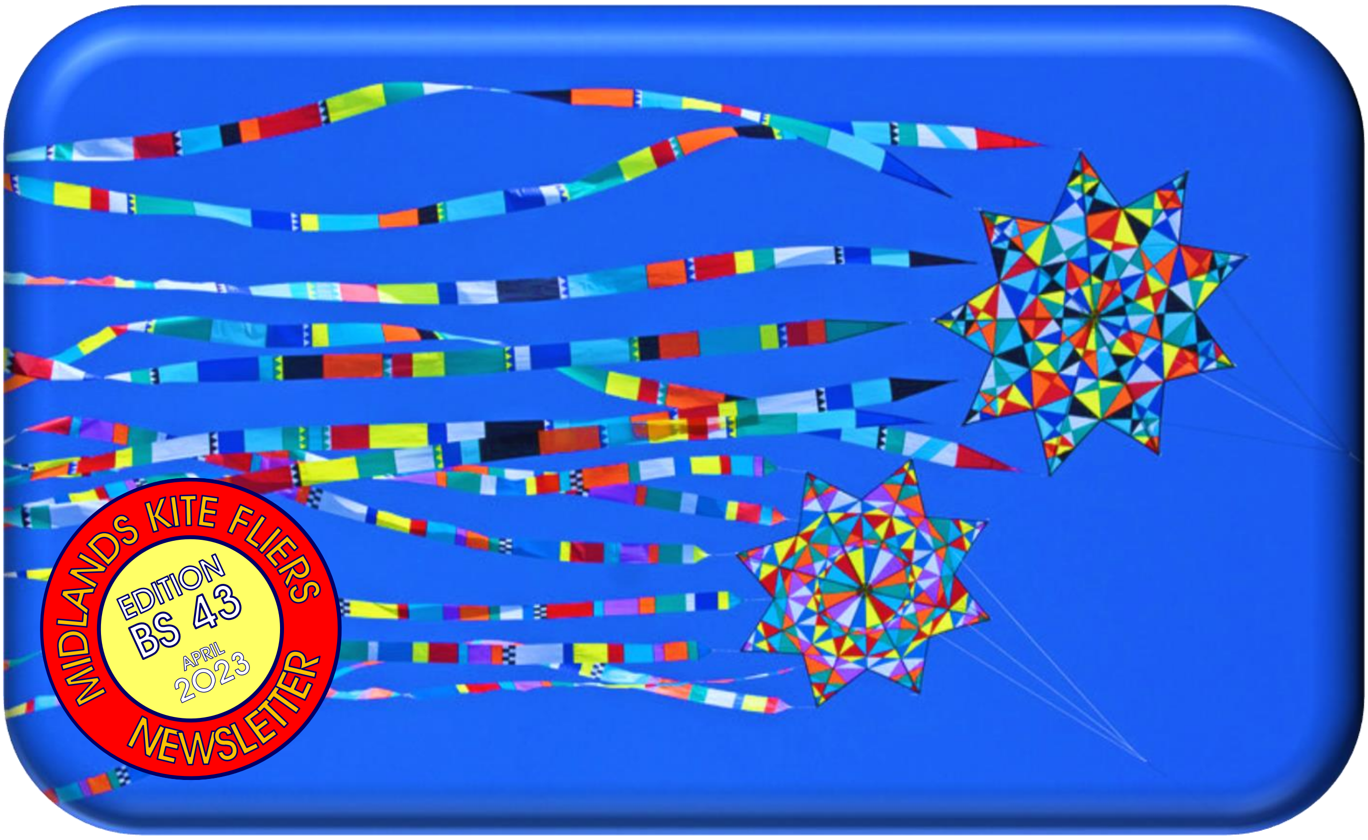
NEWSLETTER OF THE MIDLANDS KITE FLIERS OF GREAT BRITAIN

44TH ANNIVERSARY 1979 - 2023

APRIL 2023



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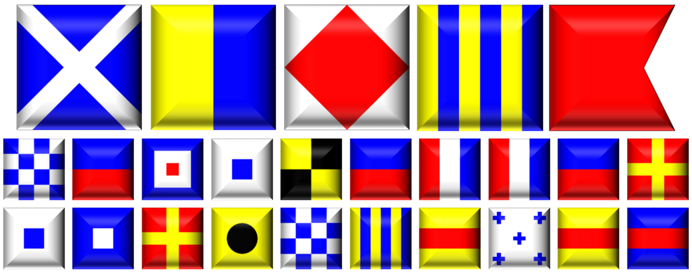

NEWSLETTER OF THE MIDLANDS KITE FLIERS SPRING 2023

GENERAL INFORMATION

CLUB FLY-INS

We hold club fly-ins each month (winter included) at various sites. These are informal events and are a great way of meeting other MKF members.

MEMBERSHIP CARDS

Your membership card may help you obtain discounts for purchases from kite retailers in the UK, and gain you entry to events and festivals free, or at a reduced cost.

Please keep them safe.

PUBLIC LIABILITY INSURANCE

All fully paid up members are covered by Public Liability Insurance to fly kites safely for '***pleasure***' anywhere in the world with the exception of the United States of America and Canada. If you injure anyone whilst flying your kite the injured party may be able to claim on the club insurance for up to **£5,000,000**. The club has 'Member-to-Member Liability Insurance'.

A claim may be refused if the flier was found to be flying a kite dangerously - e.g. using unsuitable line, in unsuitable weather; flying over people, animals, buildings or vehicles. This insurance does not cover you for damage to, or loss or theft of members' kite/s.

BUGGIES, BOARDS & KITESURFING

Unfortunately, we are not able to cover these activities within the clubs insurance policy.

The MKFNEWS is pleased to print articles and photographs submitted by any interested party. All submissions are reproduced at the Editors discretion, however the Club cannot be held responsible for any views or comments contained in any such articles.

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I am sorry but I don't do 'Facebook',
If you want me either email or phone ..... I'll always get back to you.

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'MKFNEWS' DEADLINES FOR 2023+

MKFNEWS B. SOUTEN - EDITOR	'COPY' DEADLINE	PUBLISHING DATE
44	25th June 2023	Mid July 2023
45	25th September 2023	Mid October 2023
46	25th December 2023	Mid January 2024
47	25th March 2024	Mid April 2024

Photo Journal: Flying for New Year

(Mainichi/Koichiro Tezuka)

A veteran craftsman creates a Japanese kite decorated with an image of a boar, the Chinese zodiac sign for 2019, at his workshop, "Tako Kobo Toki," in the village of Chosei, Chiba Prefecture, west of Tokyo, in this recent photo. The 68-year-old craftsman, Mikio Toki, has engaged in making traditional square-shaped kites -- regarded as lucky charms for New Year -- for more than 40 years. The kite designs have been handed down from the Edo period. They feature a stick made from split cane at the top that creates a humming sound as the kite is flown.

Kites from Around the World

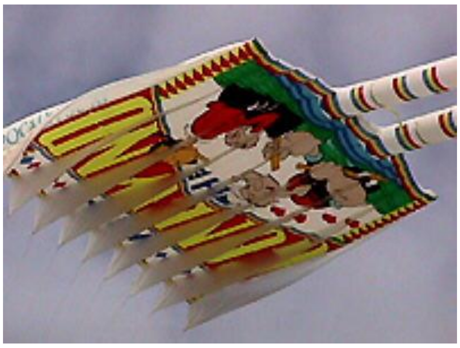
American Kitefliers Association

Australia:
Michael Alvarez of Perth, Australia, uses his large cellular kite in workshops he presents for school children

Australia:
Tony Wolfenden lives in Sidney but travels to kite festivals around the world.

Brazil:
Mr. Zecca das Pipas is called the "King Of Kites" in Rio de Janeiro.

Canada:
Robert Trepanier of Montreal, Canada, is known for the haunting faces he paints on his kites.

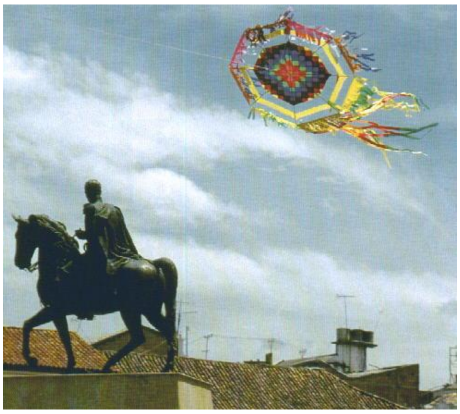


Canada:
Art Ross of Vancouver B.C. is known for his huge parafoils.

Canada:
Erick Curtis and Ann Sloboda of Ontario screen print and hand dye all of their kites.

China:
The Beijing Swallow Kite is often flown over Tianamin Square.

China:
Another traditional kite from China is the Weifang Dragon which is flown with as many as 200 cellular panes behind the ornate head.



Columbia:
Bogota hosts a popular

festivals each spring that draws 100,000 spectators.

Curacao:
Many unique kites come from throughout the Caribbean.

Denmark:
The International Kite Party on the Danish Island of Fano has some of the best buggy riding in the world.

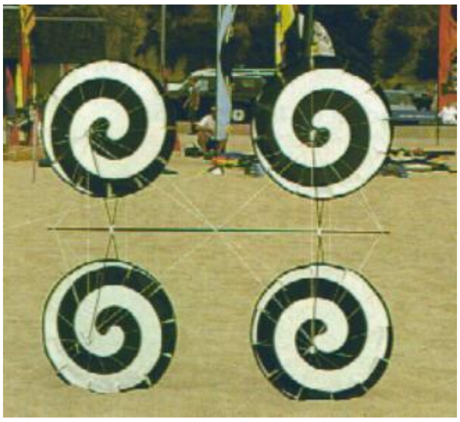
France:
The dramatic “No. 9” by Pierre Fabre

France:
Andre Cassagne designed a series of ring kites to celebrate the Olympics. He is the best known kitemaker in France and the original inventor of the Etch-a-Sketch.

France:
This large Japanese style kite was made for the international kite festival in Dieppe. The artwork copies the front page of the local newspaper.

Germany:
Rolf Sturm is the president of the Drachen Club Deutchland (German Kite Club). He is famous for his Snoopy and Red Baron inflatable kites.

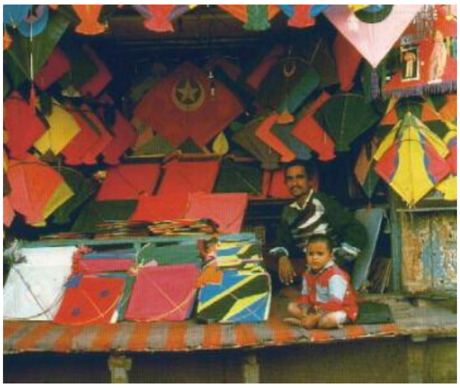
Germany:
Team No Limit flies large turning “wheels” and inflated kites that look like Sesame Street Characters



Germany:
Uwe Grysback creates interesting spinning kites that maneuver on multiple lines.

Guadeloupe:
An international sport kite competition was held on the island of Guadeloupe in 1998.

Holland:
A new kite design called the “circoflex” was invented by Ton Oostveen and Helmut Schiefer in Holland during the 1990’s



India:
Festivals involving millions of people and kites are held each January in Ahmenabad, India. Kites are sold on the street in simple stalls like this.

India:
Lightweight paper kites are used in India for fighting on glass coated line. The loser is cut free.

Indonesia:
The bird kites of Indonesia are made from hand-painted silk.

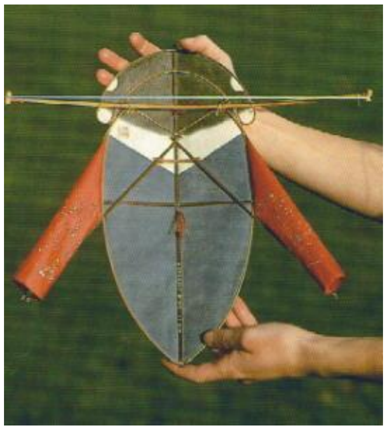
Israel:
Gill Marcus stitches pop art into each of his kites.

Italy:
Claudio Capelli paints the faces of his friends on his kites..

Italy:
Italian festivals feature large kites and banner shows.

Italy:
One Italian team has created a symphony of instrument kites that they fly to music.

Japan:
Launching an O-dako (a giant rectangular kite). Roughly 200 of these huge kites are destroyed each year in the kitebattles of Shirone.



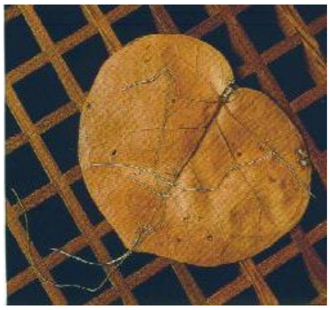
Japan:
This is a humming Bee Kite made by Satoshi Hashimoto. The bee is crafted from rice paper and bamboo that has been aged for more than 100 years. When flown, the “hummer” on the top makes a loud buzzing noise.

Japan:
A hand painted Edo kite (“Edo” is the former name of Tokyo) featuring the rabbit and

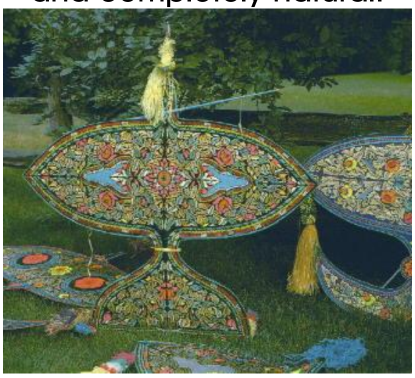
wave theme from a traditional folk tale.

Korea:
A huge "Phoenix" bird kite flown by the Korean Kite Association

Korea:
The traditional Korean combat kite with a hole in the center.



Martinique:
A leaf kite. Small, lightweight and completely natural.



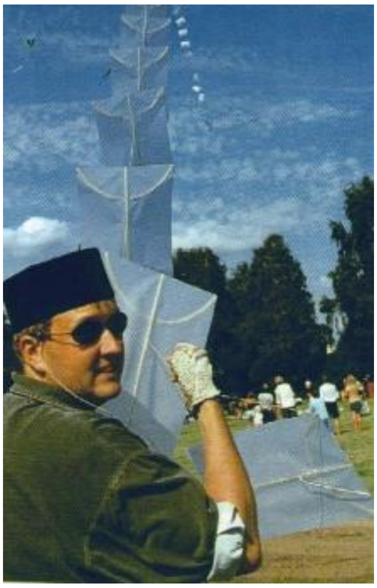
Malaysia:
The delicate Wau Kuching (cat kite) and Wau Bulan (moon kite). These examples were made for decorative contests and are too heavy to fly.

Mexico:
Jose Sainz, who now lives in San Diego, has traveled the world with his unique kites. This one combines traditional Mexican art with modern materials.

Nepal:
Kites from Nepal are some of the highest flying in the world.

New Zealand:
Designer Peter Lynn created a series of huge inflatable kites (no sticks) in the shape of various sea creatures.

New Zealand:
Peter Lynn also designed a modern kite "buggy" made from stainless steel and powered by large maneuverable kites. George Pocock used the same idea in England in 1822.



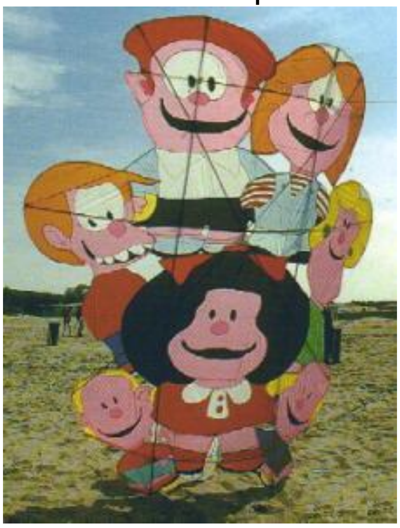
Norway:
The kites and kite fliers of Oslo are interesting and a bit different.

Portugal:
An annual kite retreat is held in

Lagos, Portugal. great fun on the beach!.

Singapore:
Mr. Shakib Gunn is a familiar face as festivals throughout Singapore.

South Africa:
Here's a sport kite team at a festival near Cape Town



Spain:
Josep Nieto of Barcelona flies cartoon character kites.

Switzerland:
Winter kite skiing is popular in the Alps

Thailand:
The traditional kites of Thailand represent male and female characters. This one, called a "chula' is the male kite. The kites are flown in sophisticated "battles" designed to capture a mate.

Thailand:
Every two year, a festival is held before the royal palace in Bangkok.

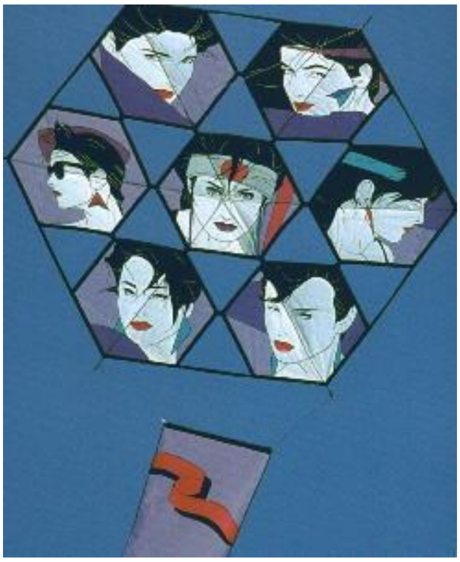
Turkey:
Turkey has hosted several kite festivals near Istanbul..

