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WORLDWIDE PARAGLIDING AND PARAMO G MAGAZINE. FOR FREE.

MAKING-OF...

Photo: Tristan Shu

Photo: Jérôme Maupoint/Gin

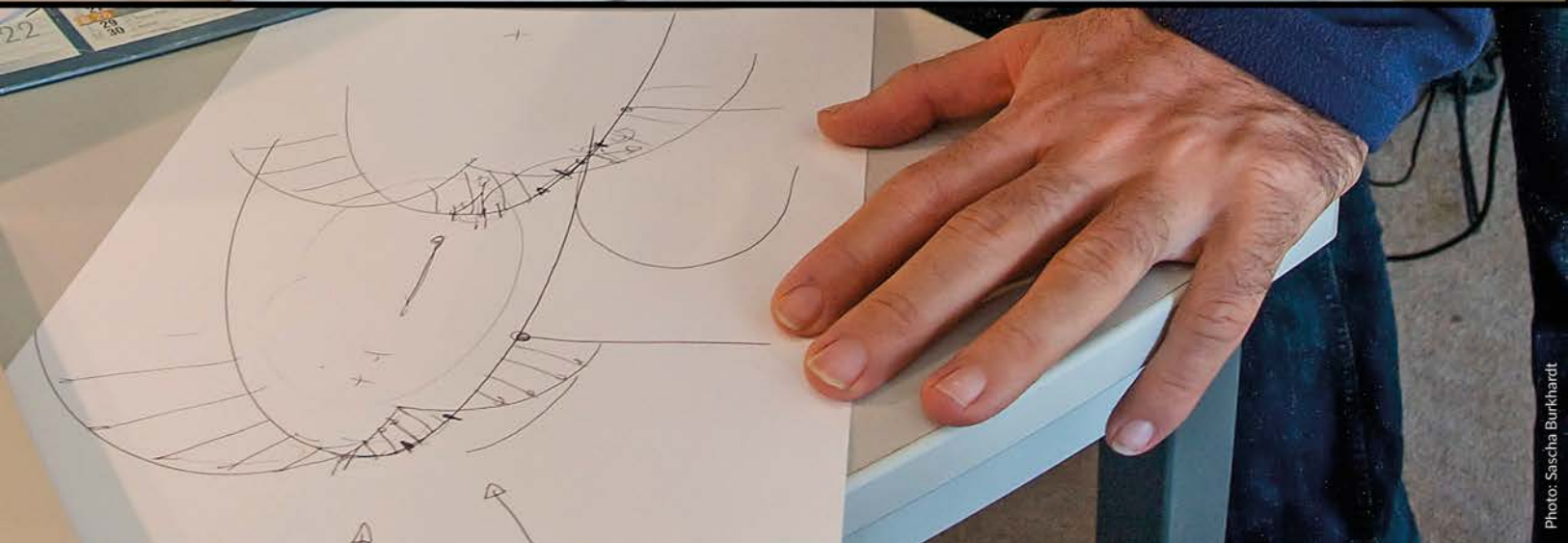


Photo: Sascha Burkhardt

Cover: The design and manufacture of our toys takes a long time. Most of the stages are done by hand...

CONTENTS

Translation by Ruth Jessop

PPG EN 926 - 1 / DGAC

DOBERMANN 2

Slalom & Freestyle

'The glider has been optimized for a better efficiency on turning, to increase maximum speed and to reduce the pilots' lap-times'.

