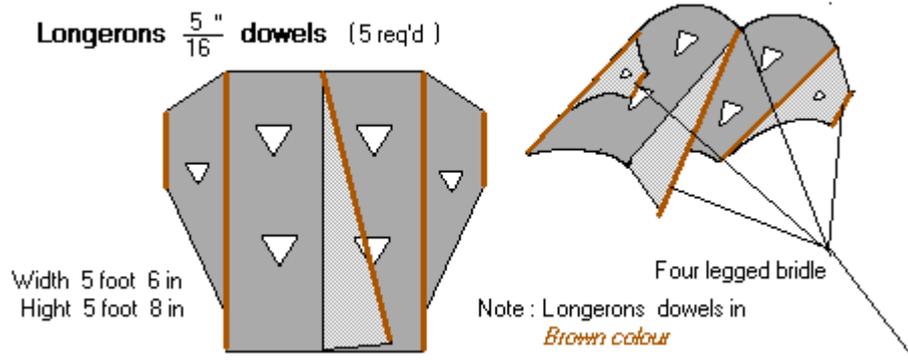
The central keel when in flight forms a double concave sail. All bridle points are attached

to dowels built into the sails (see drawing below).

This is a large kite, measuring 5 foot 6 inches when laided flat and has the ability to pull

very hard in a good wind.

Suggested material for the sail is .75 oz. ripstop Nylon.



Fluted Sled Design by Helen Bushell

The kite gets its name from the six (open both ends) full length fabric tubes on the back of the main sail canopy.

The tubes resemble Pan's Flute.

The main sail of the kite has 42 3 1/2" vents that channel the air into the full length tubes of the upper canopy.

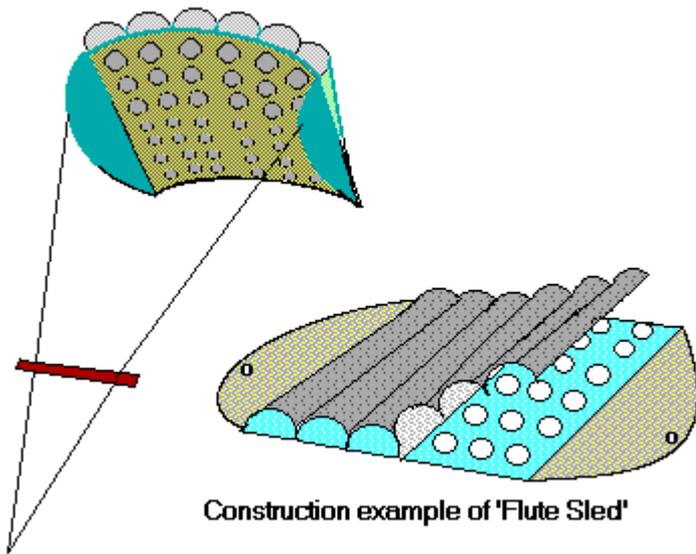
Air is also taken in by the open canopy tubes. Unlike the 'Pocket Kite', the Fluted Sled uses two longerons similar to basic flexible Sled kite.

The bridle has a spreader bar of light plastic tubing 56 inches from the kite's keels.

Bridle length, 12 feet.

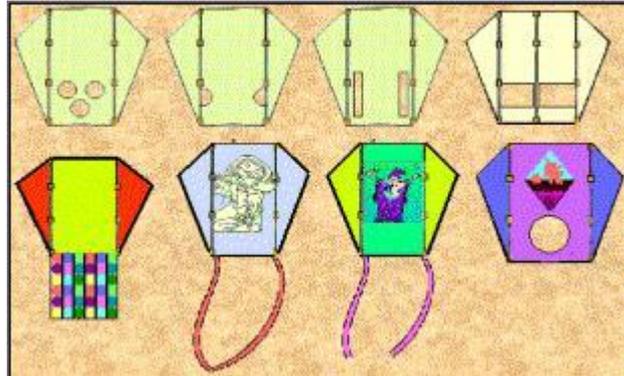
Face and keel panels, measure 72 inch span, length 48 inches. The keels are of a round shape and the bridle point dimensions are a critical factor of the design. The kite is made from .75 oz. ripstop fabric.