United Arab Emirates:
These three giant kites were flown at the First International Kite Festival of Dubai on the Persian Gulf.

United Kingdom:
The Cody Manlifting Kite was designed for the British Army about 100 years ago. It was invented by an American named Samuel Franklin Cody, who dressed much like Buffalo Bill.

United Kingdom:
Martin Lester of Bristol is known for making flying "Body Parts".

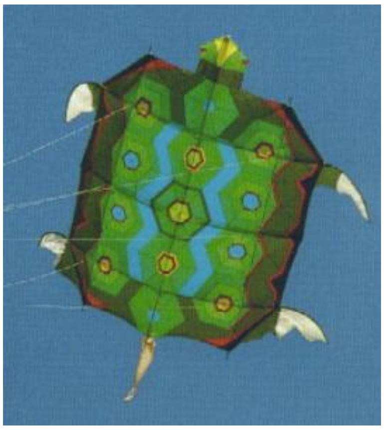
United Kingdom:
A six member performance team from England called the Decorators



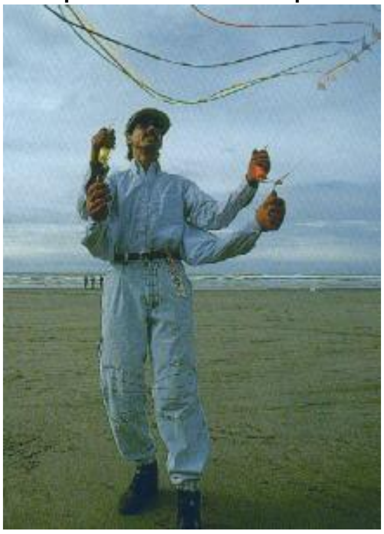
USA:
Randy Tom of San Diego won many awards with this "seven sisters" style kite with sewn copies of artwork by Patrick Nagel.

USA:
A six-sided Japanese kite is called a "rokkaku" (ro-ka-coo). Kathy Goodwind of Seattle made this model which she calls "Ro-ka-doodle-do. It now hangs in a Japanese kite museum.

USA:
Artist George Peters of Boulder, Colorado, combines interesting shapes to create whimsical kites.



USA:
Designer Scott Skinner of Monument, Colorado, combines traditional American quilting techniques with Japanese kite shapes.



USA:
Performer Dennis Kumerowski of Ft. Lauderdale, Florida, flies kites which steer with four lines. He added two extra "arms" to his costume to enhance the effect

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Against the wind: A load-bearing, yet durable, kite inspired by insect wings

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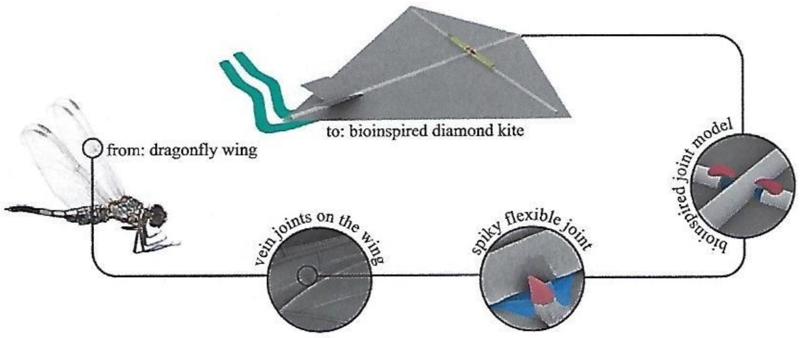
HIGHLIGHTS

- We developed a bio-inspired design strategy to combine two mutually exclusive characteristics of loading-bearing and durability.
- Our design strategy is purely structural and, therefore, can be easily modified and implemented in engineering systems.
- Using the developed strategy, we designed and fabricated the first bio-inspired 3D printed kite that can withstand strong wind gusts.
- The example of the kite confirmed the efficiency of our bio-inspired strategy in practice.
- A similar design principle could be used to develop load-bearing, yet durable, engineering structures.

GRAPHICAL ABSTRACT



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ABSTRACT

Durability and load-bearing are difficult to be combined in engineering systems. Hence, in majority of man-made structures, the two characteristics are typically mutually exclusive. Nature, however, has provided us with design strategies, through which many biological systems have overcome this conflict. Insect wings represent a striking example of such a combination. A key to this lies in the presence of vein joints. Here we 3D printed bio-inspired joints, akin to those of insect wings and tested their mechanical performance under both static and cyclic loadings. We used the so-called 'flexible joints', which had a high durability, and engineered them to further enhance their load-bearing capacity. We then implemented them into the design of the first 3D printed bio-inspired kite. The manufactured kite showed a stable flight and withstood loads induced by strong wind gusts without failure. The concept developed here can be applied to other engineering designs that pursue a compromise between load-bearing and durability. At the end, we used our data to better understand the complexities of insect wings with respect to their local and global deformations and fracture resistance.

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1. Introduction

Structural composites have found a variety of applications in aerospace, automotive and medical engineering [1,13,41]. To fulfil their roles, they are often required to bear loads, i.e. being load-bearing, and maintain their load-bearing capacity in long-term, i.e. being durable. However, most of the existing engineered structures have only one of the above characteristics while lack the other [21,39]. This, therefore, has prompted efforts to develop design strategies, which facilitate the combination of the two characteristics [5,8,11,43].

A common strategy to enhance the durability of existing structural composites, which are mostly load-bearing, is to allow some levels of deformability [6,25]. This is often achieved by the use of structural gradients [4], hierarchical architectures [23] or graded properties [42]. Limited deformations redistribute stress under extreme loads and, hence, delay the onset of damage. Although this strategy often reduces the load-bearing capacity of a structure, compared to when no such a strategy exists, it can prevent the risk of catastrophic failures.

To combine durability and load-bearing, there have been many investigations in recent years to develop structures with variable deformability levels. Previous studies are often based on complicated strategies, such as layer jamming [18,29], kinematic interaction of multiple surfaces [15] and pre-stretched sandwiched layers of multiple materials [26], in which materials with different elastic moduli were used. This points out to the need for novel approaches that simplify the development of load-bearing, yet durable, structures.

Owing to nature, we have been provided with a variety of solutions, which can enhance the durability of existing engineering structures. Previous studies have shown that the durability of many biological structures results from the same concept, as that of many man-made ones: limited levels of deformability [19,39]. An excellent example of this is represented by insect wings [47], and in particular dragonfly wings [32,34,40]. The specific design, has provided wings with two distinct deformability regimes: (i) a high deformability regime, in which wings easily deform under small mechanical loads and (ii) a low deformability regime, in which they remarkably stiffen when subjected to higher loads. While flexibility provides wings with an enhanced lift generation capacity, stiffness increases their resistance against aerodynamic forces [16,28,36,47,48]. Previous studies have shown that the balance between stiffness and flexibility in the wings is mainly achieved through highly-specialized joint-like structures, known as vein joints [12,16,37,38] (Fig. 1). Vein joints are the intersecting points of veins and are distributed all over the wing area (Fig. 2A–C). By controlling local wing deformations, they play a crucial role in the overall deformation pattern of the wings in flight [12,16,37,45].

Inspired by the vein joints of dragonfly wings, here we designed and fabricated multiple joint-like structures using 3D printing. To assess the load-bearing capacity and durability of the joints, we performed both static and cyclic tests. In terms of a compromise between load-bearing and durability, we selected the most promising type of the joints. We improved their design and then implemented them into a 3D printed diamond kite. The kite could resist forces induced by strong winds, and was deformable enough to make a chordwise camber that improved its flight stability.

1.1. Vein joints of dragonfly wings

There are a variety of vein joints in dragonfly wings [2,3,12,30], which can be subdivided into two general categories of fused and flexible, also known as immobile and mobile, joints [16,30] (Fig. 1). Fused joints are characterised by relatively large contact areas between the two intersecting veins (Fig. 1B); whereas the intersecting veins in flexible joints have almost no direct contact and are indirectly connected to each other via a patch of resilin-rich cuticle [16] (Fig. 2D). Resilin is a rubber-like protein, which is known for its strong elastic recovery [44]. Hence, it plays a key role in enhancing the deformability of the joints [35–38].

2. Materials & methods

2.1. Design and fabrication of bio-inspired joints

Table 1 represents two-dimensional (2D) sketches of all the developed models in this study. Using three-dimensional (3D) computer graphics software Blender v. 2.79 (https://www.blender.org/), we developed nine different joint models, which can be classified into two categories of flexible and fused joints, as follows: 'flexible joint with gap contacts', which had discontinuities at the interval of the intersecting elements; 'flexible joint with gap contacts and spikes', which had discontinuities at the interval of the intersecting elements and two spikes on the cross elements; 'flexible joint with soft contacts', which had soft materials at the interval of the intersecting elements; 'flexible joint with soft contacts and spikes', which had soft materials at the interval of the intersecting elements and two spikes on the cross elements; 'half-fused joint', in which the intersecting elements were fused to each other on one side of the joint; 'half-fused joint with spikes', in which the intersecting elements were fused to each other on one side of the joint and had two spikes on the non-fused side of the cross elements; 'point-fused joint', in which the intersecting elements were fused to each other only at a small

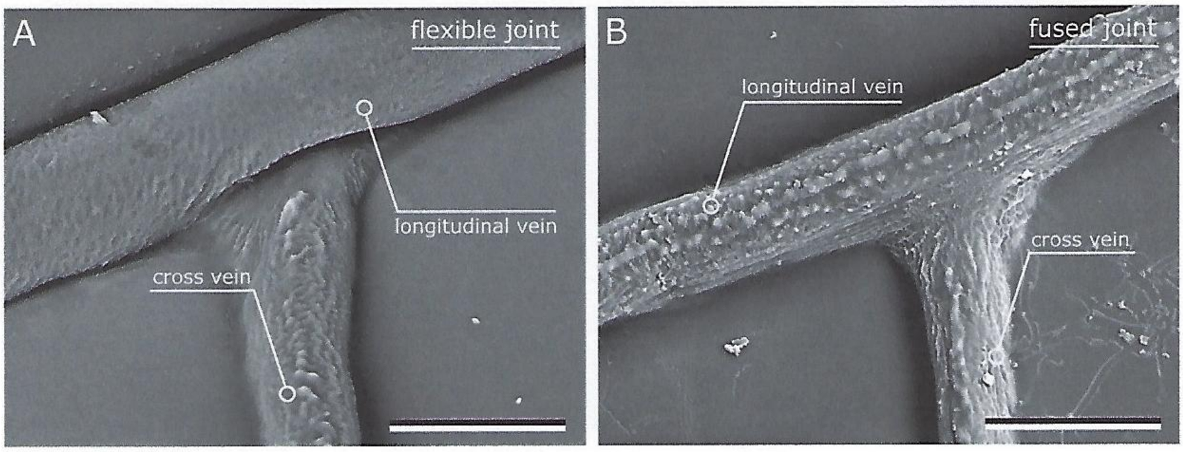


Fig. 1. Flexible and fused joints. Scanning electron microscopy (SEM) images of (A) a flexible joint and (B) a fused joint of the wings of the dragonfly *Sympetrum vulgatum* (Anisoptera, Liebellulidae). Scale bars: 50 μm (A, B).

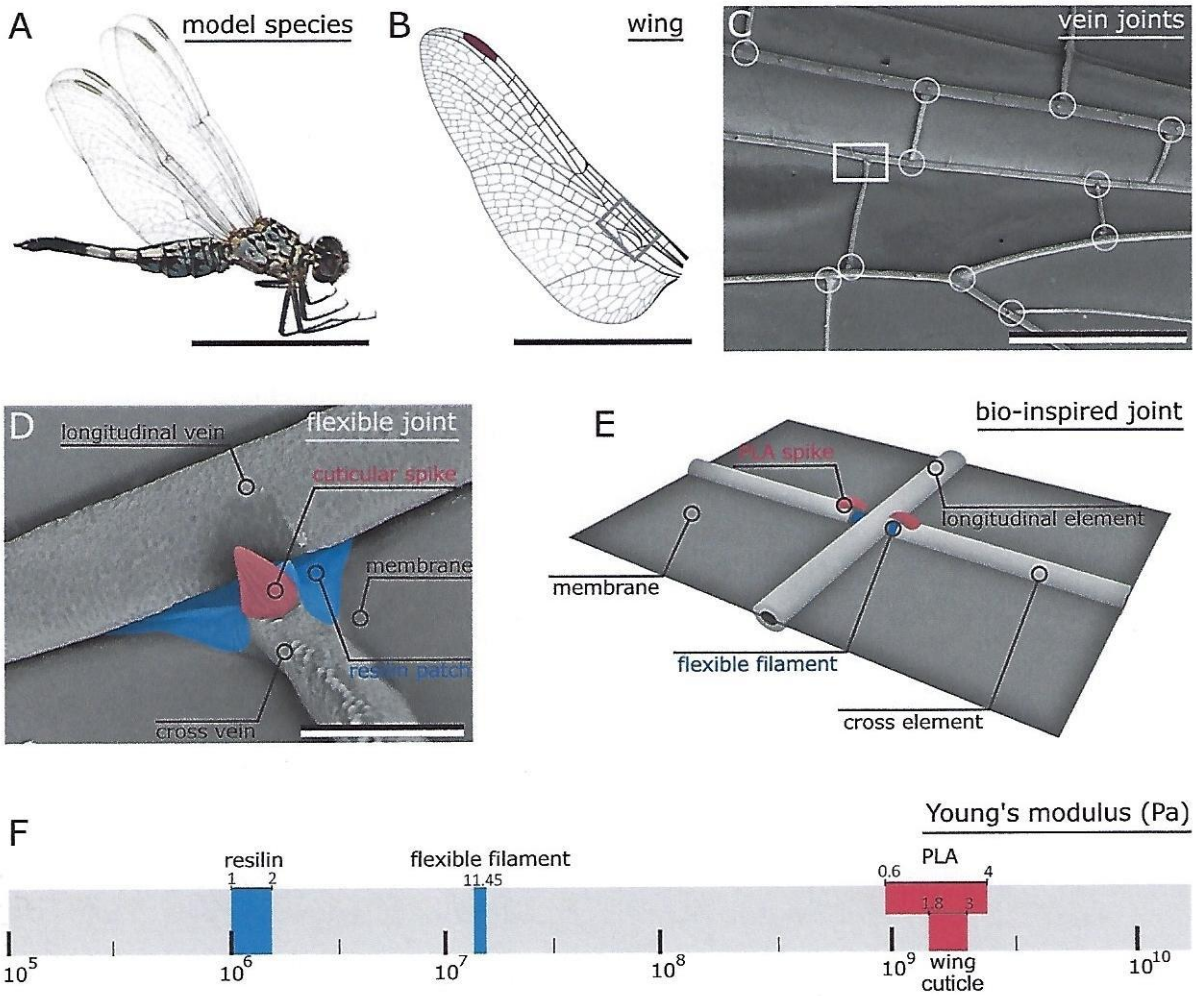
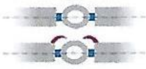
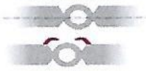
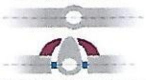
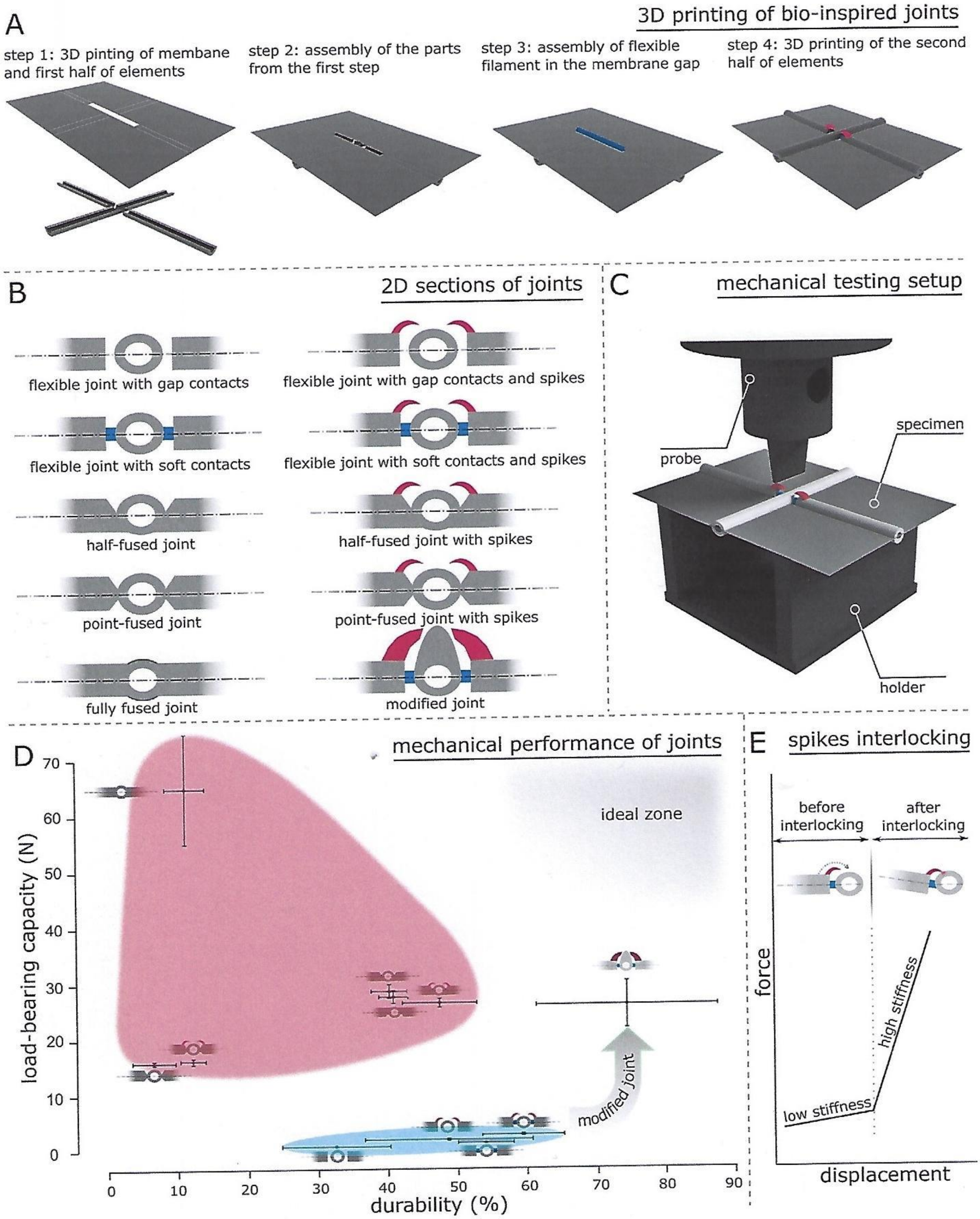


Fig. 2. From inspiration to design. (A) An image of the dragonfly *Acisoma panorpoides* (Anisoptera, Liebellulidae) [33]. (B) Hind wing of the dragonfly. Grey rectangle shows the area displayed in (C). (C) A SEM image of the basal part of the wing showing the network of veins and vein joints. White rectangle shows the area displayed in (D). (D) A SEM image of a flexible joint with a spike and a resilin patch highlighted in red and blue colours, respectively. (E) Designed joint consists of flexible filaments at the interval of the reinforcing elements and two stiff spikes on the cross elements, which represent the resilin patch and cuticlar spikes of the insect wings, respectively. (F) The Young's modulus of the wing cuticle and resilin and their representative elements in the designed joint (i.e. PLA and flexible filament). Scale bars: 15 mm (A), 10 mm (B), 2 mm (C), and 0.05 mm (D).