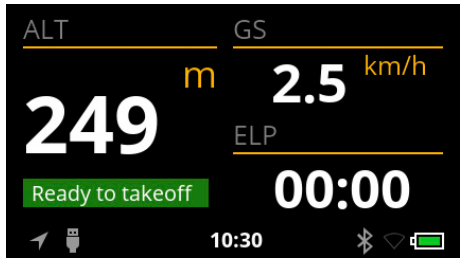
Ramón Morillas – PPG competition pilot

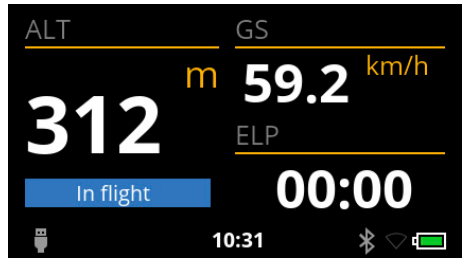
niviuk.com

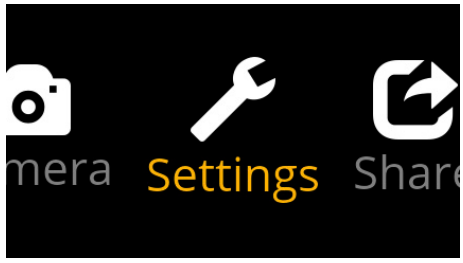
Photo : Aurelie Riviere Surzur

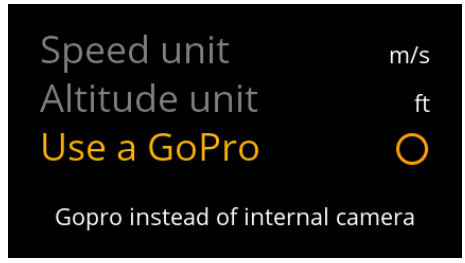
NEW AUGMENTED REALITY GLASSES

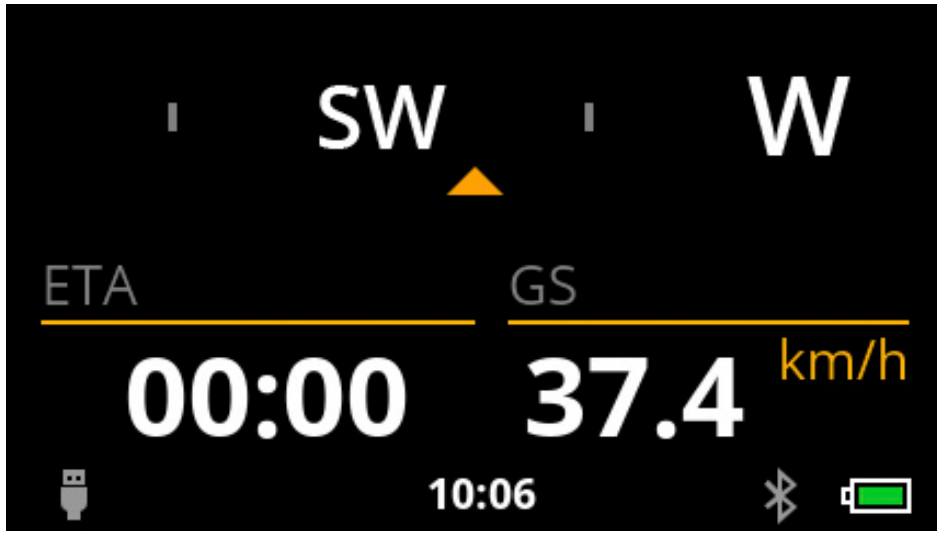
Google Glass is not making much progress as it is felt to be too intrusive socially in everyday life. The company Recon, on the other hand, who are part of the Intel group, have brought out their own glasses which are clearly aimed at the sports market. In the bottom right hand corner of the field of vision, a colour LCD screen displays the information given by the Android application produced by the 1 GHz dual-core ARM Cortex-A processor with 1 GB of memory. The glasses can therefore work on their own and are equipped with GPS and accelerometer, gyroscope, compass and pressure sensors. They can also be connected via Bluetooth 4.0 to a smartphone. An HD camera, a microphone and a loud speaker have also been included.











Stéphane Nicole (above), from the company PPGpS, which developed the PPGpS application and the Android application for free.aero, has worked on a special version of PPGpS for these glasses, thus making them specially adapted for air sports. The application displays all the important information for navigation including wind direction and strength: see examples on this page. A very promising product and, above all, at a less than exorbitant price: 525 €.

Contact: recon@ppgps.info

For more information about the basic models of glasses: http://www.reconinstruments.com/products/jet/

free.aero MAGAZINE

KILIMANJARO

Kilimanjaro is an amazing mountain in the North-East of Tanzania formed from three extinct volcanoes. Uhuru Peak, at 5,891.8 metres, is the highest point in Africa.

Paraglide Kilimanjaro is a local company; they give pilots the opportunity to take part in a breathtaking flying expedition in the massif by obtaining all the necessary authorisations.

The founders have been fans of hike and fly for more than twenty five years. In 2015 they received permission to fly paragliders from the summit. They have also organised national competitions.

NEXT EXPEDITION DATES

- 26th of August to the 7th of September 2016
- 16th to the 28th of September 2016
- 7th to the 19th of October 2016
- 11th to the 23rd of August 2017
- 1st to the 13th of September 2017
- 22nd of September to the 4th of October 2017
- 13th to 25th of October 2017

For further information:
www.paraglidekilimanjaro.com

Photos: Marianne Schwankhart

SPIRIT IN THE SKY

Pilot Elodie "Greeny" is also a graphic designer. The young Breton paraglider pilot has opened an online shop where she sells silk-screen printed clothes with a variety of very original pretty motifs with a paragliding theme.
www.fluffy-mind.com

Elodie wearing one of her designs: a red t-shirt "Color your soul" at 20$ (18€).

Pullover Oatmeal "One Life, Live It" 35$ (31€)

Pullover Oatmeal "One Life, Live It" 35$ (31€)

Sleeveless t-shirt "Highlight your flight !" 20$ (18€).

Baseball style t-shirt in green and white "Keep calm and Paraglide" 25$ (22€).

RECYCL'ART

What happens to old paragliders after their life in the sky? Svetlana from the Paratroc team has started making one-off items using paraglider and reserve fabric and lines. Each item is unique and hand made.

For more information have a look at her website - http://recycl-art.jimdo.com/
For sale at Paratroc at Doussard or online at the Paratroc webshop:
http://www.paratroc.com/fr/202-recycl-art

SharkNose Performance, Legendary Comfort

The Buzz Z5 is the highest performance Buzz that we have made, and the most solid and comfortable Intermediate class wing that we have ever flown. The Buzz legacy of comfort and ease of use has received a huge performance upgrade with the patented Ozone SharkNose profile, double 3D shaping, optimized line layout, overall line length reduction, and more cells, all of which mean reduced drag and increased glide and speed. Best of all, these performance upgrades come at no cost in passive safety, because the aspect ratio remains the same. This balance of performance and safety is the most important consideration for any pilot, and the Z5 offers what we think is the ideal amount of both for long XC flights in real conditions.

The Buzz Z5, like its predecessor, is suitable for a wide range of pilots. It is an ideal choice for those who fly 30-50 hours per year, or for experienced pilots seeking a wing with high levels of passive safety and comfort in the Intermediate Class.

WWW.FLYOZONE.COM

Photo : Niviuk

WINGS WHICH HAVE COME FROM AFAR...
MAKING A PARAGLIDER

From the design to the delivery, a paraglider and its components often travel many more miles around the world than the wing will in flight...