Due to the important dimensions of this design, the information provided on this web page is for reference and study as the design is the work of Helen Bushell and is protected by copyrights.



Construction example of 'Flute Sled'

Variations to the Design



There are many small variations to the design of the Allison, Scott Sled, other than those already covered within these pages . Some are made to get around the patent and copyrights. Although the inventors did not specify measurements in their patent applications to prevent any larger or smaller copies of their design, some gave percentages of width to length ratios as in the case of John W. Loy's 'Swallowtail Kite' (application No. 43,108 : patent 4,279,394).

Ray Holland chose to cover his invention with possible alternatives to the main patent application (patent No. 3,767,145).

Some kite manufactures still found ways around the copyrights just by making small alterations

to the basic design, round ports, curved leading edges down to the bridle points, just to name a few.

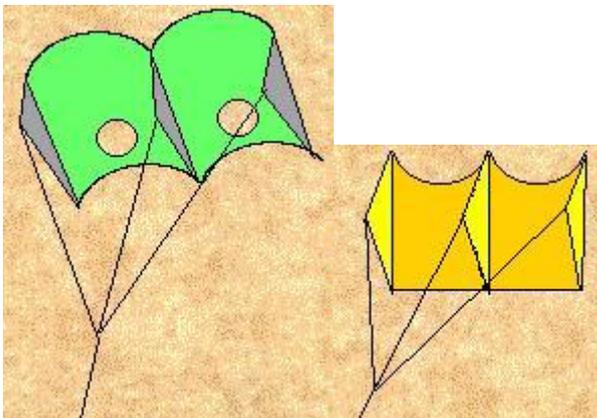
Other kite enthusiast chose to experiment with the simplicity of the design and made variations to the vent, seeking to improve on Frank Scott's version of a triangle vent.

Others made double Sleds or Hornbeam kites (right hand side).

Top left, 'Airway Kites of London' vented sled.

Fourth from the left top row, Kenneth and Keith Shields of Ambridge, Pa. with rectangular vent.

Lower four version on the left are versions made by other kite manufactures.



Round Sled Kite

Design by Tom Lehane

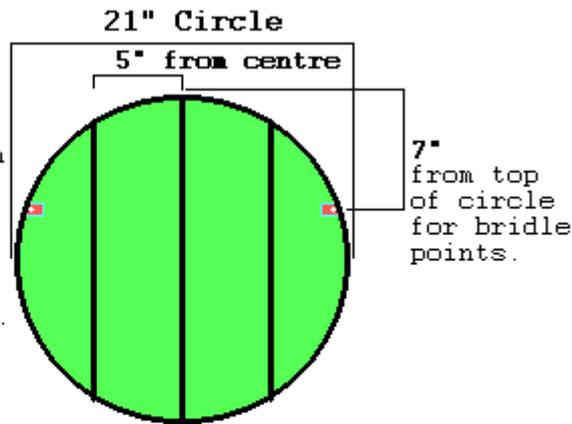
Round Sled

By Tom Lehane

Built from Plastic film such as a trash bag. The longerons are 1/4" balsa or 3/16 softwood dowel. The bridle length of 42" helps to maintain it's shape.



Due to the round shape, the bridle pulls the top of the circle in and the lower flares out making the kite stable.



Three longerons are used 21" long and trimmed to fit the circle. Each longeron is held in place with adhesive tape in three places, top, centre and bottom of circle.

Bridle points are reinforced with adhesive tape or cloth backed adhesive tape the type used in surgical dressing (Band-Aid).

Bridle is best made from flat ribbon about 1/4" wide to prevent twisting.

Refer to How to Build a Sled Kite for more information.