Table 1
Characteristics of the fabricated bio-inspired joints.

Joint categories	Soft contacts	Spikes	Sketch	Title
Flexible	×	×		flexible joint with gap contacts
	×	✓		flexible joint with gap contacts and spikes
	✓	×		flexible joint with soft contacts
	✓	✓		flexible joint with soft contacts and spikes
Fused	×	×		half-fused joint
	×	✓		half-fused joint with spikes
	×	×		point-fused joint
	×	✓		point-fused joint with spikes
	×	×		fully fused joint
Flexible-modified	✓	✓		modified joint

point; 'point-fused joint with spikes', in which the intersecting elements were fused to each other only at a small point and had two spikes on the cross elements; and 'fully fused joint', in which the intersecting elements were completely fused to each other and made a comparatively large contact. The characteristics of the models is summarized in Table 1.


A
3D printing of bio-inspired joints
step 1: 3D pinting of membane and first half of elements
step 2: assembly of the parts from the first step
step 3: assembly of flexible filament in the membrane gap
step 4: 3D printing of the second half of elements
B
2D sections of joints
flexible joint with gap contacts
flexible joint with soft contacts
half-fused joint
point-fused joint
fully fused joint
flexible joint with gap contacts and spikes
flexible joint with soft contacts and spikes
half-fused joint with spikes
point-fused joint with spikes
modified joint
C
mechanical testing setup
probe
specimen
holder
D
mechanical performance of joints
load-bearing capacity (N)
durability (%)
ideal zone
modified joint
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
E
spikes interlocking
before interlocking
after interlocking
force
displacement
low stiffness
high stiffness

In order to fabricate the virtual models, we used the 3D printer Prusa i3 MK3 (Prusa Research, Prague, Czech Republic). 3D printing has shown to be a promising technology to fabricate complicated geometric forms ([7,20,22,24]). At first, a 70 mm × 50 mm membrane with a thickness of 0.15 mm was 3D printed using polylactic acid (PLA) filament (filament diameter: 1.75 mm, printing temperature: 200–220 °C, Prusa Research) (Fig. 3A, step 1). Several cuts and gaps were included in the membrane. These discontinuities enabled us to later connect the two halves of the reinforcing elements through 3D printing, which sandwiched the membrane. We then printed the first half of the reinforcing elements. Longitudinal element was a tubular structure with a length of 50 mm and an internal diameter of 4.3 mm and a thickness of 0.95 mm. Cross elements had a length of 30.1 mm an internal diameter of 3.8 mm and a thickness of 0.95 mm. Next, the print was paused and the membrane from the first step was placed on the reinforcing elements, which were 3D printed in half (Fig. 3A, step 2). A segment of a flexible filament (FilaFlex, filament diameter: 1.75 mm, printing temperature: 210–230 °C) with a length of ~10 mm was inserted into the gap designed in the membrane (Fig. 3A, step 3). The flexible filament worked as a connector, similar to the flexible resilin in the vein joints of insect wings [2,3,12,16]. At the end, the second half of the reinforcing elements was printed on top of the membrane and flexible filament (Fig. 3A, step 4) (Fig. S1, Video S1).

Here we chose PLA and flexible filaments to represent the cuticle and resilin in insect wings, respectively. This choice was made because of the similarity of material properties, in particular the elastic modulus, of the selected materials and their natural counterparts [9,17,35] (Fig. 2F).

2.2. Mechanical testing of 3D printed joints

2.2.1. Static tests

Bending tests were performed on 3D printed joints using a ZwickiLine uniaxial compression testing machine (Zwick Roell, Ulm, Germany) equipped with a 500 N load cell (Xforce HP load cell, Zwick Roell) (Video S2). As shown in Fig. 3C, the specimens were placed at the cross elements on a 3D printed sample holder. A customized probe was used to apply a force to the middle of the joint on the longitudinal element. A displacement of 15 mm at a loading velocity of 1 mm/s was applied to the specimens and the force required for this displacement was continuously recorded. In total, 38 specimens, including 3–4 specimens of each joint type were tested.

2.2.2. Fatigue tests

The same setup, as that used in the static tests (Fig. 3C), was used here. The 3D printed joints were subjected to a displacement equal to 90% of the displacement in which their maximum load-bearing capacity was reached. We decided to perform a displacement control experiment, since the joint models appeared to have very different load-bearing capacities. The displacement was applied to the specimens for 1000 loading cycles (i.e. low-cycle fatigue) at a frequency of 1 Hz (Video S3). The load required for this displacement was recorded throughout the test. The force in the last loading cycle was expressed as a fraction of the force in the first loading cycle, and used as a measure of the durability (i.e. preserved load-bearing) of the joints. In total, 41 specimens including 3–4 specimens of each joint model were tested.

2.3. Design and fabrication of a bio-inspired bowed diamond kite

To fabricate the kite, we used the same 3D printer (i.e. Prusa i3 MK3) and the same materials (i.e. PLA) as those used for 3D printing of the joints. The developed kite was designed to be a rhombus with 27 cm × 24 cm diagonals. The kite consisted of different components, which are illustrated in Fig. 4A, B. Akin to the joint models, the kite had a thin PLA membrane with a thickness of 0.15 mm. Two reinforcing tubular elements were situated along the long and short diagonals of the kite, here called as longitudinal and cross elements, respectively. For the sake of simplicity (i.e. to fabricate the whole kite in a single print), the reinforcing elements were designed to be only on one side of the kite (Fig. 4C, Model S1). By implementing two joint categories into the kites, where the reinforcing elements bisect, two types of kite were fabricated: (i) a kite with a bio-inspired 'modified joint' and (ii) a kite with a conventional 'fully fused joint'.

2.4. Mechanical testing of bio-inspired diamond kites

2.4.1. Static tests

As shown in Fig. 5A, the kites were placed at their longitudinal element on a 3D printed sample holder. A customized two-tip probe was used to apply local forces to the two wings of the kite, directly on the cross elements. A displacement of 15 mm was applied to the kites at a loading velocity of 1 mm/s (Video S4). The force required for this displacement was recorded as a measure of the load-bearing capacity. In total, 6 kites including 3 kites with 'modified joints' and 3 kites with 'fully fused joints' were tested.

2.4.2. Fatigue tests

The same setup, as that used in static tests (Fig. 5A), was used here. The 3D printed kites were subjected to a displacement corresponding to 10 N load, as an estimation of the displacement of the kites when subjected to winds with 80 km/h speed (the product of the aerodynamic pressure, 302 Pa, and kite surface area, 324 cm^2). We decided to test the durability of the kites under the same force, since they were expected to work under similar conditions in practice. The displacement was applied to the kites for 1000 loading cycles at a frequency of 1 Hz (Video S5). The load required for the displacement was recorded throughout the test. The durability of the kites was quantified using the same methods as described earlier. We expressed the durability using the force in the last loading cycle as a fraction of the force in the first loading cycle. In total, 6 kites including 3 kites of each type were tested.

2.4.3. Flight tests

Laboratory experiments (i.e. static and dynamic tests) were carried out to quantify the performance of the kites under controlled conditions and to prevent comparative testing in an open area. Due to many variables involved, no two outdoor experiments would have been identical. Hence, we decided to perform flight trials, only as a proof of concept, to show the functionality of the kites with bio-inspired 'modified joints' in practice.

The kites with the bio-inspired 'modified joint' were tested in Kiel Baltic Sea coast (Südstrand, Berliner Straße, 24,340 Eckernförde, Germany) (latitude: 54.450432, longitude: 9.856988) (Video S6). The flight performance of the kites were tested for multiple times (>20 times) at wind speeds of ~80 km/h (according to the weather forecast, *Deutscher Wetterdienst*). After each trial, the kites were carefully checked for any sign of fracture or plasticity.

Fig. 3. Fabrication, testing and mechanical performance of bio-inspired joints. (A) 3D printing of a bio-inspired joint model. 3D printing was done in four steps (B) Two-dimensional sketches of the developed joint models. (C) A perspective view of the experimental setup for static and fatigue tests. (D) Load-bearing capacity vs. durability of 3D printed joints. An ideal joint should have a high load-bearing capacity and a high durability. The spike-containing flexible joints were geometrically improved to achieve higher load-bearing capacity. The region highlighted in the red colour shows the joints that frequently failed (either by fracture or plasticity) under loading, while those in the blue highlighted region did not fail. (E) Spikes activation by interlocking transforms the joints from a high deformability regime (low stiffness) to a low deformability regime (high stiffness).

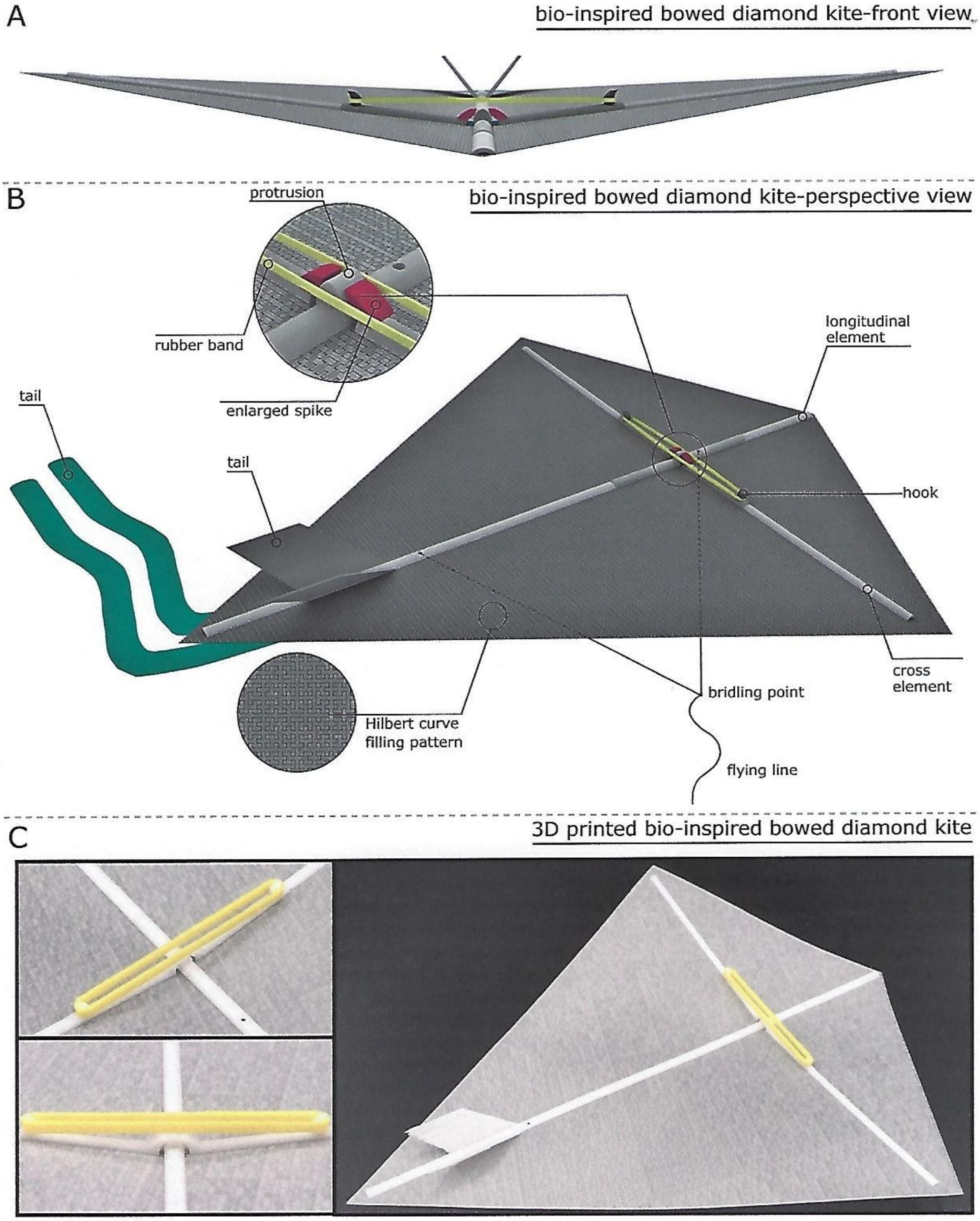


Fig. 4. Bio-inspired bowed diamond kite. (A) Front view of the kite. (B) A perspective view of the kite showing the different components. (C) 3D printed kite with the magnified views of its joint from different perspectives.

3. Results

3.1. Mechanical performance of 3D printed joints

Inspired by vein joints of insect wings, we developed a set of models, which consisted of a thin membrane and three reinforcing elements including a longitudinally oriented tubular element and two cross elements, resembling wing longitudinal and cross veins, respectively (Fig. 2D, E). The reinforcing elements were connected to each other by joint-like structures, which differed among the models (Table 1). A perspective view of a representative model is shown in Fig. 2E. This is a flexible joint model, which in addition to a longitudinal element and two cross elements consists of two spikes and a soft connecting part at the interval of the reinforcing elements.

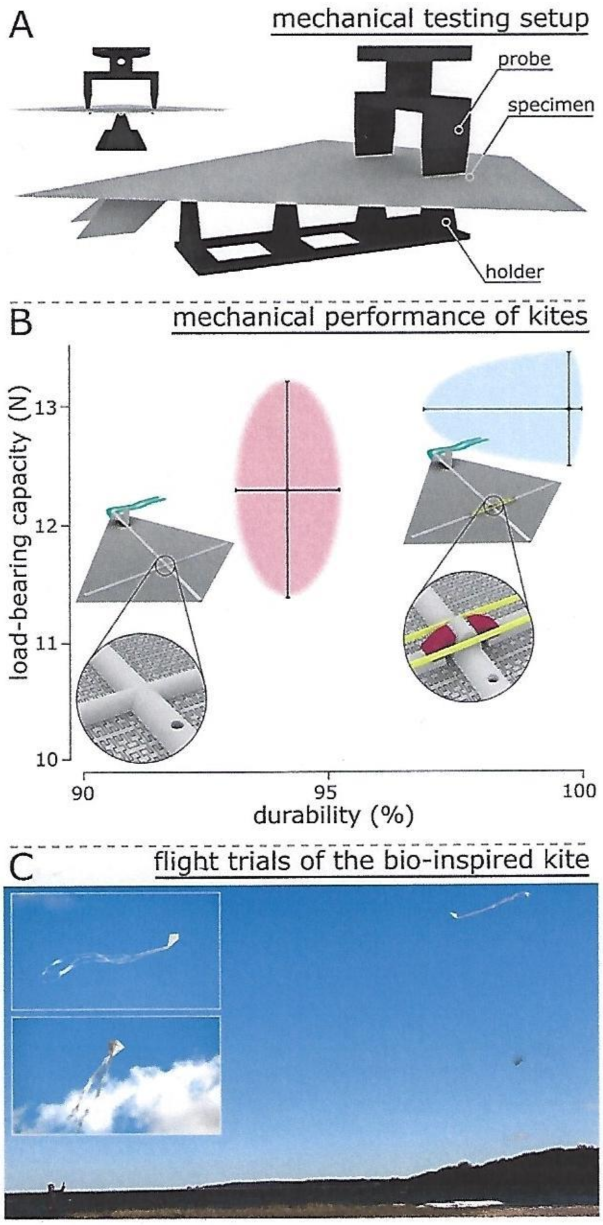


Fig. 5. Mechanical testing and performance of the bio-inspired and conventional 3D printed kites. (A) Experimental setup for static and fatigue tests of the 3D printed kites. (B) Load-bearing capacity vs. durability of the 3D printed kites with the conventional 'fully fused joint' and the bio-inspired 'modified joint'. (C) Flight trial of the kite with the bio-inspired 'modified joint'.