WHERE ARE THE PILOTS IN THE WORLD

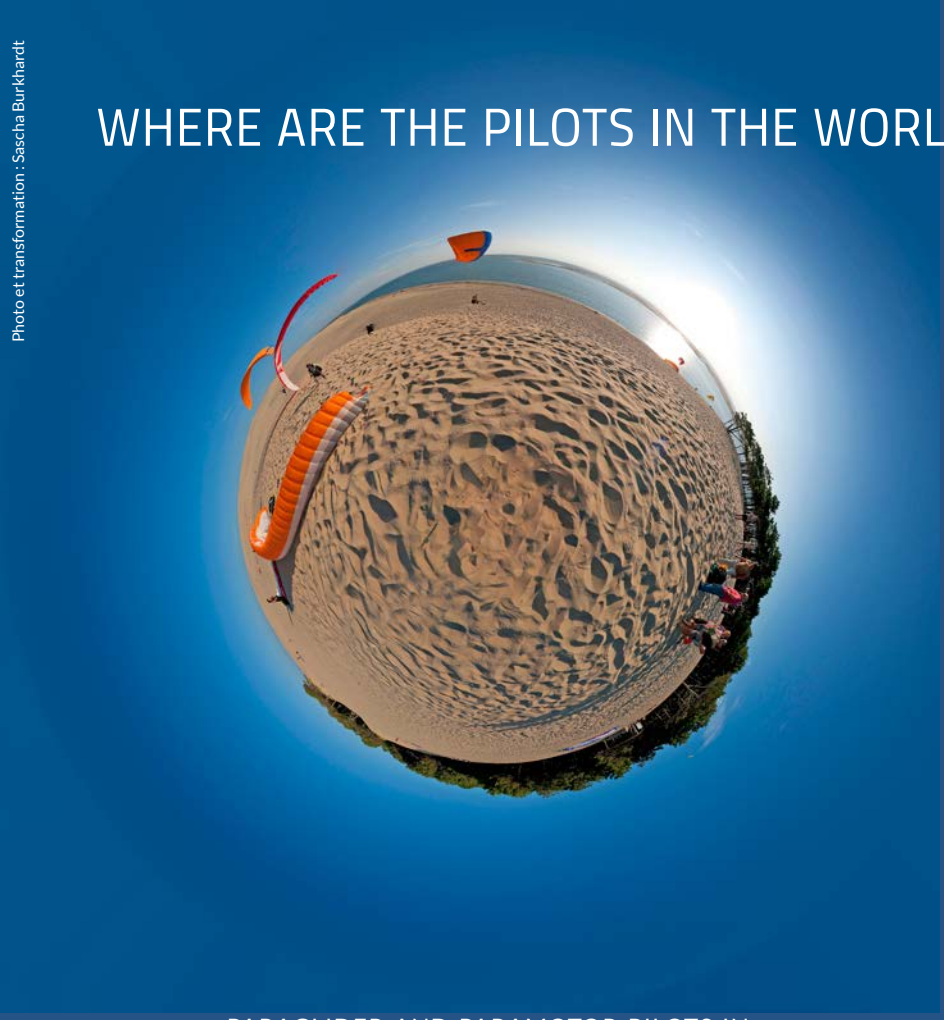


Photo et transformation : Sascha Burkhardt

PARAGLIDER AND PARAMOTOR PILOTS IN THE WORLD

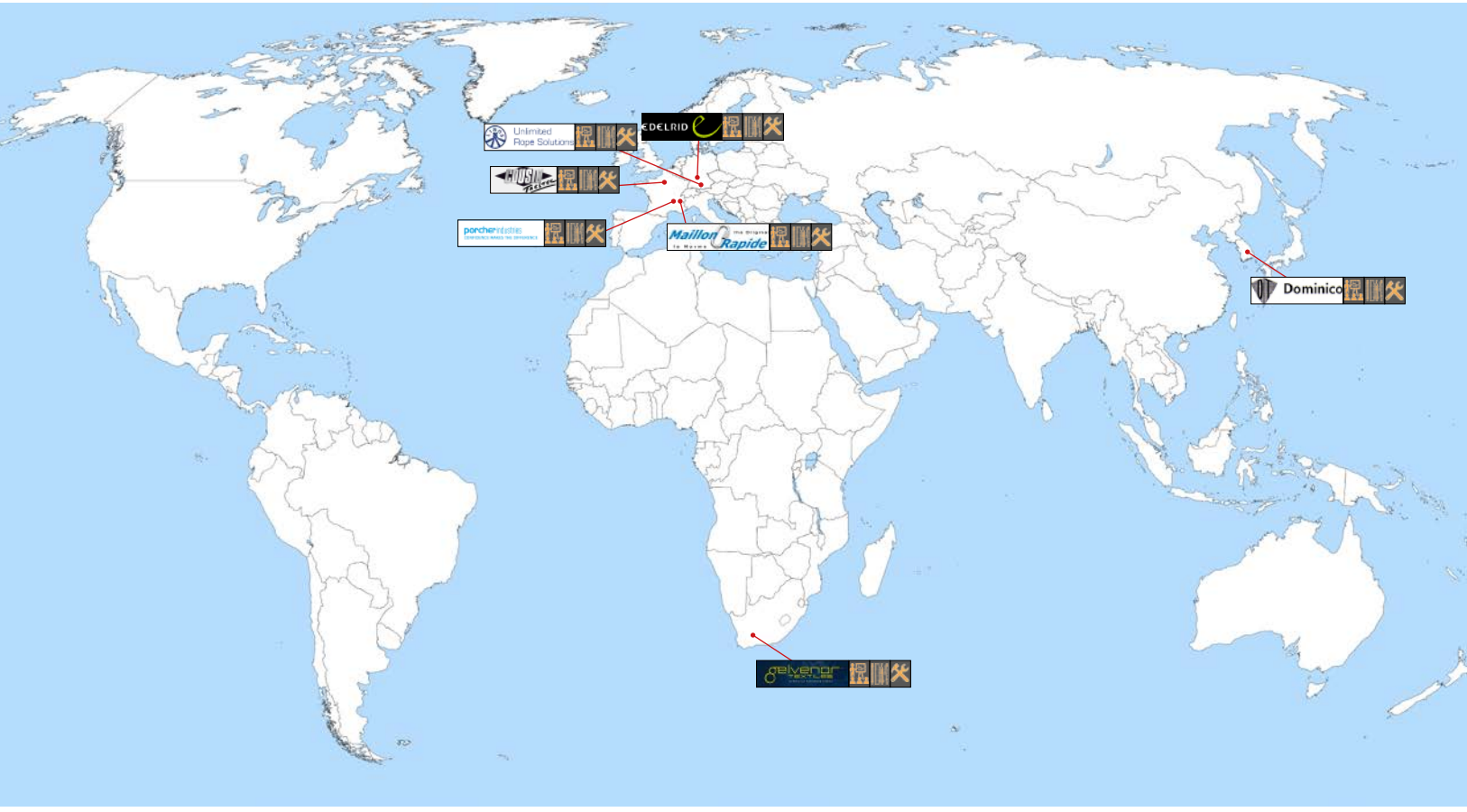
In 2015, we published some very enlightening figures from a study by the PMA, the Paraglider Manufacturers Association.

The result: there are 127 000 current paraglider pilots and 26 000 current paramotor pilots. Europe is the continent which has by far the most pilots (99 000 paragliders and 19 000 paramotors), followed by Asia (14 000/1200). In Latin America, there are about 8300 paraglider pilots. In the United States, the study found there were only 5700 paraglider pilots, but as many as 4500 paramotor pilots.