Experimenting with different variations in the Allison (Sled) kite genre, I tried longer than normal

sail lengths but found they had a tendency to collapse much more easily. Another shape similar to the diamond kite shape but in a flexible Sled form proved to be unstable.

Another shape which I felt would not perform due to the curvature of the keels proved otherwise. Normally keels are of a triangle shape so the tension is evenly spread without any loose material folding out of shape. The curvature of the **Round Sled's** keel pulled the top of the circular sail in and flared the lower section out, making the kite very stable and flying at a higher angle than my other Sled Kites which were tethered near by.

All experiments with different shapes were carried out on the same day and within 15 minutes of each trial so a reasonable comparison could be made.

Self - Stiffened Flexible Kite

Inventor David M. Checkley Patent number 3,860,204
issued on January 14th 1975

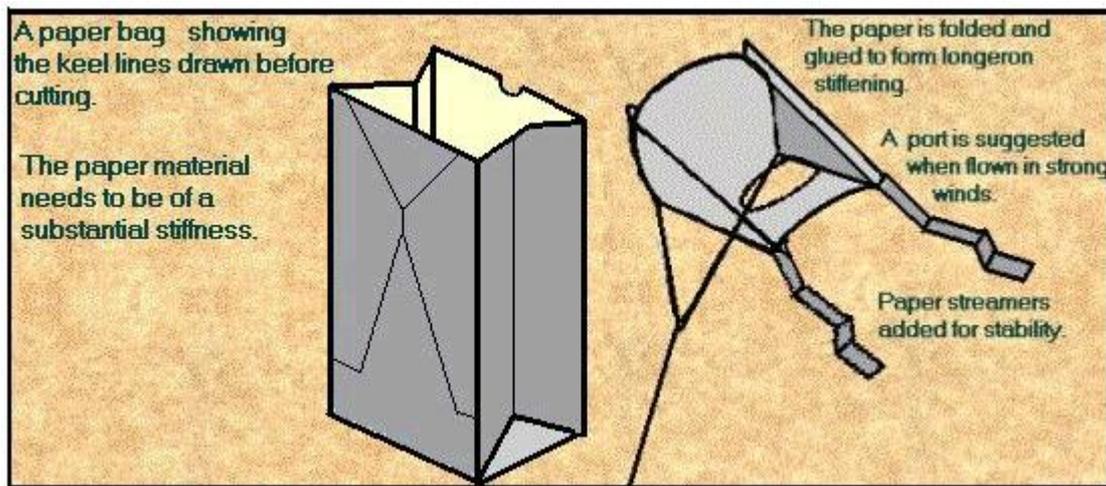
The primary object of this invention is to build a Allison Sled type kite using the material of the main sail as longitudinally stiffening.

The material used for construction of this kite as mention in the patent can be any light material that is impervious to the passage of air. The patent suggests a variety of plastic film and tight weave fabrics but the inventor prefers paper to cut cost.

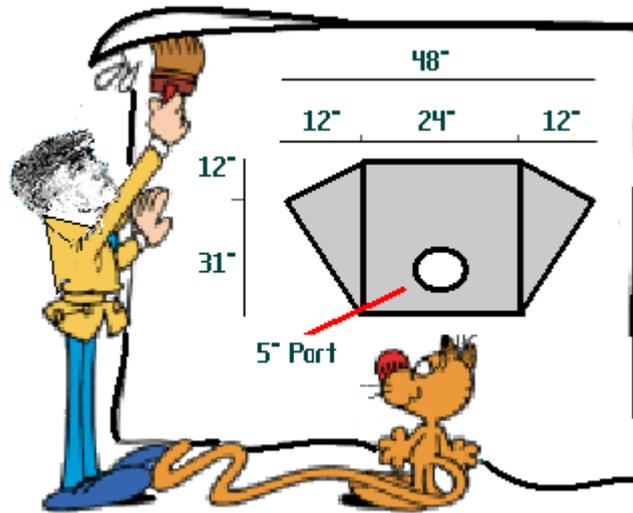
The paper material needs to be of a substantial stiffness.