The developed models were then 3D printed (Fig. 3A). To characterize the mechanical performance of the 3D printed joints, we used the setup illustrated in Fig. 3C and performed two sets of experiments: static tests to analyse their load-bearing capacity and fatigue tests to examine their durability. Fig. 3D presents the results of the mechanical tests on the 3D printed joints. Here the ordinate is the maximum force that the joints withstood under a displacement of 1.5 cm, as a measure of their load-bearing capacity. The abscissa represents the durability. This is the load-bearing capacity of the joints in the last loading cycle as a fraction of their load-bearing in the first cycle.

All flexible joints, which had gaps or soft contacts at the interval of the reinforcing elements, withstood notably lower forces than the fully fused joints ('flexible joint with gap contacts': 0.62 ± 0.03 N; 'flexible joint with gap contacts and spikes': 1.82 ± 0.18 N; 'flexible joint with soft contacts': 1.22 ± 0.06 N; 'flexible joint with soft contacts and spikes': 2.66 ± 0.18 N; 'fully fused joint': 65.09 ± 9.92 N). Half-fused joints and point-fused joints withstood higher forces than flexible joints, but notably lower than the fully fused joints ('half-fused joint': 28.47 ± 1.23 N; 'half-fused joint with spikes': 26.36 ± 0.79 N; 'point-fused joint': 15.75 ± 0.35 N; 'point-fused joint with spikes': 16.08 ± 0.56 N).

Comparison of the data showed that adding a segment of the flexible filament in the 'flexible joint with soft contacts' increased its load-bearing by two times, compared to the 'flexible joint with gap contacts'. Adding the spikes, on the other hand, increased the load-bearing capacity of the 'flexible joint with gap contacts and spikes' by almost three times, in comparison with the 'flexible joint with gap contacts'. And, the use of a combination of both flexible filament and spikes added up their effects and enhanced the load-bearing capacity of the 'flexible joint with soft contacts and spikes' by four times, compared to the 'flexible joint with gap contacts'. Hence, the 'flexible joint with soft contacts and spikes' had the highest load-bearing capacity among the flexible joints (Fig. 3D).

Spikes had a notably higher influence on the load-bearing capacity of the flexible joints compared to the 'half-fused joint' and 'point-fused joint'. This was because the two latter joints failed prior to their spikes activation. Both these two types of joints and the 'fully fused joint', which had a direct connection between their reinforcing elements, failed either by brittle fracture or plasticity before the maximum applied displacement was reached.

When deformed in two opposite directions (i.e. upwards and downwards), activation of the spikes resulted in notable asymmetries in the load-bearing capacity of the spike-containing joints (i.e. 'flexible joint with gap contacts and spikes', upwards: 1.82 ± 0.18 N, downwards: 0.62 ± 0.03 N; 'flexible joint with soft contacts and spikes', upwards: 2.66 ± 0.18 N, downwards: 1.22 ± 0.06 N). In contrast, only a very minor difference was found in the load-bearing capacity of the 'half-fused joint', which had an asymmetric shape (upwards: 28.47 ± 1.23 N, downwards: 27.44 ± 1.16 N).

Flexible joints preserved their load-bearing capacity better than the others (Fig. 3D). Among all flexible joints, the 'flexible joint with soft contacts and spikes' exhibited the best durability by maintaining $59.46 \pm 5.89\%$ of its original load-bearing capacity. In contrast, the 'fully fused joint', 'point-fused joint' and 'point-fused joint with spikes' exhibited the poorest durability and maintained only $11.13 \pm 2.88\%$, $6.46 \pm 3.09\%$, and $12.08 \pm 1.83\%$ of their load-bearing capacity, respectively. 'Half-fused joints' showed a durability between the fully fused joints and flexible joints ('half-fused joint', upwards: $40.34 \pm 2.59\%$, downwards: $40.92 \pm 2.09\%$, with spikes: $47.57 \pm 5.34\%$).

3.2. Modified joint

A 'modified joint' was designed and 3D printed to enhance the load-bearing capacity of the bio-inspired flexible joints (Fig. 3B). This was done by enlarging the spikes on the 'flexible joint with soft contact and spikes'. A protrusion was added to the middle of the longitudinal element to allow earlier spikes activation. Our 'modified joint' with enlarged spikes got closer to the ideal zone of the graph, in comparison to the other bio-inspired joints (Fig. 3D). The ideal zone shows a region of the graph in which both the load-bearing capacity and durability are high. The 'modified joint', on average, withstood ~10 times higher loads and had ~1.3 times higher durability, compared to their original form (i.e. the 'flexible joint with soft contacts and spikes').

3.3. Performance of bio-inspired kites

We implemented our 'modified joint' into the design of a 3D printed diamond kite, where the reinforcing elements bisect (Fig. 4). A thin circular latex rubber band with a diameter of 70 mm was stretched between two hooks that were designed on the cross elements.

This enabled us to create a slight chordwise camber and develop a bowed kite (Fig. 4A). The camber was intended to enhance the stability of the kite during flight. The protrusion of the 'modified joint' allowed us to prevent excessive kite camber by the spike activation. Spike activation could further stiffen the kite and avoid the loss of load-bearing capacity under excessive loading in flight. The 'modified joint' was then replaced with a 'fully fused joint'. This resulted in another version of the kite that had everything else the same, but a conventional joint instead of the bio-inspired one.

In order to characterize the mechanical performance of our 3D printed kites in practice, we performed two sets of experiments, as those performed on the 3D printed joints: static tests and fatigue tests to measure the load-bearing capacity and durability, respectively (Fig. 5A). To displace the kite equipped with the 'modified joint' for 1.5 cm, a force of 12.97 ± 0.48 N was required (Fig. 5B). The load needed to apply the same displacement to the kite equipped with the conventional, 'fully fused joint' was slightly lower and equal to 12.29 ± 0.92 N. Applying a constant displacement corresponding to a force of 10 N (an estimation of the kite's displacement when subjected to wind speeds of 80 km/h, see Methods) over 1000 cycles did not reduce the load-bearing capacity of the kite with the 'modified joint'. After 1000 loading cycles, the load-bearing capacity of the kite with the 'fully fused joint' decreased to $94.22 \pm 1.06\%$ of its original load-bearing.

Flight trials were performed for the kite with the 'modified joint', as a proof of concept, to show the performance of our design strategy in practice (Video S6, Fig. 5C). Prior to flight tests, we attached tails and bridle strings to the kites, which allowed us to increase flight stability and control the angle of attack, respectively. The kites exhibited stable flights and could quickly reach altitudes >12 m (Fig. 5C). The effect of the joint in generating a chordwise camber while preventing the kite folding is clearly visible in Video S6. Even under wind gusts up to 80 km/h, kites maintained their camber, stability and structural integrity. We found no sign of failure (neither plasticity nor fracture) after the flight trials. In spite of its relatively small size, due to the small printing platform of the 3D printer used here, our kite could achieve high lift and stability without breaking. To the best of our knowledge this is the only available fully 3D printed kite (except for the strings, tails and rubber bands which needed to be attached to the kites after fabrication); it is very cheap to be produced and can be fabricated quickly in a single print (Model S1).

4. Discussion

4.1. A bio-inspired joint for an engineering application

An engineering system can be subjected to both static and cyclic loads in practice. Therefore, it needs to be load-bearing, to withstand applied loads, and to be durable, to resist fatigue. To combine load-bearing capacity and durability in a man-made system, we designed and fabricated joint-like structures, akin to those of insect wings (Figs. 2 and 3B). The results of mechanical testing on our 3D printed bio-inspired joints showed that 'fully fused joints', due to their rigidity and more amount of material at the interval of their intersecting elements, exhibited the highest load-bearing capacity among others (Fig. 3D). However, they exhibited a low durability among the fabricated joints. This was because 'fully fused joints', and all other types of fused joints, lost a large portion of their load-bearing capacity when subjected to cyclic loading. Hence, although fused joints performed well under static loading, they were not suitable for applications in which fatigue might occur.

One should also take into account the likelihood of catastrophic failures in the 'fully fused joints' and other types of fused joints (Fig. 3D). Although these joints withstood higher loads in comparison to flexible joints, when the maximum load-bearing capacity was reached, all these joints failed suddenly, in contrast to the progressive failure observed in flexible joints (Fig. S2). This resulted in a sudden permanent drop in the load-bearing of these joints and, therefore, was another reason for excluding fused joints from further analysis.

Flexible joints, in contrast, exhibited an inherent fatigue resistance (Figs. 3D and S3). Fatigue tests showed that, due to their elasticity, the flexible joints exhibited a higher durability under repeated stresses, in comparison to the fused ones. A segment of a flexible filament at the interval of the intersecting elements of the flexible joints has likely played an important role here. This is akin to the patches of the rubber-like resilin found in the vein joints of insect wings [16]. The use of a stiffness transitional zone in the joints, similar to those in many natural joint systems [4], could further improve the durability of the bio-inspired flexible joints.

In comparison to fused joints, flexible joints showed a poor load-bearing capacity. However, this could be improved by several times using rigid spikes. The application of the spikes in the flexible joints offered an extra advantage over the fused joints by enabling us to fine-tune the deformability of the joints. This was made possible by changing the location, shape and size of the spikes, which influenced the displacement in which the interlocking took place. Similar to those of insect wings, spikes in our 3D printed joints worked as 'mechanical stoppers', and provided the joints with two deformability regimes (Fig. 3E). First, a high deformability regime prior to the spikes activation, in which the deformability of the joint was determined by the stiffness of its material. Second, a low deformability regime after the spikes activation, in which the stiffness of the joint is increased due to the physical contacts between spikes and neighbour reinforcing elements. This phenomenon is referred to as interlocking. The interlocking effect allowed a reversible transition in the deformability of the joints through a simple design strategy, in contrast to more complex approaches, in which materials with variable elastic moduli were implemented [26].

4.2. Modified joint in application

The inherent durability of flexible joints made them suitable templates for the design of a 'modified joint'. Taking into account the influence of the spikes on the load-bearing of the joints, the 'modified joint' was designed to have enlarged spikes and a pronounced protrusion on the reinforcing longitudinal element. Using these two design strategies, the 'modified joint' achieved an earlier and stronger interlocking, which led to a notably higher load-bearing and a slightly better durability compared to its original form (i.e. the 'flexible joint with soft contacts and spikes').

The 'modified joint' was used in the design of a diamond kite, which demonstrated promising results in practice. While the tubular elements reinforced the kite structure, the inclusion of the 'modified joint' enhanced its durability and enabled it to switch between high deformability and low deformability regimes (i.e. deformable and stiff regimes). The presence of the enlarged spikes enabled the kite to reach a slightly higher load-bearing capacity than the kite with the 'fully fused joint' (Fig. S4). Taking into account the higher load-bearing of the isolated 'fully fused joint' than the 'modified joint', this observation can be attributed to two main reasons. First, joints are not the only structural components of the kites, but they are combined with other components that also contribute to the kite deformations (e.g. enlarged membranes and reinforcing elements). Hence, it is logical to assume that the mechanical behaviour of the joints in combination with other components is not exactly the same as their behaviour in isolation. In fact, here we observed that, in contrast to the kite with the 'modified joint', the reinforcing cross elements in the kite with the 'fully fused joint', exhibited remarkably larger bending deformations. The second reason is that, as previously mentioned, the joints were 3D printed only on one side of the kites, for the sake of simplicity. This printing method is likely to have a stronger impact on the load-bearing of the stiff 'fully fused joint', in comparison to the flexible 'modified joint'.

Here our main aim was to obtain a compromise between the load-bearing capacity and durability. Our developed design strategy, adequately achieved by the 'modified joints', enabled us to fulfil this aim by combining two deformability regimes in our designs. This was confirmed by the superior mechanical performance of the bio-inspired kite in comparison with the conventional kite in the laboratory experiments. Thus, the application of the 'modified joints' in the bio-inspired kite was a proof of concept to demonstrate the potential of our design strategy in practice. The use of flexible joints in general, and spike-containing joints in particular, could be a universal solution for developing load-bearing, yet durable, engineering structures.

4.3. Biological insights and bio-understanding

Although in this study we mainly aimed to translate the latest findings on insect wings into an artificial design, our results also provided multiple biological insights into the wing functional morphology. Here we found that soft contacts and spikes can help us to combine load-bearing and durability in our 3D printed joints. This resembles flexible joints in insect wings, which passively control wing local deformations and provide wings with an increased resistance to fracture [27,40]. Our findings, therefore, confirmed the results of previous studies, suggesting the key role of the rubber-like resilin and joint-associated spikes in enhancing the durability and load-bearing of insect wings, respectively ([38]; 2016c).

Our results could also be used to explain the mechanics behind both the distribution and the increase of area loss of dragonfly wings over the fight season [40]. According to previous studies, cracks often initiate and develop in regions close to the wing trailing margin and only very rarely propagate to other wing regions [31,34,40]. Taking into account the high risk of catastrophic failures in the fused joints and their poor durability, the increasing frequency of area loss in the wing trailing margin can be attributed to the higher density of fused joints in this region, compared to other wing regions [40]. A future study on the fatigue tolerance of different wing regions could shed more light on the validity of the proposed mechanism.

The results of static and fatigue tests on the 3D printed joints revealed notable differences in their behaviors, so that not only morphologically but also mechanically they can be subdivided into different categories. While previous morphological studies subdivided the joints in insect wings into two categories of fused and flexible joints [16,30], our mechanical data suggested that, from a mechanical perspective, they can be subdivided into three categories: (i) fused joints, with high load-bearing capacity but low durability, (ii) flexible joints, with a low load-bearing capacity but a high durability and (iii) spike-containing flexible joints, with an improved load-bearing capacity (compared to the flexible joints with no spikes) and high durability.

The mechanical testing on the 3D printed joints also provided insights into the influence of vein joints on the asymmetry of wing deformations. Wings in many insects, such as dragonflies, exhibit asymmetric deformations when subjected to the same load on the dorsal and ventral sides [10,14,46]. This asymmetric deformability plays a crucial role in the ability of wings to produce aerodynamic lift, by facilitating the development of a cambered section in the down strokes [48]. Previously, it was thought that vein joints with asymmetric morphologies contribute to the wing asymmetric deformability during flight. However, our results suggested that the asymmetric mechanical interlocking of the spikes could be a more important reason for the asymmetric deformability of the wings during flight.

A summary of this study for non-expert, general audience is presented in Video S7.

5. Conclusions

In this study, we developed a set of bio-inspired joint-like structures and implemented them into the design of a bowed diamond kite. The use of spikes in our developed flexible joints increased their load-bearing and further provided them with two deformability regimes: high and low deformability regimes. The results enabled us to develop a design concept that can be used to combine two mutually exclusive characteristics of load-bearing and durability. Such a combination was achieved through purely structural strategies, which can be easily modified and can facilitate the use of our design concept in real-world applications.

Two directions for future research seem worth following. First, an optimization technique or a computational intelligence-aided design framework could be applied to modify the design of the joint-like structures with the aim of improving their performance from both aspects of load-bearing and durability. Second, future studies should focus on the application of the developed design concept in other engineering designs, in which the presence of the two characteristics is equally important.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.matdes.2020.109354.

Data accessibility

All supporting data are available in the article and on: https://figshare.com/s/12c815ee335bee786d92.

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Media summary

Kites can best fly in winds about 10 km/h. Any wind near or above 20 km/h is strong enough to break most of the conventional kites. This is a reason that explains why broken kites can often be found in a kite-flying spot. Here, inspired by insect wings, we designed and 3D printed kites that can fly, and successfully survive, in strong wind speeds of about 80 km/h. The bio-inspired design allowed us to combine two characteristics which are often mutually exclusive: loading-bearing and durability. Our developed design principle could give rise to a universal paradigm for developing load-bearing, yet durable, engineering structures.

Credit Author Statement

Ali Khaheshi: Investigation, Data curation, Formal Analysis, Funding Acquisition, Methodology, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing. **Halvor Tramsen**: Conceptualization, Investigation, Writing – Review & Editing. **Stanislav Gorb**: Conceptualization, Supervision, Funding Acquisition, Resources, Writing – Review & Editing. **Hamed Rajabi**: Conceptualization, Supervision, Investigation, Data Curation, Funding Acquisition, Methodology, Project Administration, Visualization, Writing – Review & Editing.

Declaration of Competing Interest

The authors declare there are no conflicts of interest to disclose.