Conclusion: for the manufacturers, their clients are mainly in Europe, especially in the Alps.

Source : http://www.p-m-a.info/

	Paragliders	Paramotors
Europe, Middle East, Africa		
Germany	27609	4126
France	17748	5400
Switzerland	13440	560
Austria	4623	502
Spain	3500	1500
Italy	7500	2500
Czech Republic	3000	200
UK & Republic of Ireland	4116	1764
Russia	2250	250
Benelux	1734	577
Scandinavia	2521	644
Poland	3133	348
South Africa	457	100
Slovenia	1326	70
Turkey	2600	110
Hungary	1395	155
Ukraine	720	80
Greece	657	73
Slovakia	790	86
Total	99 120	19 045
Asia		
Japan	5500	500
Australia and New Zealand	1534	194
South Korea	2750	250
China	900	100
Taiwan	900	40
India	950	25
Indonesia	1045	55
Malaysia	700	10
Total	14 279	1 174
Latin America		
Brazil	6300	700
Mexico	960	240
Total	8 340	1 060
North America		
USA	4900	3500
Canada	800	1000
Total	5 700	4 500
Total Worldwide	**127 439**	**25 779**



THE RAW MATERIALS

Surprising: almost all the companies making the raw materials for our paragliders are based in Europe and not in Asia where most of the wings are produced...