The paper is folded and glued to form longeron stiffening (see graphic drawing).

A port is suggested when flown in strong winds, paper streamers are added for stability.



How to make a Sled Kite



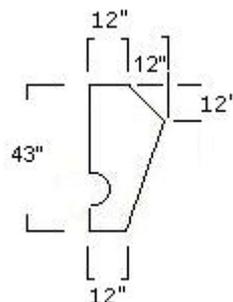
Materials required

- 1) Polyethylene trash bag or PVC (plastic) sheet
- 2) Two 1/4" balsa wood spars or 3/16" dowel, 43" long.
- 3) A length of ribbon 174" long by 1/4" wide (for 86" bridle).
- 4) Two Band-Aids
- 5) Adhesive tape
- 6) 15 lb B/S flying line.

Note: I have found the ribbon bridle helps the kite to recover from a collapse, as there is no twist in a flat ribbon and it will not tangle like a twisted cord would after released from tension if the kite collapses from a strong cross wind.

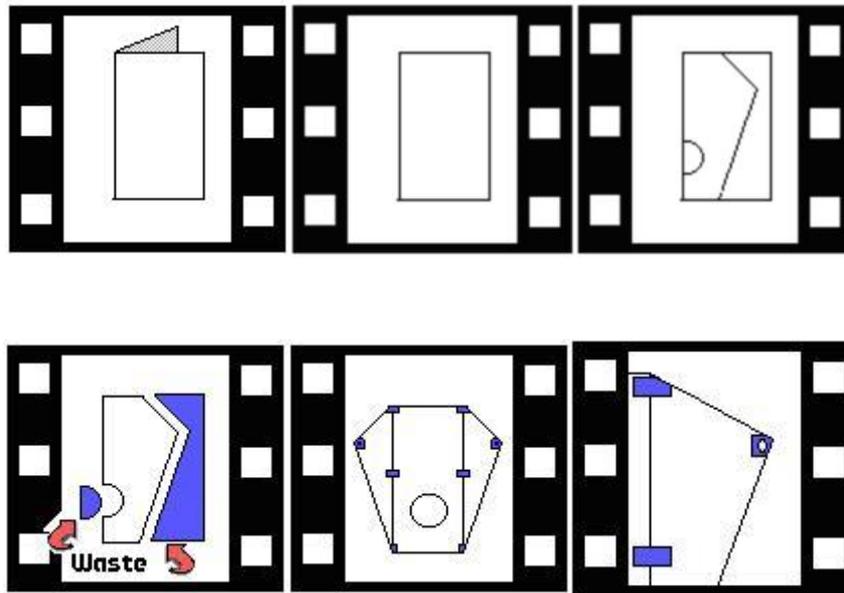
This kite measuring 48" when laid flat is made from a Polyethylene trash bag or a PVC sheet. If a bag is used cut the sealed section off so you have a sleeve when opened. For a PVC sheet, fold in half as shown below.

Using the measurements provided on this page, draw half the kite onto the material.



measurements when folded

Using scissors cut around your pattern



Remove the waste and unfold the kite pattern. Lay the kite on a flat surface. Place the two spars on the pattern as shown and stick down with adhesive tape at three points.

Top, centre and trailing edge. Reinforce the two keel tips for the bridle line with a Band-Aid, folded so the adhesive is on both sides of the keel tip.

Punch a hole on each keel tip through the Band-Aid reinforcement.

Obtain your length of ribbon 174" long by 1/4" (for the bridle).

Tie each end of the bridle line (ribbon) to the keel tip through the holes at the reinforcements.

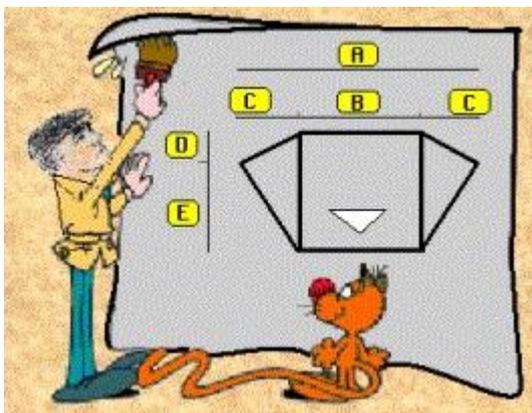
Take the kite from the flat building surface and fold in half, bring both keel tips together.