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References

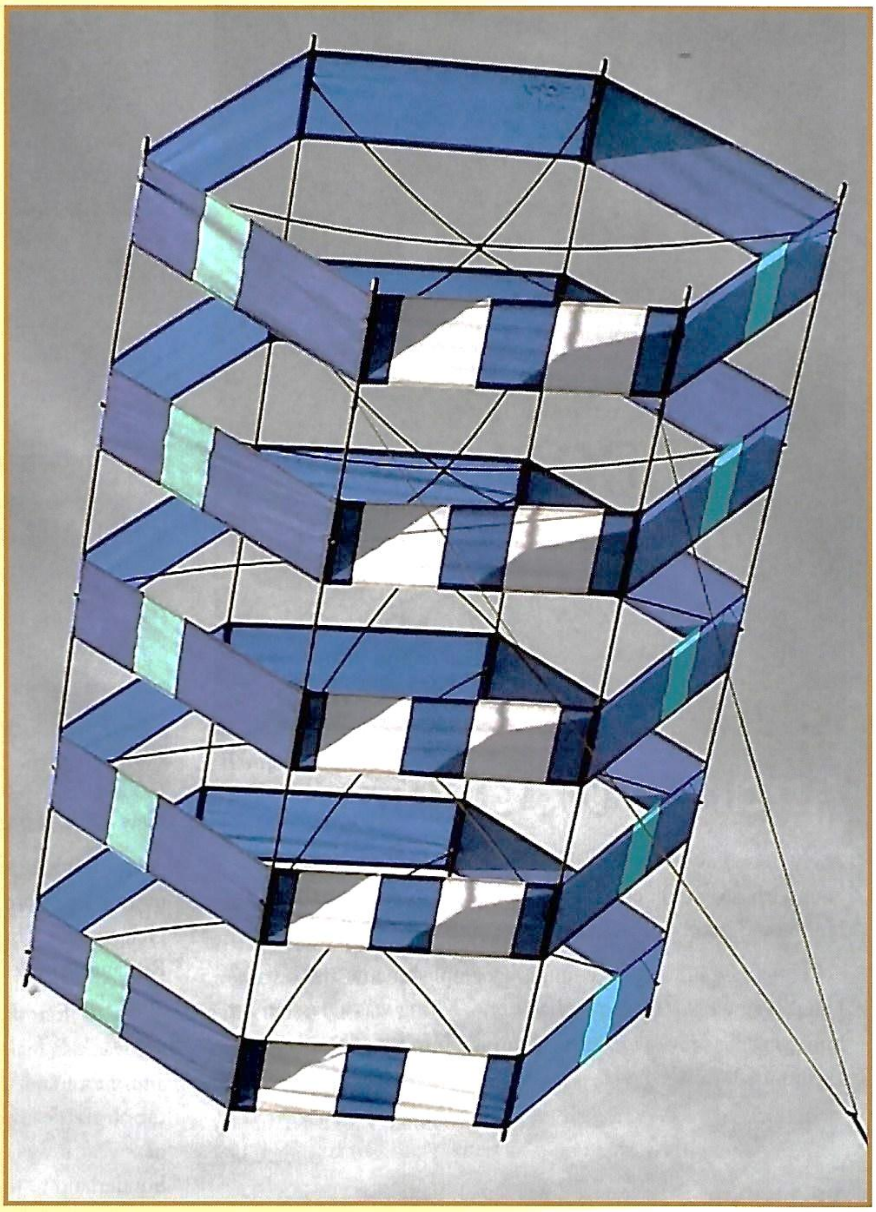
[1] O. Akampumuza, P.M. Wambua, A. Ahmed, W. Li, X.H. Qin, Review of the applications of biocomposites in the automotive industry, Polym. Compos. 38 (11) (2017) 2553–2569.

[2] E. Appel, S.N. Gorb, Resilin-bearing wing vein joints in the dragonfly *Epiophlebia superstes*, Bioinspiration Biomimetics 6 (4) (2011), 046006, .

[3] E. Appel, S.N. Gorb, Comparative functional morphology of vein joints in Odonata, in: Hannes F. Paulus (Ed.), Zoologica, Schweizerbart Science Publishers, Stuttgart, 2014.
[4] E. Avgoulas, M. Sutcliffe, A review of natural joint systems and numerical investigation of bio-inspired GFRP-to-steel joints, Materials 9 (7) (2016) 566.
[5] F. Barthelat, M. Mirkhalaf, The quest for stiff, strong and tough hybrid materials: an exhaustive exploration, J. R. Soc. Interface 10 (89) (2013) 20130711.
[6] F. Barthelat, R. Rabiei, Toughness amplification in natural composites, J. Mech. Phys. Solids 59 (4) (2011) 829–840.
[7] M. Bodaghi, A.R. Damanpack, G.F. Hu, W.H. Liao, Large deformations of soft metamaterials fabricated by 3D printing, Mater. Des. 131 (2017) 81–91.
[8] F. Bouville, E. Maire, S. Meille, B. Van de Moortèle, A.J. Stevenson, S. Deville, Strong, tough and stiff bioinspired ceramics from brittle constituents, Nat. Mater. 13 (5) (2014) 508.
[9] V.H. Carneiro, H. Puga, Axisymmetric auxetics, Compos. Struct. 204 (2018) 438–444.
[10] S.A. Combes, T.L. Daniel, Flexural stiffness in insect wings I. scaling and the influence of wing venation, J. Exp. Biol. 206 (17) (2003) 2979–2987.
[11] A.S. Dalaq, F. Barthelat, Manipulating the geometry of architectured beams for maximum toughness and strength, Mater. Des. 194 (2020) 108889.
[12] S. Donoughe, J.D. Crall, R.A. Merz, S.A. Combes, Resilin in dragonfly and damselfly wings and its implications for wing flexibility, J. Morphol. 272 (12) (2011) 1409–1421.
[13] M. Dziadek, E. Stodolak-Zych, K. Cholewa-Kowalska, Biodegradable ceramic-polymer composites for biomedical applications: a review, Mater. Sci. Eng. C 71 (2017) 1175–1191.
[14] A.R. Ennos, Mechanical behaviour in torsion of insect wings, blades of grass and other cambered structures, Proc. R. Soc. Lond. Ser. B Biol. Sci. 259 (1354) (1995) 15–18.
[15] R. Ghosh, H. Ebrahimi, A. Vaziri, Contact kinematics of biomimetic scales, Appl. Phys. Lett. 105 (23) (2014) 233701.
[16] S.N. Gorb, Serial elastic elements in the damselfly wing: mobile vein joints contain resilin, Naturwissenschaften 86 (11) (1999) 552–555.
[17] P. Haque, A.J. Parsons, I.A. Barker, I. Ahmed, D.J. Irvine, G.S. Walker, C.D. Rudd, Interfacial properties of phosphate glass fibres/PLA composites: effect of the end functionalities of oligomeric PLA coupling agents, Compos. Sci. Technol. 70 (13) (2010) 1854–1860.
[18] M. Ibrahimi, L. Paternò, L. Ricotti, A. Menciassi, A Layer Jamming Actuator for Tunable Stiffness and Shape-Changing Sevices, 2020 (Soft Robotics).
[19] M. Jafarpour, S. Eshghi, A. Darvizeh, S. Gorb, H. Rajabi, Functional significance of graded properties of insect cuticle supported by an evolutionary analysis, J. R. Soc. Interface 17 (168) (2020) 20200378.
[20] O. Jeon, Y.B. Lee, H. Jeong, S.J. Lee, D. Wells, E. Alsberg, Individual cell-only bioink and photocurable supporting medium for 3D printing and generation of engineered tissues with complex geometries, Mater. Horizons 6 (8) (2019) 1625–1631.
[21] V.M. Karbhari, J. Chin, D. Hunston, B. Benmokrane, T. Juska, R. Morgan, ... A.D. Reynaud, Durability gap analysis for fiber-reinforced polymer composites in civil infrastructure, J. Compos. Constr. 7 (3) (2003) 238–247.
[22] A. Le Duigou, D. Correa, M. Ueda, R. Matsuzaki, M. Castro, A review of 3D and 4D printing of natural fibre biocomposites, Mater. Des. 108911 (2020).
[23] F. Libonati, G.X. Gu, Z. Qin, L. Vergani, M.J. Buehler, Bone-inspired materials by design: toughness amplification observed using 3D printing and testing, Adv. Eng. Mater. 18 (8) (2016) 1354–1363.
[24] K. Liu, L. Han, W. Hu, L. Ji, R. Tao, Z. Wan, ... Z. Li, 4D printed zero Poisson's ratio metamaterial with switching function of mechanical and vibration isolation performance, Mater. Des. (2020) 109153.
[25] M.A. Meyers, J. McKittrick, P.Y. Chen, Structural biological materials: critical mechanics-materials connections, Science 339 (6121) (2013) 773–779.
[26] S. Mintchev, J. Shintake, D. Floreano, Bioinspired dual-stiffness origami, Sci. Robot. 3 (20) (2018).
[27] A.M. Mountcastle, S.A. Combes, Biomechanical strategies for mitigating collision damage in insect wings: structural design versus embedded elastic materials, J. Exp. Biol. 217 (7) (2014) 1108–1115.
[28] A.M. Mountcastle, S.A. Combes, Wing flexibility enhances load-lifting capacity in bumblebees, Proc. R. Soc. B Biol. Sci. 280 (1759) (2013) 20130531.
[29] Y.S. Narang, B. Aktaş, S. Ornellas, J.J. Vlassak, R.D. Howe, Lightweight Highly Tunable Jamming-Based Composites, 2020 (Soft Robotics).
[30] D.J. Newman, The Functional Wing Morphology of some Odonata, University of Exeter, Exeter, 1982.
[31] H. Rajabi, J.H. Dirks, S.N. Gorb, Insect wing damage: causes, consequences and compensatory mechanisms, J. Exp. Biol. 223 (9) (2020).
[32] H. Rajabi, S.N. Gorb, How do dragonfly wings work? A brief guide to functional roles of wing structural components, Int. J. Odonatol. 23 (1) (2020) 23–30.
[33] H. Rajabi, K. Stamm, E. Appel, S.N. Gorb, Micro-morphological adaptations of the wing nodus to flight behaviour in four dragonfly species from the family Libellulidae (Odonata: Anisoptera), Arthropod. Struct. Develop. 47 (4) (2018) 442–448.
[34] H. Rajabi, V. Schroeter, S. Eshghi, S.N. Gorb, The probability of wing damage in the dragonfly Sympetrum vulgatum (Anisoptera: Libellulidae): a field study, Biol. Open 6 (9) (2017) 1290–1293.
[35] H. Rajabi, N. Ghoroubi, K. Stamm, E. Appel, S.N. Gorb, Dragonfly wing nodus: a one-way hinge contributing to the asymmetric wing deformation, Acta Biomater. 60 (2017) 330–338.
[36] H. Rajabi, A. Shafiei, A. Darvizeh, S.N. Gorb, Resilin microjoints: a smart design strategy to avoid failure in dragonfly wings, Sci. Rep. 6 (2016) 39039.
[37] H. Rajabi, N. Ghoroubi, A. Darvizeh, E. Appel, S.N. Gorb, Effects of multiple vein microjoints on the mechanical behaviour of dragonfly wings: numerical modelling, R. Soc. Open Sci. 3 (3) (2016) 150610.
[38] H. Rajabi, N. Ghoroubi, A. Darvizeh, J.H. Dirks, E. Appel, S.N. Gorb, A comparative study of the effects of vein-joints on the mechanical behaviour of insect wings: I. Single joints, Bioinspiration Biomimetics 10 (5) (2015) (056003).
[39] R.O. Ritchie, The conflicts between strength and toughness, Nat. Mater. 10 (11) (2011) 817.
[40] J. Rudolf, L.Y. Wang, S.N. Gorb, H. Rajabi, On the fracture resistance of dragonfly wings, J. Mech. Behav. Biomed. Mater. 99 (2019) 127–133.
[41] K.K. Sairajan, G.S. Aglietti, K.M. Mani, A review of multifunctional structure technology for aerospace applications, Acta Astronautica 120 (2016) 30–42.
[42] A. Seidi, M. Ramalingam, I. Elloumi-Hannachi, S. Ostrovidov, A. Khademhosseini, Gradient biomaterials for soft-to-hard interface tissue engineering, Acta Biomater. 7 (4) (2011) 1441–1451.
[43] A. Shanygin, E. Dubovikov, V. Fomin, I. Mareskin, M. Zichenkov, Designing pro-composite truss layout for load-bearing aircraft structures, Fatigue Fract. Eng. Mater. Struct. 40 (10) (2017) 1612–1623.
[44] T. Weis-Fogh, A rubber-like protein in insect cuticle, J. Exp. Biol. 37 (4) (1960) 889–907.
[45] R.J. Wootton, Functional morphology of insect wings, Annu. Rev. Entomol. 37 (1) (1992) 113–140.
[46] R.J. Wootton, Leading edge section and asymmetric twisting in the wings of flying butterflies (Insecta, Papilionoidea), J. Exp. Biol. 180 (1) (1993) 105–117.
[47] R.J. Wootton, R.C. Herbert, P.G. Young, K.E. Evans, Approaches to the structural modelling of insect wings, Philos. Trans. R. Soc. Lond. B Biol. Sci. 358 (1437) (2003) 1577–1587.
[48] R.J. Wootton, D.J. Newman, Evolution, diversification, and mechanics of dragonfly wings, in: Alex Córdoba-Aguilar (Ed.), Dragonflies & Damselflies. Model Organisms for Ecological and Evolutionary Research, Oxford University Press, Oxford, 2008.

SINGLE STACK Hex Box

Text and photos by Sam King



Materials List:

15 – 11 x 4-inch fabric panels in background color
3 – 11 x 20-inch fabric panels in background color
1 – 11 x 6-inch strip of fabric in a contrasting color
1 – 11 x 4-inch strip of fabric in a contrasting color
30 – .093 vinyl end caps with holes punched near ends
14 – .093 vinyl end caps without holes
6 – .125 thin wall carbon tube @ 36 inches
100# line for bridle
Multi-purpose assembly tool (aka: the bamboo skewer)
5 sets of spreaders (each made up of):
  1 – .070 carbon @ 23 1/4 inches
  2 – .070 carbon @ 18 inches
  1 – 3/16 wall 1/4-inch O-ring

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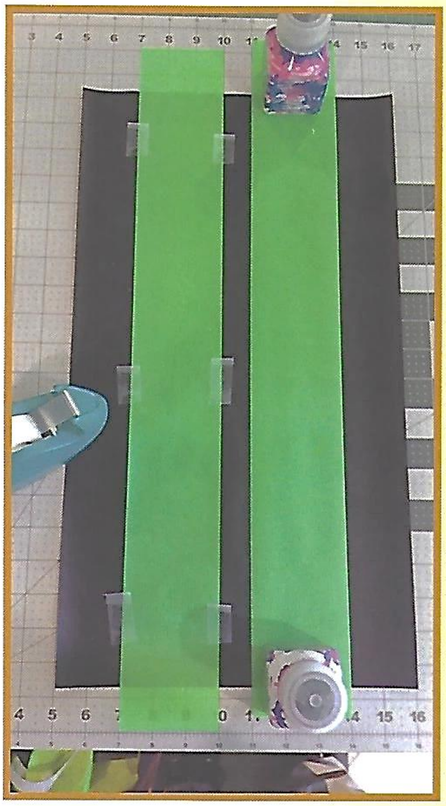
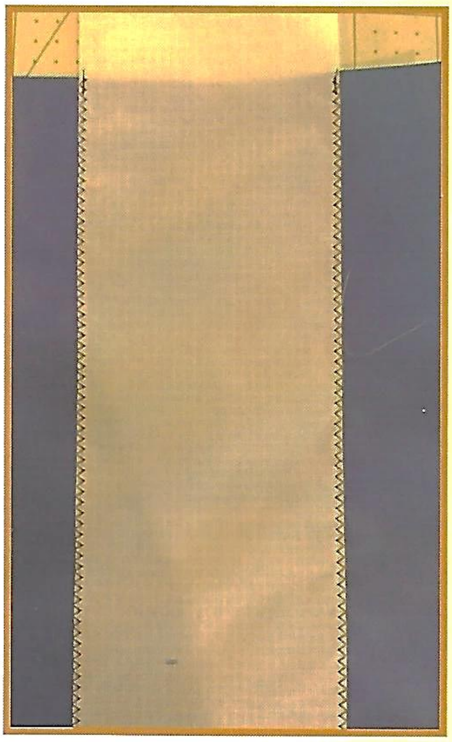


Pic 1. Stripes laid out on back of darker background fabric. Stripe on left is taped down.



Pic 2. Stripe is sewn down very close to the edge with a narrow zig-zag.

Decorative Appliqué

You have an opportunity to decorate your kite to make it unique to you. The three 11 x 20-inch panels can be appliqued with stripes to add visual interest in the sky. The contrasting-colored strips that are 4 and 6 inches wide respectively are for the stripes. The 6-inch-wide strip is intended for the panel that will face towards the ground. You can choose to keep it solid or cut it in half (or something else... asymmetric?) and applique multiple stripes onto one of the 11 x 20-inch panels. The important thing to remember is that out of the 11-inch width, 1/2 inch on either side will disappear as the kite goes together, so leave yourself some room on either edge. The 4-inch piece is intended to be cut in half, with one 2-inch-wide strip being appliqued onto each of the other 11 x 20-inch pieces. You can follow that path, or something else, as suits you.

This appliqué is straight forward. Lay out your stripes, tape them down (I like Scotch tape for this) [See Pic 1], then sew very close to the edge [See Pic 2]. If your stripes are darker than your background fabric, put them on the front. If your background fabric is darker, put the stripes on the back. Once the stripes are sewn, back cut the applique, removing the background-colored fabric from where you have appliqued the stripes.