PICTOGRAM KEY

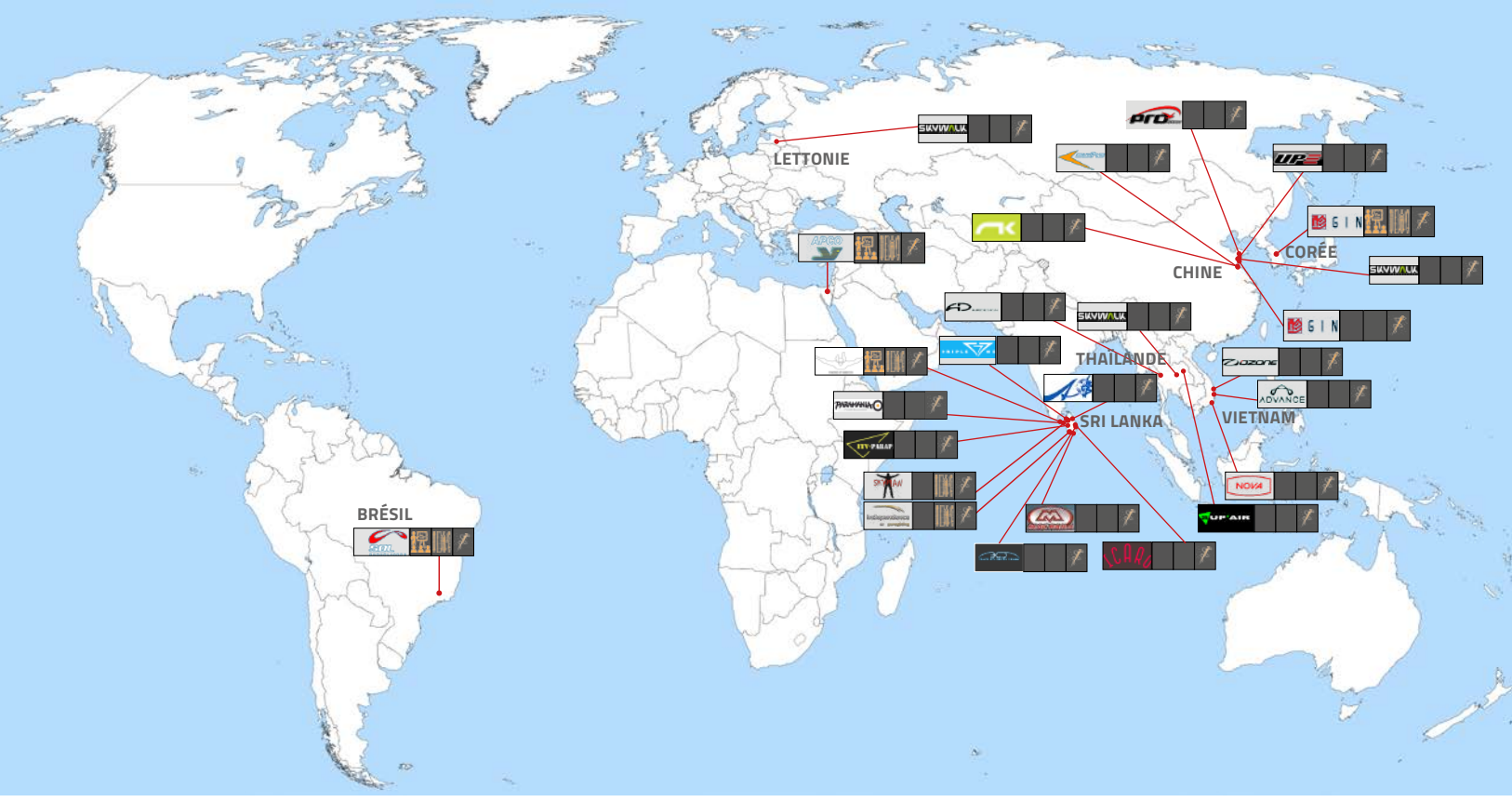
ADMINISTRATION
DESIGN
MANUFACTURE

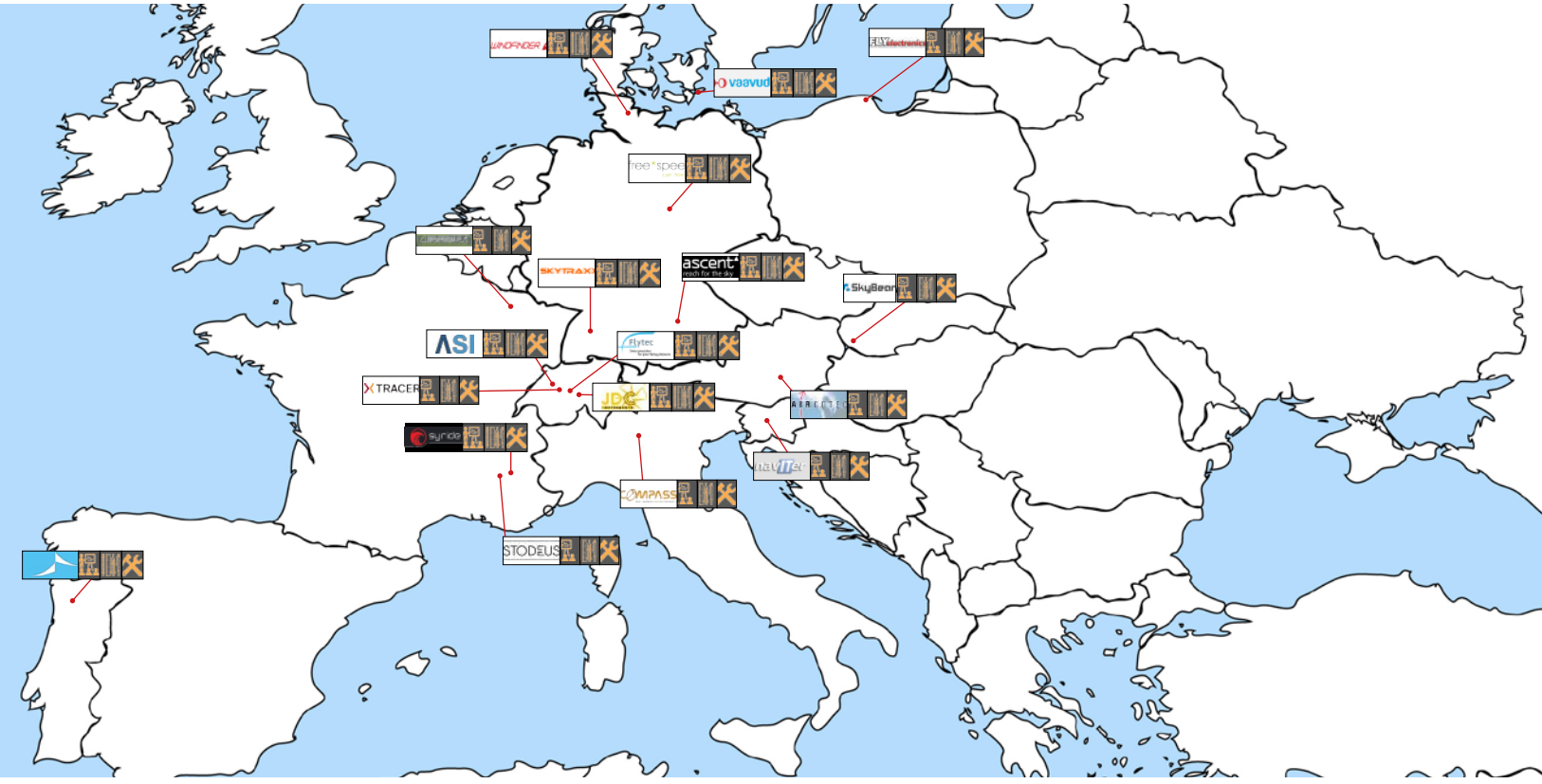
PARAGLIDER MANUFACTURERS

Not surprising: paraglider design and the manufacturers' administration are concentrated in Europe, the principal purchase base in the world. For production, Asia remains dominant. Here are some of the sites where they are designed and manufactured, without claiming our list to be exhaustive. It's worth noting that, in Sri Lanka alone, there are two different factories, Sky Sport and Aqua Dynamics. This map also takes into account the recent changes due to the closure of the Kaesong industrial zone in North Korea.

PICTOGRAM KEY

- ADMINISTRATION
- DESIGN
- MANUFACTURE





PICTOGRAM KEY

- ADMINISTRATION
- DESIGN
- MANUFACTURE

INSTRUMENT MANUFACTURERS

An interesting bit of additional information: flying instruments are also manufactured near the pilots, with a substantial concentration in Switzerland, the land of watch-making.

PARAGLIDERS CLOCK UP THE MILES…

The raw materials are mainly made in Europe, most of the wings are made in Asia and most of the pilots live in Europe. Our wings and their component parts make return journeys across the globe. It isn't great for the carbon foot-print but, apparently (for the moment), there's no alternative.

The raw materials travel around the world partly by boat, partly by plane, with the last leg by lorry obviously.

The wings made in Asia return either by plane, or by boat, but mainly by plane. For some manufacturers it has even become the only means of transport.

By boat, it takes a paraglider about six weeks to travel from Asia to Europe. By plane, four days after leaving the factory, the wings can be with the distributor.

Photo : chrisberic - Fotolia

Photo : Yuri Bizgaimer - Fotolia

GIN

The classic intermediate paraglider, re-engineered

Share your experience #gingliders

www.gingliders.com

Sprint 3

The manufacturers are helped by teams, many of whom are there thanks to their love of paragliding. Here is part of the Niviuk team at their head office in the Pyrenees.
Photo: S. Burkhardt

THE OFFICE STAFF AND TEAMS

Almost all the designers and headquarters of the different makes are in Europe, near flying sites, and near the pilots who buy the wings. Here are a few examples in photos...

Photo: Thomas Ulrich/Advance

Advance are based at Thun, surrounded by the most beautiful flying sites in Switzerland such as the waterfalls near the Schilthorn.

Photo : S. Burkhardt

Hannes Papesh and Simon Campiche: since 2014, with the arrival of Hannes, Advance now also have an Austrian accent.

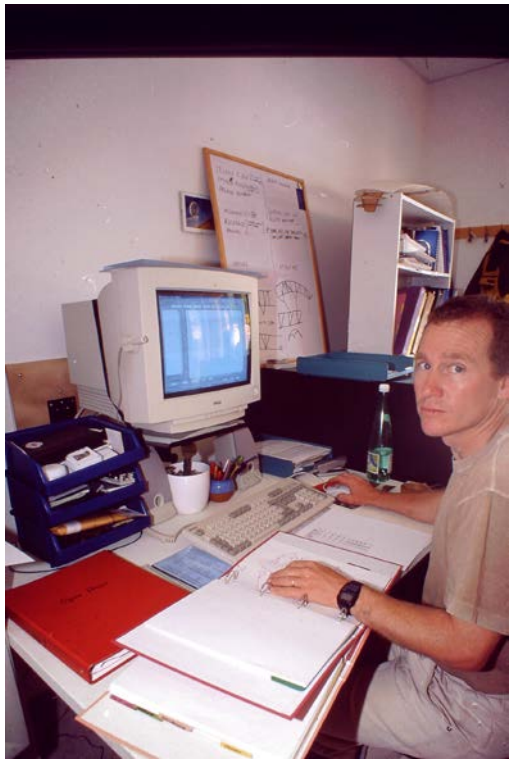
GIN do a lot of their design work in Korea but they also rely on their partners in Europe like Michael Sigel and designer Torsten Siegel for testing (just in front of Gin in the photo). They work mainly at the sites in Switzerland but also at Bassano for example.