Hold keel tips with one hand and with the other hand run out the bridle line so both are under slight tension. Tie an over hand knot at the end so it forms a towing loop at the exact centre.

When the two bridle lines are tied you should have an 86 inch bridle.

Tie a flying line to the loop of the bridle and you ready to fly your kite.

Scale chart



A	36 in	48 in	54 in
B	18 in	24 in	27 in
C	9 in	12 in	13 1/2 in
D	9 in	12 in	13 1/2 in
E	23 in	31 in	34 1/2 in
Bridle	64 in	86 in	96 in

The port is triangular with three equal sides.

Port	9 in	12 in	13 in
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Wind speed indicator (anemometer)

This device to measure wind speed is made from corrugated cardboard. A discarded cardboard box will do the job. Cut the box so it will lay flat on a table.

Mark off four 3 inch sections and a ½ inch section for an over lap to enclose one side of the box tube.

Crease along the corrugations using a ruler for a straight edge and the handle of a spoon. Fold the cardboard at the creases to make the box tube and glue the ½ inch over lap to the 4th side.

Follow the plan below to complete the wind speed indicator.

To calibrate the anemometer requires two people. Choose a still day with no wind, early morning is best.

Have a friend drive a car at low speed, about 10 MPH. Place your anemometer into the wind and mark the area

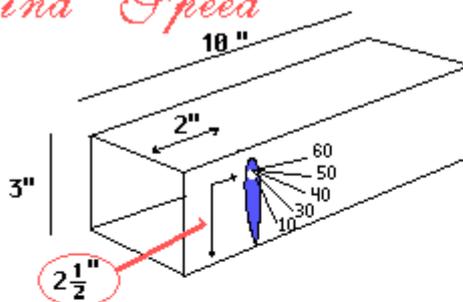
the needle is steady at for 10 MPH. Increase the car speed to 20 MPH and mark the area as 20 MPH.

Continue up the speed range and mark off the speeds. Stay with in the road rules and don't exceed the speed limit.

Now with the anemometer calibrated you can measure the wind speed at ground level as wind speed will be different at higher altitudes.

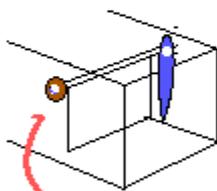
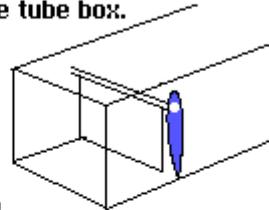
When you take a reading, first hold the anemometer level by holding your hand over the opening and move the box tube until you have the needle at rest on zero. Remove your hand and point the anemometer into the wind.

Wind Speed



Make a square tube from stiff corrugated cardboard.

Cut the inside flap from the same cardboard, making it smaller by 1/8" all round so it can move freely inside the square tube box.



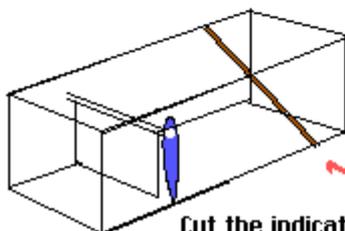
For the shaft use a 1/8" wooden barbecue skewer.

Make a hole in the tube box's sides using the measurements shown.

Place the skewer shaft through one side and thread the shaft into the corrugated flap using the second line of corrugations as a guide.

Glue a cardboard washer on the far side of the shaft.

Glue the flap to the shaft allowing room both sides of flap to move freely.



1" from the end of the tube box thread a wooden skewer through each corner as shown and glue in place to prevent the box collapsing.

Cut the indicator pointer from stiff coloured card and glue to the shaft.