If you follow the path of the example kite, you will have sewn two stripes onto the 11 x 20-inch piece that will become the front panels, and a 2-inch stripe onto the 11 x 20-inch pieces that will become the two sets of adjacent panels, you'll have three bigger pieces with stripes appliqued onto them. [See Pic 3 below]

Pic 3. Three large panels with completed applique.

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Cut the large panels apart

Using a self-healing mat and a quilter's ruler, cut each of the three 11 x 20-inch appliquéd pieces into five panels that are each 11 x 4 inches. The stripes should run between the long edges. [see below] These should match up to the 15 11 x 4-inch panels in your kit. I cold-cut these with a snap blade knife as all four sides will be finished. Keep like panels stacked together to make your life easier later.

Pic 4. Appliquéd panel with top and bottom edges hemmed.

Hemming the panels

Each of the 30 panels need to be hemmed on the top and bottom. To do this, on the BACK side of each piece, mark a line parallel to the two longest sides, 1/2-inch from each edge. To make a 1/4-inch single fold hem for the long edges, fold the edge to the line and crease. Do this for both long edges of each fabric panel.

Pic 5. Panel with tape.

Next, sew down each hem using a zig-zag stitch. The quickest way to do this is to chain stitch all the pieces together. You do not need to tack the ends as they will be captured by stitching later. Sew down the hems of one side of each panel, cut the panels apart, and trim your threads. Repeat for the other sides of the panels. When complete, the panels should look like Pic 4 above.

Sewing your panels together

Mark seam lines on the back side of each panel, parallel to the short sides of each panel, 1/2-inch from each edge. The side of the panels with the lines should also be the side that your hems were folded towards. This is the interior of the finished cell, the 'bad' side, or the side away from view. The "good" side is the side that will be seen from the ground.

You'll want to use some method of holding the panels together while you sew them. If you choose double-stick tape, when sewing your panels together, place one panel with the good side up. Place a piece of double-stick tape on one short end between the line and the edge. [Pic 5] Remove the backing on the tape and place the panel to be joined with the bad side up, lining up the edges. The tape will help to keep the panels from shifting. The good sides should be together.

Pic. 6. Sewing the panels together.

Another method is to put the good sides together and hold the panels in place with quilter's spring clips, binder clips, clothespins, or the like.

Sew with a straight stitch on the line. [Pic 6] Back tack three or four stitches at the beginning and end of each seam. This will lock in the hem stitching. Chain stitch these as you did the hem. I find it easiest to lay out the panels in six stacks of

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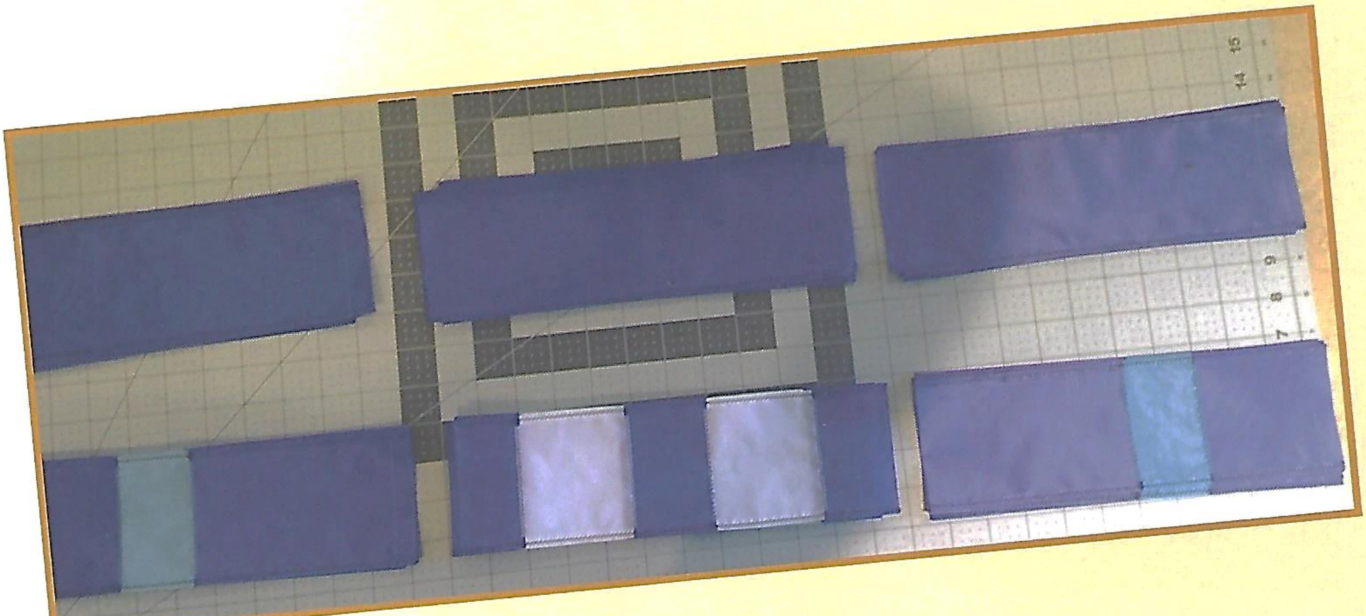
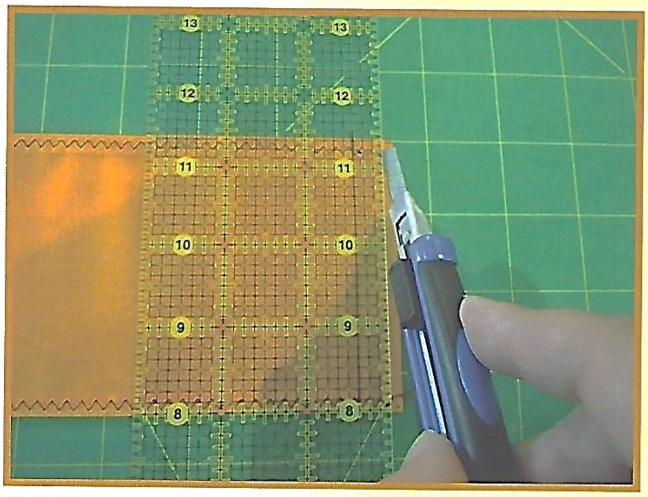
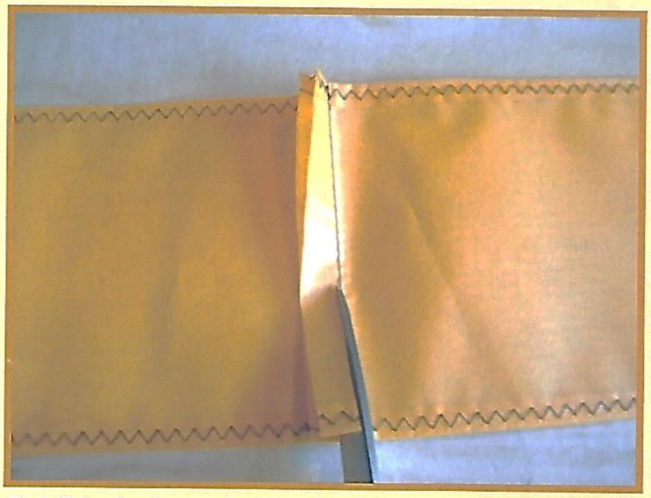


Pic 7. Six like stacks of five panels each.



Pic 8. Trimming to 3/8 inch.



Pic 9. Trimming the excess from the right side.

like panels. [Pic 7] Sew the panels together in groups, working around the hex. You'll end up sewing all six pieces together into one long strip.

Preparing the spar channels

Once you have five sets of six panels, remove the double-stick tape from within the seams if you used it. Before sewing the seams down, trim the "waste" of the hem to 3/8-inch. [Pic 8] Your hems need to be folded over in the same direction. Right or left doesn't matter, just as long as either are all folded to the right or all are folded to the left. If you fold to the right, with scissors, trim the excess of the piece that's on the right (reverse for left). [Pic 9]

Sewing the spar channels

Fold the seam excess in the direction you chose above (resulting in the trimmed portion being hidden on the inside.

Pic 10. Sewing the spar channel close to the edge.

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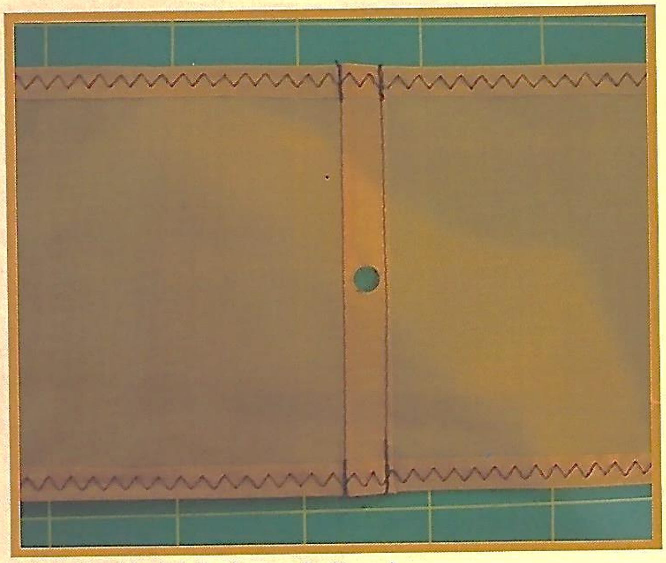
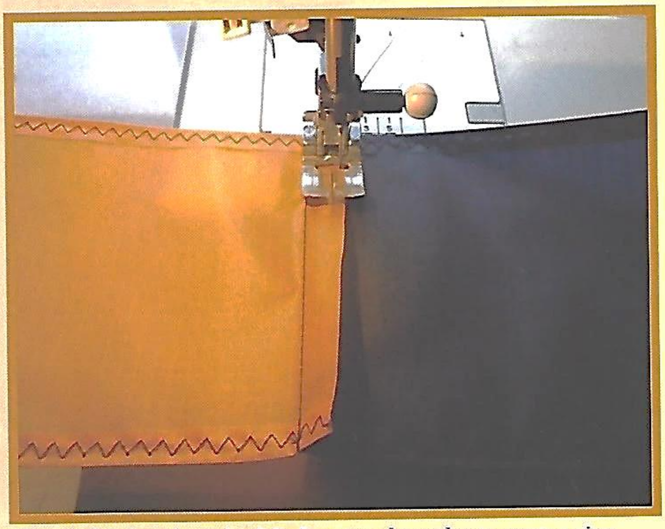
Pic 11. Centering the gauge on the channel and mark.



Pic 12. Resulting hole (in the center in this case).



Pic. 13 Joining the ends of the long panel together to create a ring.

Sew with a straight stitch close to the edge. [Pic 10] Back tack three or four stitches on each end of each seam. This adds strength to the channel. Repeat for each channel.

Holes in the spar channels

Lay out your panels. On the inside/bad side of the channels, mark one panel 1-inch from the top across each of the spar channels for that cell. Mark one panel 1-inch from the bottom across each of the spar channels of that cell. Mark the remaining three panels in the middle (1 3/4–inch from either edge) of each spar channel.

Using a knitting needle gauge, center the K-sized hole on the mark and within the seam. [Pic 11] Hot cut through the channel. Be careful that the hole does not extend into the stitching. [Pic 12]

Creating the rings

All the previous steps were done flat because it's easier that way. You turn the flat strips into rings by sewing the ends together. Use the same techniques as before. Stick the good sides together. Sew down the line. [Pic 13] Trim the excess to 3/8-inch. Trim the side of the excess in the direction you intend to fold the channel. BE VERY CAREFUL THAT THIS CHANNEL IS FOLDED IN THE SAME DIRECTION AS THE REST OF THE CHANNELS IN THE RING. Fold the channel over and sew close to the edge. Mark and cut the hole, being VERY careful not to accidentally hot-cut your previous work. Congratulations! You are done sewing.

Assembly

First, you'll want to flip your rings right side out. The channels and hems should be on the inside of the rings. Next, you will need to open up the channels, as they were sealed shut when we cut the holes with the hot cutter. Use the multi-purpose tool (the bamboo skewer) and push it through each end of each channel. Now, lay out your top cell (with the holes towards the top of the kite), your middle three cells (with the holes cut in the center), and the bottom cell (with the holes towards the bottom of the kite). Make sure your stripes are lined up the way you want them.

Starting with the bottom cell, insert one of the 36-inch spars into a channel and slide the end out of the hole towards the inside of the cell. Slide an end cap onto the spar so that about 1/16-inch of the spar is past the end cap. [Pic 14] Then, using your multi-purpose tool to open the remainder of the channel, slip the spar back into the channel. [Pic 15] Slide the panel fully onto the spar. Repeat for the other five spars. When complete, you will have one fabric ring that has six sticks extending from it. Insert one of the sets of spreaders into the vinyl endcaps to tension the cell. This will help the kite maintain its shape as you slip the remaining rings onto the sticks.

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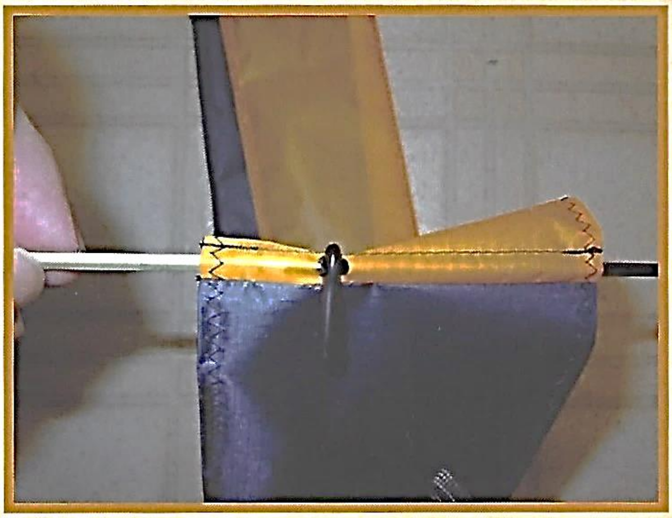
Pic 14. Spar sticking out of hole with end cap fitted onto spar.



Pic 15. Using the multi-purpose tool to fish the end of the spar into the channel.

Working from the bottom up, slide each fabric cell onto the sticks. The end caps should extend from the spars towards the interior of the cells.

BEFORE you slide the top cell onto the sticks, take two of the vinyl end caps that don't have holes. Cut off the solid end, resulting in a pair of vinyl tubes. Cut each tube in half, resulting in four shorter vinyl tubes. Slide two of the vinyl tubes onto each of the front-most facing spars. These will secure your bridle.

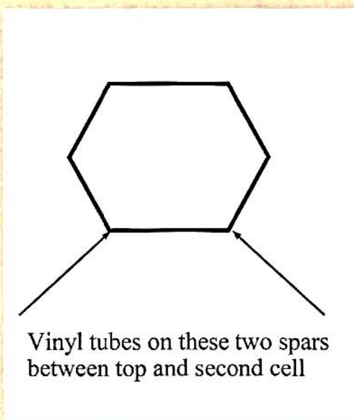
As you have with all the spars in a given cell, insert the spreaders to tension the cell. This will make assembly easier.

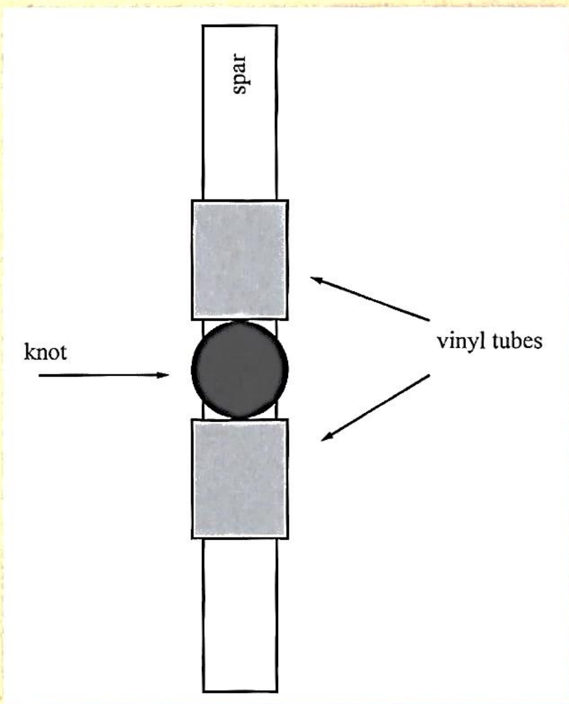
Finishing & Bridle

Place the remaining 12 solid vinyl end caps on the ends of the 36-inch sticks. Adjust the cell location along the long spars so that the space between cells is even both top to bottom and around each cell.

This kite utilizes a two-point bridle. Tie an overhand knot very close to each end of the long bridle line. Tie one end of the bridle line in a sliding overhand knot between the two vinyl tubes on one of the front spars. Tie the other end with a sliding overhand knot between the tubes on the other front spar. Attach a pigtail to the middle of the bridle.

The flight angle can be adjusted by sliding the sleeves (and the bridle with them) up and down. Just make sure that the right and left bridle attachment points are the same distance from the nose of the kite.