Skywalk's headquarters are at the foot of the Bavarian Alps, near some sites. The company was founded in 2001, by amongst others, the pilot Arne Wehrlin (bottom right). He is also very active in the development of exhibition tents as well as kites.
Photos: Skywalk

The all new Ozone Zeno in July 2016. Based in Provence, the development team, as well as part of Ozone's administration team, are close to some of the most famous sites in Europe, with their thermals and very strong winds.

This comes across in the wings sometimes too: there was a time when Ozone wings preferred windy take-offs.

The team paid a rare visit to managing director Mike Cavanagh in England (on the left in the photo) in the company's other administration offices. The weather isn't quite the same.
Photo: Ruth Jessop



In 1999, we were amongst the first to visit the little 'start-up' called Ozone in Gréolières and at the take-off above Gourdon. Bruce Goldsmith was still part of the initial team. Since then, the company has developed to become one of the leading makes on the market.
Below, the Ozone team in Texas: the cosmopolitan company includes numerous champions like Seiko Fukuoka and Charles Cazaux in its team.
Recently Honorin Hamard also joined Ozone. Photo: Nick Greece

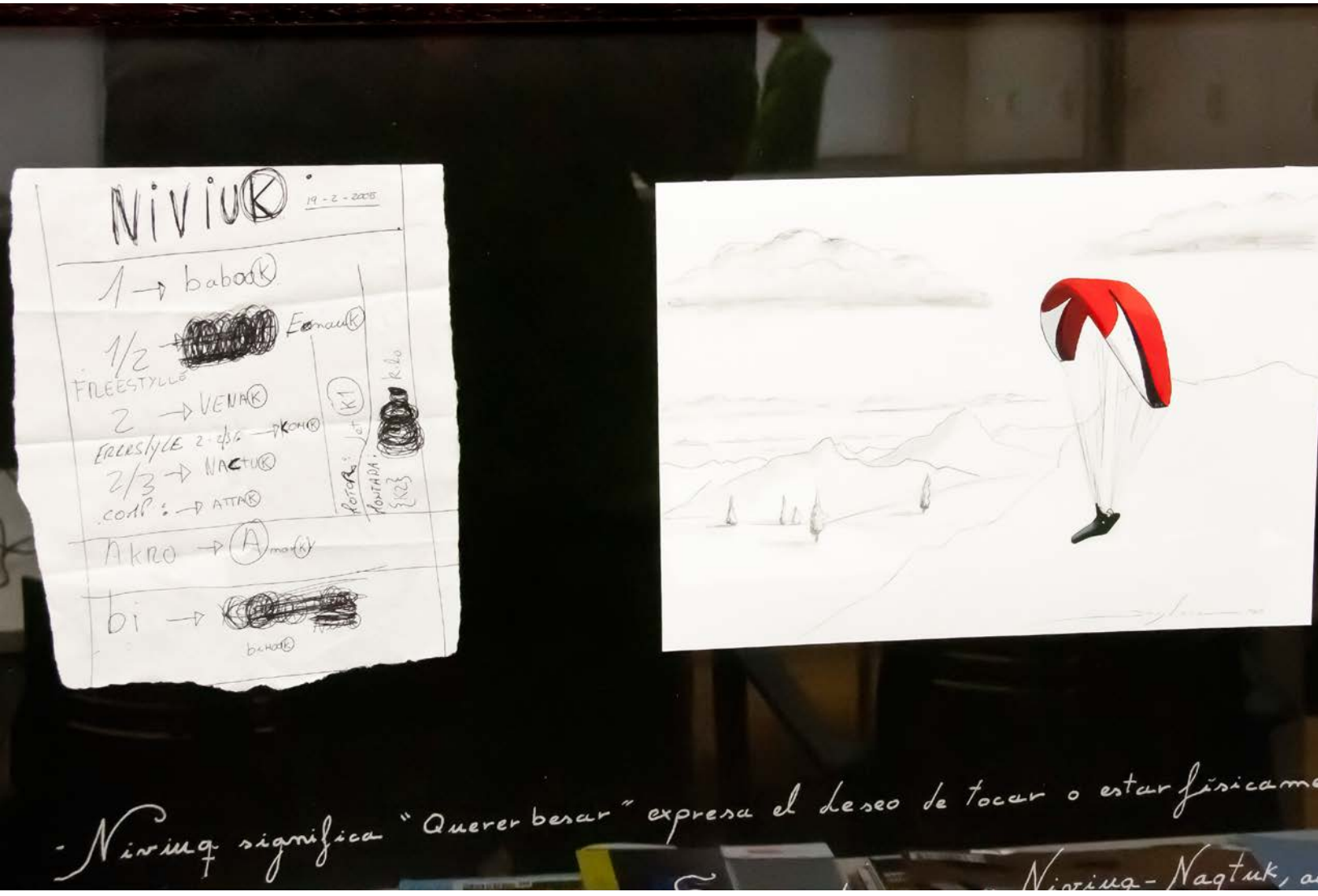
Unusual: Konrad Göry's company Kontest/ AirCross is based on a farm in Northern Germany. An original mix: Konrad always has to find the time when the land and the harvest beckon. Most of the time, he runs AirCross and Kontest. At least once a year, he tests the latest models during 400 km XCs in Brazil.

Niviuk's headquarters are in the Spanish Pyrenees, not far from Barcelona. This is where some of the 22 employees in Europe work, but the design work, for example, is run by Olivier Nef from their office in Switzerland.