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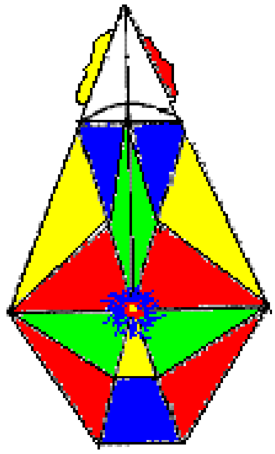
How to Make a Headstick Kite



You will need:

1. **four sticks - 2 x 24 inches, 1 x 22 inches (head stick), 1 x 20 inches (cross stick). The 22 inch stick should be tapered towards the bottom where it will be nailed in the center of the kite**
2.
    - If the sticks are too heavy the kite won't fly
    - The best wood is strong and light
    - Cyprus and white pine are two good types of wood to use
    - Make sure there are no knots in the wood
3. **9 inch bamboo bow**
    - This could be a metal one but bamboo or cane is safer
4. **Covering material**
    - Tissue paper is the material most often used for covering Bermuda kites.
    - You can mix and match your own colours
    - Newspaper, brown paper or polythene can also be used
5. **Glue**
    - Any paper glue or paste is suitable
    - If you are using flour and water glue mix in a little cayenne pepper to keep away cockroaches!
6. **Nails**
    - 1 inch nails will make the kite strong
    - A disadvantage to this is that if your kite gets caught in wires, metal could be dangerous
    - You can use string to tie the kite together
7. **String**
    - Any strong, light cord is good for stringing the frame
    - Cotton seine cord is very good (this is known as "'fishin' line"!)
8. **Scissors**
    - Long straight sharp scissors are the best

Making your kite

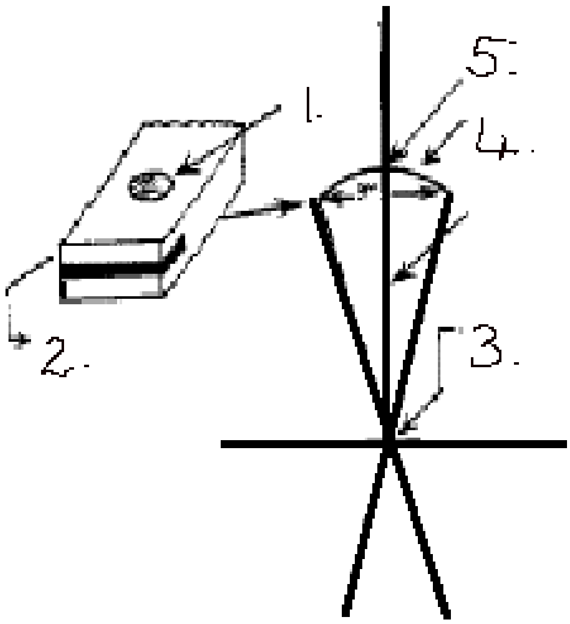
1.Make 3/16 inch holes at the ends of the two 24 inch sticks

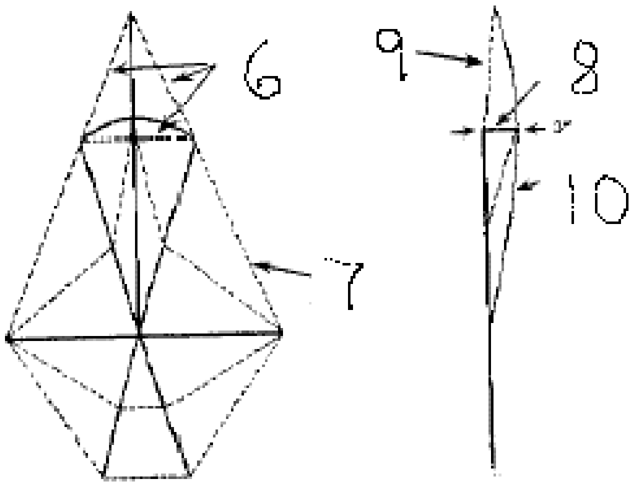
2. Make a groove on the top (only) of the headstick and at the ends of all the other sticks

3.Nail sticks at center of 20 inch cross stick, 2 inches down from the center of the 24 inch sticks and through the tapered end of the head stick

4.Stretch the bamboo bow between the two small holes in the longer sticks

5. Secure it with string to the head stick





6. and 7. String the kite as shown in the diagram. (6. This string is used for 'hummers' or 'buzzers only. Paper does not go here)

7. Paper your kite with the tissue paper. First cut out all your shapes. Paste light colours before dark ones. Paper lying over the inner strings lies flat. Paper over the outer strings is turned over and glued on itself.

8. This shows a side view of the bamboo bow - there should be a 3 inch space between the head stick and the 'hummer' string underneath.

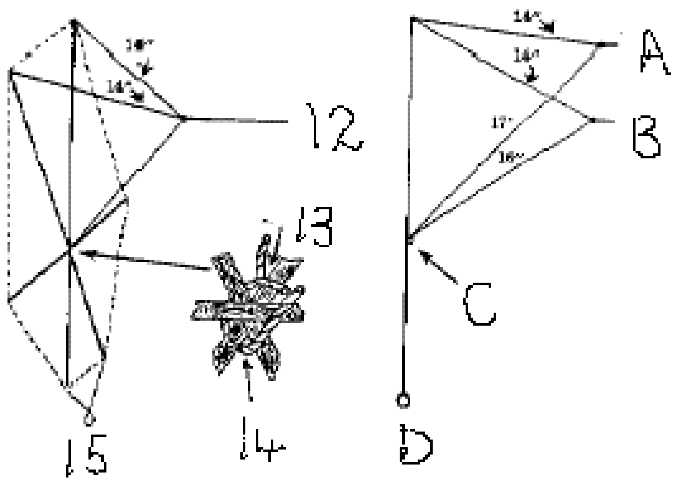
9. Hummers can be put on this string - these are cut like wings, folded over the strings and pasted to themselves

10. Notice the way the headstick is bowed.

11. Decorations can be added to make the kite look pretty. Hearts and stars are common. Some kites have strips of coloured paper wrapped around the head stick, others have "tassels" made of strips of paper cut into narrow ribbons and streamed off the headstick and cross stick.

Flying your kite

You will need strong string, and strips of torn-up cloth for the tail



12. Tie small loop here to prevent slipping

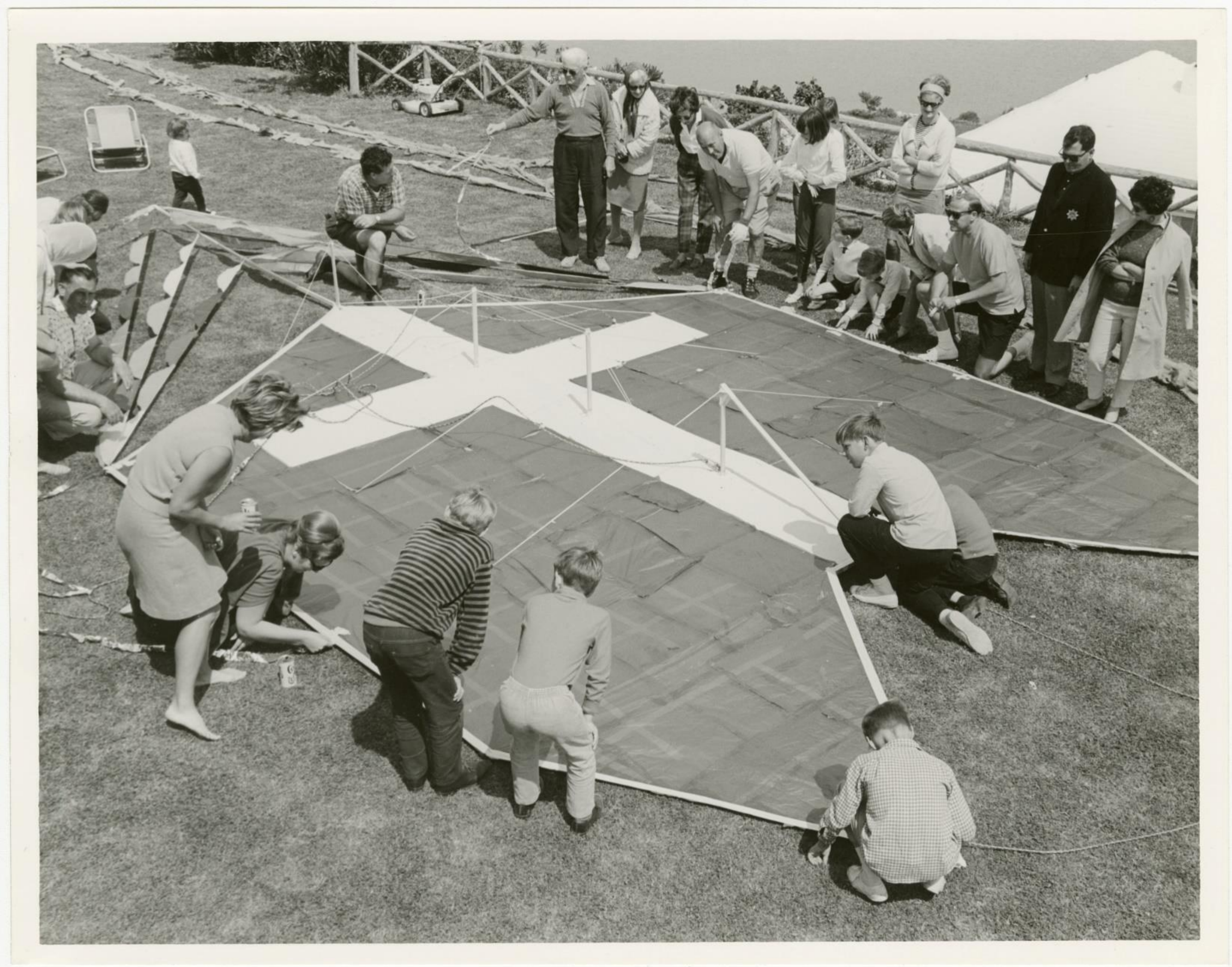
13. Tie the end of the flying string to this stick in back.

14. Pass string through paper, close to these two sticks

15. This is the tail loop - tie tail to this

A. Mounting Loop B. Pulling Loop C. Cross stick D. Tail loop

Bermuda Kite Photographs



There is a long-standing tradition in the Bermuda Islands of building and flying kites as part of celebrations occurring on Good Friday, the Friday before Easter Sunday. Although the origin of the tradition is unclear, it is said to have started on a Good Friday when a local teacher attempted to explain the Ascension of Jesus into Heaven to his Sunday school class. As a visual aid, the teacher made a kite with a cross design, flew it from a hilltop, and then cut the string, allowing the kite to rise up into the sky. Over the course of the twentieth century, the tradition of flying kites on Good Friday became firmly embedded in Bermudian culture, and led to the development of iconic kite designs specific to Bermuda. Traditional Bermuda kites are shaped either as a narrow hexagon or as a "roundy" variation with eight or 12 sides; they can range in size from about 30 inches (75 cm) across to several feet in diameter. Both types feature a "headstick" which extends up past the top edge of the kite body and supports tight strings carrying strips of paper which produce a loud humming sound when the kite is flown ("hummers"). Long streamers affixed to the bottom edges of the kite as a tail help keep the kite upright in flight as well as adding to the festive look. Bermuda kite flying eventually came to the attention of Smithsonian National Air Museum curator Paul E. Garber, a noted kite enthusiast, and in early 1968 he wrote to the Bermuda News Bureau asking for photographs of Bermuda kites in action. The Bureau provided a group of six photographs prepared for a story on Bermuda kite flying which featured the final preparation, blessing, and launch of a very large hexagonal kite from a hilltop in Bermuda. The undated photographs were likely taken on March 24, 1967, during Good Friday celebrations the previous year.

The Bermuda Kite Hummer

A paper covered (the so called "wing") little, but very loud hummer, which belongs to the family of the kite musical bows.

Traditionally the people of the Bermuda Islands fly their kites in the season of springtime on "Good Friday". The kites have strong frames, are paper colored and are similar to the hexagonal or octagonal angled flat kites being traditionally flown in autumn here in Germany. The front part of the Bermuda kites is longer than the rear part, it has an additional "headstick" and is carrying ornamental paper fringes and last but not least the noisy hummer.

Many stories are circulating, why "Good Friday" became the favourite day for kite flying. According to Frank Watlington's book (see Bibliography) one of these stories relates, that long times ago, there lived a minister on the Bermuda islands. One fine day he noticed, that many of his parishioners stayed away from church on this particular day, when ordinarily they were good attendants.

When the pastor asked his flock, why they didn't come to church, he got various excuses. Looking at this problem for a time, he finally decided to resign himself to this fact and make the best of a bad bargain. So he recommended that if they were not going to attend church, they might as well occupy themselves with a good healthy sport such as flying kites. In any event, as the nearby hill was a good place to do this, it might bring them at least nearer to heaven. He recommended further that they should fly a kite with the frame of the holy cross....

So tells Frank Watlington (*see Literature*). A good story, isn't it? But in fact nobody exactly knows, how kite flying came to the Bermuda Islands.

Now, let's go to the Bermuda Musical Kite-Bow:

It is fixed crosswise to the attacking wind like all kite bows at the front end of the kite's spine. It is made from a strong bamboo split lath, a bamboo sort called "Cane" by the Bermudians. Under tension, the bow is approximately 30cm long and tightly strung with a strong linen (or polyester) thread. The string is turned to the backside of the kite. In contrary to other musical bows (for example the *Japanese "Unari"*), the string is not of a ribbon form but round. Also it is not the string itself which the wind makes vibrating like for example in an *aeolian harp*. The wind is acting on a elliptical piece of paper glued around the string, making it vibrating violently, thus having an effect on the string. The string is transferring onto the bow, which is fastened to the paper covered kite frame, thus acting as a resonance box, amplifying the tone considerably.

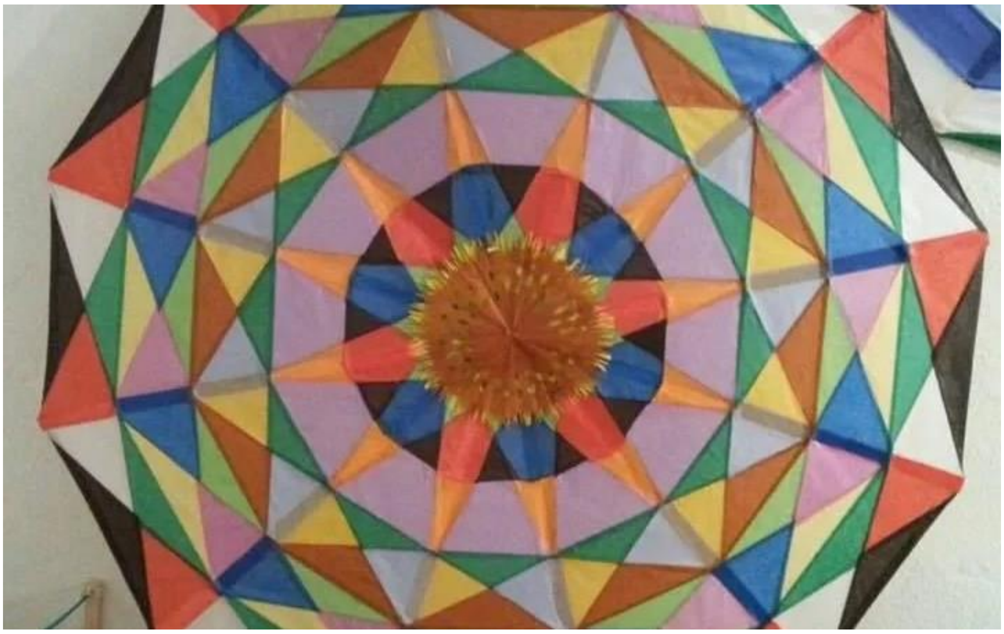
The tone is depending of the following factors:

- The string material (thickness, elasticity, weight). Increasing of these factors make the tone deeper.
- The bamboo-bow (Strength, flexibility). The stronger, the tighter the string; the higher the pitch and the more windspeed will be required until the string is responding.
- The paper material. The thicker, the higher the weight, the deeper the resulting tone.
- The form of the so called "wing", the piece of paper, glued around the string. The higher the "wing depth" and the longer; the deeper the tone.

It makes a lot of fun, to experiment with this manner of sound generating. The tone is pleasant and is similar to the humming of insects. With in-/ decreasing Kite-/ windspeeds the pitch of the hummer will change also. So very beautiful tone effects are generated with that interesting type of kite, which can be maneuvered like a "fighter kite", having a highly vivid flying picture.

The Bermuda Kite is flown with a fabric tail changeable in length, dependent on the desired performance.

Police On Easter Kites & Hummers:
'Let's Not Make Things Even More Difficult For Each Other'



- *The following statement was released this morning by Assistant Commissioner of Police Martin Weekes…*

With the Easter season upon us, and everybody Sheltering at Home the Bermuda Police Service (BPS) anticipate an increase in the Bermudian tradition of kite flying.
The BPS, understands that as Easter approaches many Bermudians will take advantage of being at home and will try to fly kites from their residences.
However, we note that there has also been an increase in persons making reports to the BPS of loud kites, kites fitted with what are traditionally called hummers, disturbing their peace, particularly with people being home all day.
Whilst the BPS is sympathetic to kite enthusiasts, particularly at this time of year, we must also be sensitive to those who make reports and must be seen to uphold the law. The BPS Parish Constable have recently held a number of Town Hall style meetings to address these concerns and to remind the public that Section 18a of the Summary Offences Act 1926 states:
"It is an offence for any person who in any public place flies any kite to the annoyance or danger of any passenger or frequenter."
In most cases when the BPS are called to investigate such reports, the kite flyers have been reasonable and taken down their kites, however in some cases persons have been and will continue to be placed before the courts if they continue to fly kites in a manner that disturbs their neighbours.
We currently are all facing unprecedented times. The novel Coronavirus (COVID-19), and the restrictions implemented to prevent its spread, have everyone now Sheltering at home. We therefore urge kite enthusiasts to take this into consideration, in the days leading up to Good Friday and to additionally be careful not to have kite strings and monofilament fall across power lines and their neighbours yards.
Let's not make things even more difficult for each other during this already testing time.