The owner of Niviuk, Dominique Cizeau (photo on the right), is himself very cosmopolitan. Born in France with Viking origins, he settled with Niviuk in Spain after having worked in, amongst other things, marketing paragliders from Andorra.

Photos: Sascha Burkhardt

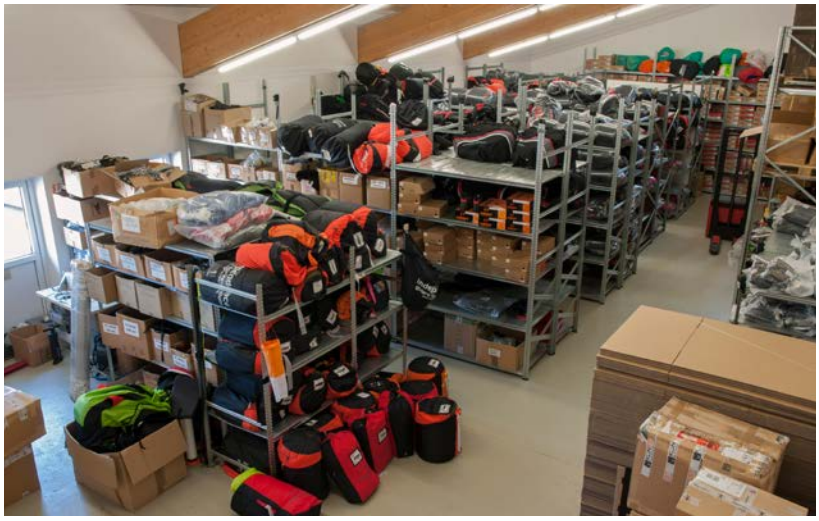
A major part of Niviuk's R&D takes place at Olivier Nef's in Switzerland, near Lac Leman and the site at Villeneuve. Ideal for testing the new N-Gravity which can be seen in this photo taken in June 2016... Olivier Nef (left) goes to Spain regularly to discuss the new models. Just above the office there is a small site. For more committing flights, sites like Organya and Ager are also very close.



Never forget your roots…Niviuk was launched in 2005, in the bar in a little Catalonian village. A few friends put their heads together and came up with different possible names. In the Inuit language, "Niviuk Naktuk" means the 'the devil is in the detail'. The company's work is discussed over tapas and beers within the walls of their new building, which was inaugurated in 2010. Right, co-founder Claudio Mena.

Independence and Skyman are run by Stefan Kurrle (right) at Eisenberg at the foot of the Bavarian Alps. The sites are close and their partner Markus Gründhammer (Skyman, left) obviously tests a lot at his stomping ground, the Stubai valley in Austria.

Stefan Kurrle started working with paragliders as soon as he left school and Markus is also one of the veterans: he was one of the first acrobatic pilots with André Bucher.



Part of the design is done by Anupe, a Sri Lankan computer specialist.

The Geronimo 2 by Independence. We've just received one to test. Watch this space...

Swing is based near Munich. Even if there aren't sites above their office, you can still see the Alps from the windows. When the new headquarters were being built, the owner, Günther Wörl made sure that the building had the theme of a paraglider.

Günther Wörl started paragliding in 1987, he bought the Swiss company Swing in 1994.

The designer Michael Nesler is now part of the development team.

Not really in Europe, but not far from a variety of sites, Apco, owned by Anatoly Cohn, is based in Israel. It's also a good region for paramotoring.

Nova is thirty minutes from Lac Achensee in Austria. This lets them test a prototype, like the Phantom in the photo and to make small changes the same day. (Photo: Mario Eder www.photography.aero).

This lake is also the preferred site for many other German and Austrian companies. Strong thermals, an aerology which is often turbulent and water for safety (Nova always have a boat on hand) make it a great playground for testing. This is also where competing companies often discover, and get a preview of, what the others are working on...

Bottom left, Nova's designer, Phillip Medicus.

Twenty years ago, Piotr Dudek (left) set up Dudek with Wojtek Domanski (right). Piotr Dudek did his first thermic flight on a parachute in 1987! In 1993, he took part in the World Championships on a home made wing. Wojtek Domanski was a computer specialist. Dudek is one of the pioneers in optimising manufacture by using computers.

Middle: Jean Baptiste Chandelier, who is part of the Dudek team and works on development. Dudek's birthday was fittingly celebrated near their head office in Poland. (Photo below).

Paramotoring is still the most important part of the range, but the free flying side is constantly growing. The prototype tests are initially done on a winch, then in France in the Alps.

All the companies in the plains have to travel frequently to the mountains to test their prototypes.

On some of the models by the Czech company Gradient, for example, a bit of the influence from flat land flying can be detected, with a very efficient flat turn.

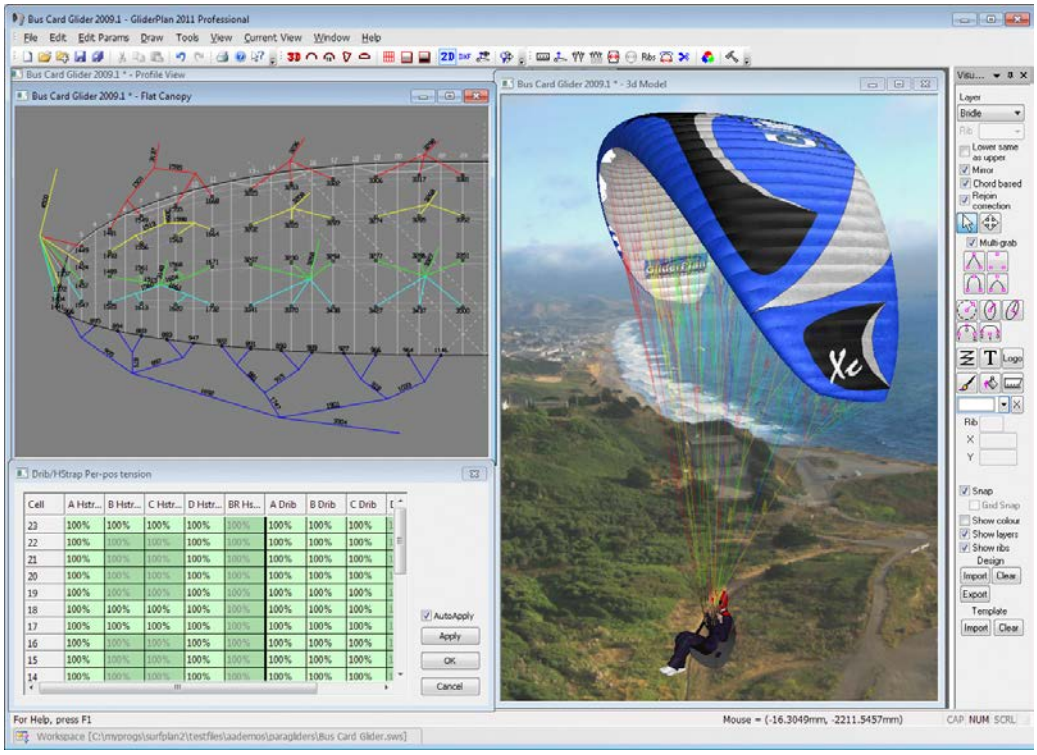
Dudek's 20th birthday party in Poland. Photo: Armin Appel