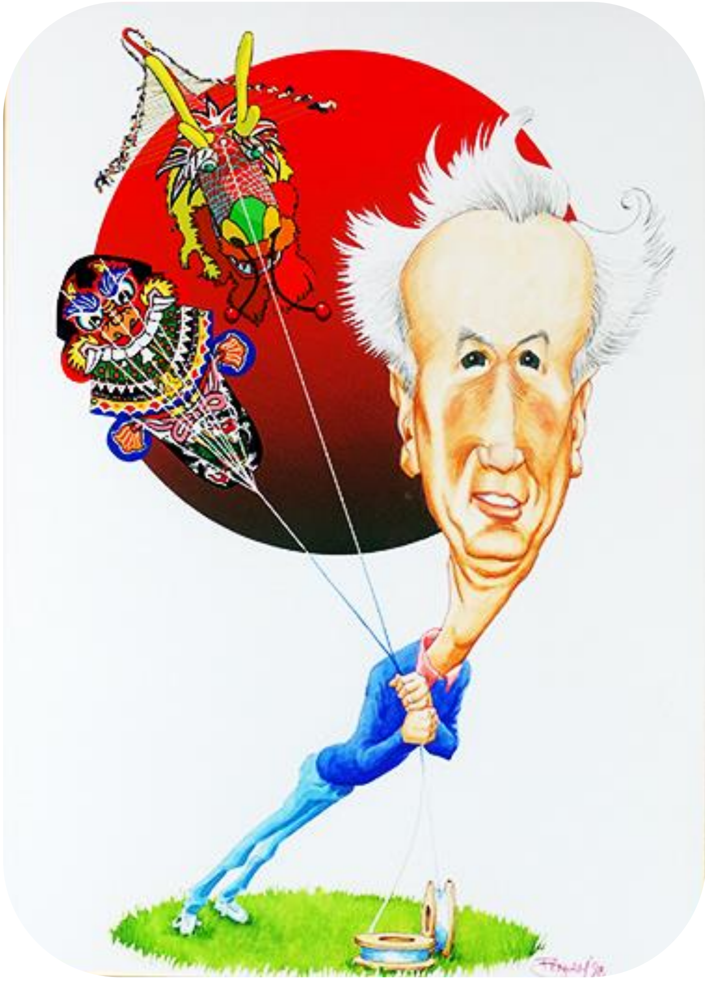
Dean Souza
13 January at 21:57 ·
Has anyone learned about Bermuda kites "Hummers " In this group. ?

Alan Poxon
Many years ago at a festival I had the chance to spend some time with a guy who had grown up making traditional Bermudan Head-stick kites. In England, he now made them out of plastic carrier bags & trash bags, so they lived a little longer than tradit…

Dean Souza
Author
That are an art to make. It's not hard tho. And yes. They make hella a noise. I'm having a hard time trying to find kite sticks to make one as I am bermudian and miss my noise makers. Also I think it would be great to fly here as they are very rare !

Alan Poxon
Dean , you're correct, don't see many of these kites at festivals.
For spars, if you go to a timber merchant and buy a length of 2" x 4" hardwood, I'm sure they would cut it into smaller pieces for you. Finding good dowel & small size wood in DIY sto…

Dean Souza
Author
Alan Poxon thank you 🙏 .



The kiteman

I'm Malcolm Goodman, nicknamed "The Kiteman" by local children. I have been responsible for introducing thousands of people to the joys of kite flying by giving kite displays, teaching kite workshops, organising kite festivals and helping to form kite clubs. In my spare time I can be found in schools, art centres etc. teaching the art of kite making.

Kites have developed considerably over the years with the evolution of hi-tec lightweight materials and research along with the enthusiasm and skills of many kite makers and kite flying is now one of the fastest growing pastimes/sports in the world. In fact there are probably now more adults flying kites than children!

Finding a new home for my kites

Pursuing our hobby in various parts of the world for nearly 50 years, my wife and I have built up one of the largest private and comprehensive oriental kite collections in the world.
We're very lucky to have been invited to represent England at many kite festivals throughout the Far East. During our travels we have bought, bartered, swapped kites and many more have been very kindly given to us. We have also been able to invite many of the World's best kite makers to the UK to participate in Festivals and Displays we have organised.

The collection is unique as sadly there are very few kite masters alive with the skills to make traditional kites in the Far East.

As we're looking to move home (and downsize), we're looking for a new home for the collection so these fabulous and remarkable kites can be preserved and seen by future generations.
There are also many thousands of photographs, videos, kite books, magazines and data accumulated over 50 years.
Please contact me if you or you know of someone who would be interested in finding a home for this unique and priceless collection. Our dream would be to keep the collection in the UK if possible.
Please feel free to get in touch if you think you may be able to help:

The longest-running and continuous International Festival dedicated to kites, flying in the sky of Cervia since 1981 to celebrate the history and cultures of the art of wind, in the company of 200 official guests and thousands of participants from over 40 countries around the world.

By choosing all the colors of the rainbow as its flag, praising the motto "we are the rainbow" and celebrating the bee as its identity symbol, as well as being the most important international observatory on the kite as an art form, ARTEVENTO Cervia presents an original and memorable visual show, soliciting a unique multicultural and interdisciplinary encounter.For 11 days the most extraordinary interpreters of a millenary tradition in constant dialogue with the wind meet on the perfectly served beach of the Romagna town to discuss the poetic theme of kite, celebrate respect for the environment and give shape and color to a spectacular message of PEACE, shared by 300,000 visitors every spring.

From April 21st to May 1st 2023, the wind designers fly together with the Masters of the tradition, experts in the history of flight, Kite Aerial Photographers and sports pilots, giving life to a complete review of art, ethnic, historical, giants, acrobatics and fighters. And while the beach is transformed into a wonderland thanks to the wind installations of the "Giardini del Vento", the unmissable appointments of the original format follow one another without interruption in a healthy and creative atmosphere, oriented towards the promotion of psychophysical well-being through the experience of an exciting show, completely free and suitable for audiences of all ages and abilities.

Scheduled on the beach, for 10 days of celebration dedicated to wonder: "The Night of Miracles", "Wind Fair" and specialized market, performances by the Guest of Honor country, "Kites & Puppetry" demonstrations, acrobatic flight to the rhythm of music , combat and KAP Aerial Photography with Kites, "Special Award for Flight Merits", Acrobatic Flight Championship and STACK courses, in-depth analysis on the Historical Kite and "Flying Fantasy Images", "Flag Ceremony", meetings with guests , postmark in collaboration with FILATELIA Poste Italiane, exhibitions and multidisciplinary educational workshops on sustainable creativity organized by the Kite Museum…

Supported by the RAI Public Utility Media Partnership for its efforts to promote the Sustainable Development Goals of the UN 2030 Agenda, ARTEVENTO CERVIA International Kite Festival is organized in collaboration and under the patronage of the Municipality of Cervia, the Emilia Romagna Region and APT Services.

https://artevento.com/

Every year in March / April, Berck Sur Mer holds international kite festival. The colorful event takes place for more than two decades.

People flying kites from France as well as from all over the world participate in this happening. The spectators can see kites from every color and shape.

Due to the numerous visitors during the festival days and the high demand for accommodations it is recommended to check hotel rates and book rooms well in advance.

The festival's program, venue, lineup information show time / schedule of events, how to get, parking etc. is present in the festival's link website. See details below, under "Event Related Information" section.

For accommodations, check the most recommended hotels in Berck Sur Mer and around, most of them suggest **FREE CANCELLATION** option or **NO PREPAYMENT NEEDED – PAY AT THE PROPERTY**:

BRIDLINGTON KITE FESTIVAL
21st & 22nd MAY 2022

Come and join the fun!

Some of the world's largest inflatable kites take to the skies above the dramatic cliffs of the East Yorkshire coast for the annual Bridlington Kite Festival.

Kites of all descriptions, sizes and colours take to the air for two days of aerial displays over Sewerby Fields. From flying frogs to sky-high snakes and leaping lizards to daredevil dragons, scores of exotic inflatables add a splash of colour to the cliff tops above the popular seaside resort of Bridlington.

Year on year a number of internationally renowned experts return to provide spectacular displays for hundreds of spectators over the weekend. As well as professional demonstrations, visitors can have their own chance to have a go with kites available for loan during supervised sessions.

Along side of this vast array of giant inflatable kites, you will find street food stalls, fairground rides and children's entertainment - making it an action packed, fun filled festival for all the family.

For enquires, updates and further information please email:
info@veyevents.co.uk

Bridlington Kite Festival on Facebook and YouTube

Location: Sewerby Road, Sewerby near Bridlington (Postcode YO15 1ER)
Co-ordinates: 54.0K98738 & -171415
What3words: Kick.action.larger
Times: 10am until 5pm daily
Admission: Free

Parking:

- **Bridlington - Sewerby (picnic) Car Park** (500 spaces and charges apply) Cash or cashless parking system MiPermit in place
  No parking on verges
- **Bridlington Park & Ride**

Car Park details

Access: on foot along the coastal footpath from Bridlington to Sewerby Hall, or via the land train (charges apply). Wheelchair accessible. Stop on site

Facilities

- Refreshments: food stalls. Picnics welcome.
- Seating: picnic tables (limited)
- Facilities: portable units on site.
- First Aid: on site.
- Entertainment: fun fair, demonstrations, activities.
- Stalls: kiting and associated goods.

Accommodation
Accommodation bookable at: visiteastyorkshire.com

No overnight camping permitted. No barbeques permitted. No alcohol on site. Dogs must be kept on leads.
For enquires, updates and further information please email:
info@veyevents.co.uk
Bridlington Kite Festival on Facebook and YouTube

St Annes International Kite Festival Returns For 2023!

Friday 8th to Sunday 10th September 2023

Visitor information – what you need to know…
The 2023 St Anne's Kite Festival will take place in September. Joined by kite teams from across the UK and beyond, the event is a partnership between Fylde Council and kite fliers SmileFactor10 with support from St Annes Town Council. The skies above St Anne's seafront will be awash with colour on Friday evening, Saturday and Sunday as fabulous display kites take to the air on the beach adjacent to the pier.
There is a planned illuminated kite flying evening on Friday 8th September. There will be a fairground on the beach, a stage for music and entertainment and additional stalls on the Promenade, so if you're looking for refreshments you are very much encouraged to visit the town centre as well or bring your own picnic.
Weather permitting, the event promises a thrilling and thoroughly enjoyable trip out for young and old alike. Timings for this year are as follows:

- Friday 8th – 11am onwards
- Saturday 9th – 11am to 5pm
- Sunday 10th – 11am to 4pm

Please note the event is entirely weather dependent and the planned programme may be changed without notice, for safety reasons. The dates have been chosen as the planned tides support this.

Facilities at the event

- Information point, lost children point, lost property and security desk
- First aid team constantly on patrol
- Food, drink and merchandise stalls on the Promenade
- Please note the dog exclusion zone either side of St Annes Pier
- Additional event toilets
- Parking – please research prior for car parks away from the busy sea front. Additional event parking signposted on South Promenade (up to 600 cars) adjacent to Fairhaven Rd Car Park – FY8 1NW

Margam International Kite Festival

Saturday 27th May 2023 10:00 - Monday 29th May 2023

Bring your kite along and join in the fun! Kites of all shapes and sizes (Bank Holiday Entry fee applies for Monday 29th May).

- Saturday 27th – Monday 29th Margam International Kite Festival Bring your kite along and join in the fun! Kites of all shapes and sizes (Bank Holiday Entry fee applies for Monday 29th May).

Margam Country Park

MargamPort TalbotSA13 2TJ
www.margamcountrypark.co.uk/
margampark@npt.gov.uk
0044 01639 881635
0044 01639 895897

Bring your kite along and join in the fun! Kites of all shapes and sizes
(Bank Holiday Entry fee applies for Monday 29th May).

Cardigan Bay Kite Festival 24th & 25th June 2023

Cardigan Bay Kite Festival 24th/25th June 2023 held at Cardigan Island Coastal Farm Park, Gwbert-On-Sea, Cardigan SA43 1PR. Camping is available from Thursday afternoon until Monday morning for kite flyers who are members of kite groups and are putting on the displays. This year there is a small charge for camping which will be £15 for tents and £20 for campervans/caravans. Spectators who wish to camp need to contact Lyn or Ellen Jenkins on 01239 612196 or 01239 623637 for camping prices and availability on their main campsite.

Once again this will enable kite flyers to enjoy a month of travel/holiday incorporating Cardigan, Barmouth, Berrington and Cleobury Festivals if they are able. We will also be sporting our TuTu`s once again as we had so much fun last year. Look forward to seeing you there 🙂🙂

For more info email kites@skybums.com or PM

Saturday 26th & Sunday 27th August 2023

Telford Town Park, Telford, Shropshire, TF4 3NE
(Use TF3 4BZ)

FURTHER DETAILS TO BE ANNOUCED SHORTLY

Civil Aviation Authority

CAP 393
Air Navigation: The Order and the Regulations
-
TODAY'S HEIGHT LIMIT WILL BE
1,000 feet
MIDLANDS KITE FLIERS

PRE REGISTERED ON SITE CAMPING AVAILABLE

MIDLANDS KITE FLIERS OF GREAT BRITAIN

c/o Sunnyside, Cheadle Road, Oakamoor, Stoke on Trent, Staffordshire, ST10 3AF.

Email: cdhw25@gmail.com - 07598 392613

In the event of poor weather conditions the fly-in will be cancelled.
It is always advisable to check that the event is happening before travelling any distance
All our 'fly-ins' are Civil Aviation Authority and Site Owner approved.

THERE'S NEVER A 'LOBSTER' AROUND WHEN YOU NEED IT!

David Wadeson

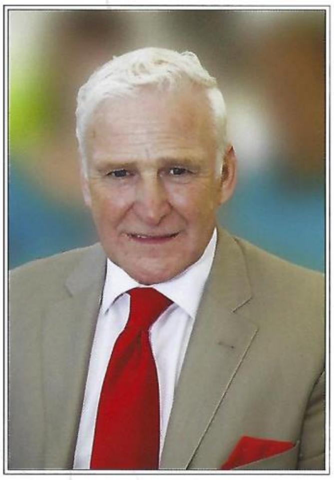
Had a good Monday morning flying the new to me 6m lobster that I got from the club auction last year. I also flew the 6m fish, but didn't get any photos. It was a new flying site in Loughborough complete with somehandy ground anchors…

To Celebrate the Life of

William John Ryan

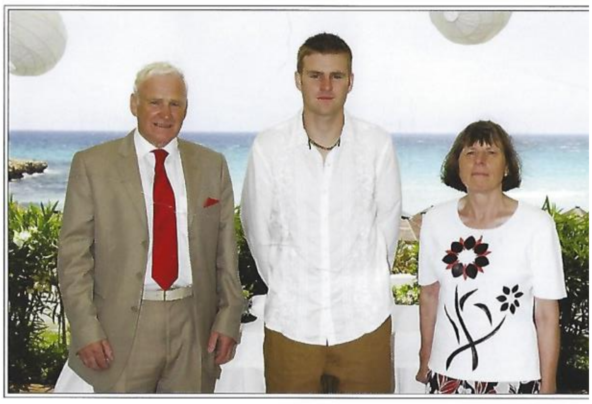
'John'

10th March 1945 - 8th January 2023



Streetly Crematorium, West Chapel
Wednesday 1st February 2023 at 3.15 pm

Service led by Alex Reed



John's family wish to thank everyone for their kind thoughts and messages of sympathy, and for joining them today to celebrate his life.

You are all most welcome to join them at
Farmer John's, 251 Aldridge Road, Streetly B74 2DX,
following the service to share more memories.

Donations will be given to the Asthma + Lung UK
(formerly known as the British Lung Foundation)
and may be placed in the donation box when leaving the chapel
or forwarded to John Short & Son Funeral Directors
at the address below.

John Short & Son
3 High Street, Chasetown, Burntwood WS7 3XE
Tel: 01543 686204

MEMBERS THOUGHTS ON 'FACEBOOK'

Bill Souten
It is with great sadness to let everyone know that John Ryan passed away on the 8th January 2023. John was a member of the club for several decades and served as Chairman. Turning up to nearly all fly-ins he was a lovely man, great with the general public and particularly with children. He will be sorely missed on the flying field.

Dave Hardwick
John you will be sadly missed.

Nick Hale
Such a smashing fellah. RIP

David Shakspeare
A lovely man, I used to enjoy our chats at Roden. RIP John.

Hans-Ulrich Draheim
RIP !

Ann Buckland
John was a really lovely man he will be missed x

David Green
Thank you for all you did for MKF . R.I.P John, good man .

Gill Pryor
He was a lovely man with a beautiful soul.
Fly high in clear skies John. ❤️

Dave Salmon
Johns smile Improved so many days of my life. Many kite fields will miss his Joyful presence. And he did so much for folks on and off the field.

Pete Slater
I'm sorry to hear of John's passing. He was always a good friend right from the first time I met him at Calke. One of the nicest people you could meet and I still have his kite wind chime in the window. God bless John. Plenty of good winds for you n