Photo:Jörg Maa

In Dudek's headquarters in Poland, a work of art by painter Włodek Bykowski. He's the one responsible for the new decorative design on the XX range, with the symbols for the four elements water, air, fire and earth all present.

Right, the Nucléon XX that we have on test.

Photo: Véronique Burkhardt



A screen shot of Gliderplan, software which is very popular for designing paragliders.

DIGITAL DESIGN

Our wings are always designed with lots of passion, by 'feel', by 'trial and error' and by prototyping. Even if computer science has evolved, the flexible fabric doesn't always follow suit…

Photo : Karen Skinner

If a paraglider was simply curved, but not flexible, and instead solid like a piece of wood, it would be very easy to simulate.

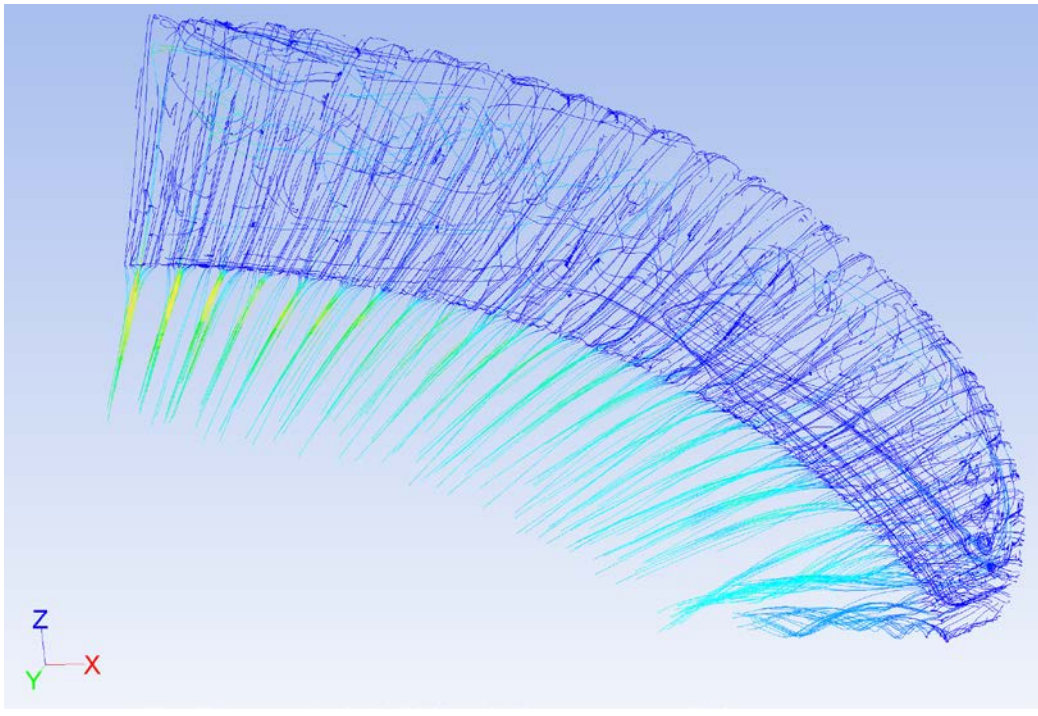
The paragliders remains a flexible aircraft, which is unpredictable: the internal pressure inflates the cells, transforming them into more or less distorted sausages. In addition, the whole wing expands and contracts like an accordion along the wingspan and even along the line of the chord, as can be easily seen on single skin wings.

The wing can twist too and the amount of deformity this causes depends on the stage of flight. In short, even if the aeronautical engineers know how to predict and calculate fairly precisely the behaviour of an Airbus prototype in a virtual wind tunnel such as a flight simulator, for paragliders, we're still a long way off.

Yet, decades ago, computer geniuses like Hannes Papesh started integrating CFD* into their designs to predict the airflow around the profile.

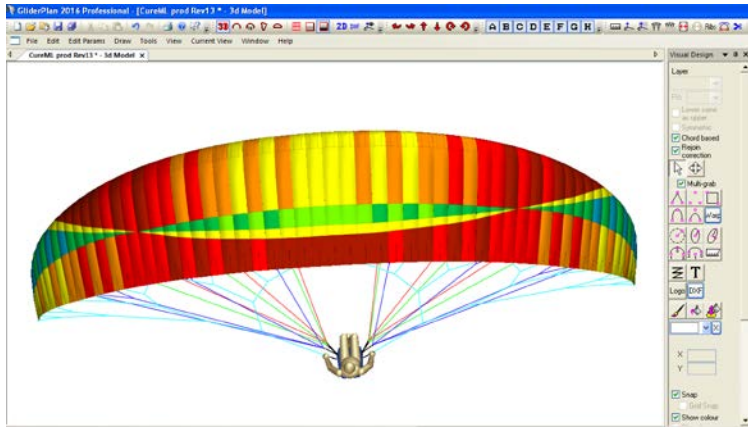
Or inside the profile, because our wings are also empty and therefore fill with circular turbulent currents of air. This works, but the torsions and the inflation of the cells makes predictions fairly imprecise. On the following pages you can see some photos and illustrations of what is involved in designing a paraglider...

An approximate simulation of the air currents inside a paraglider.

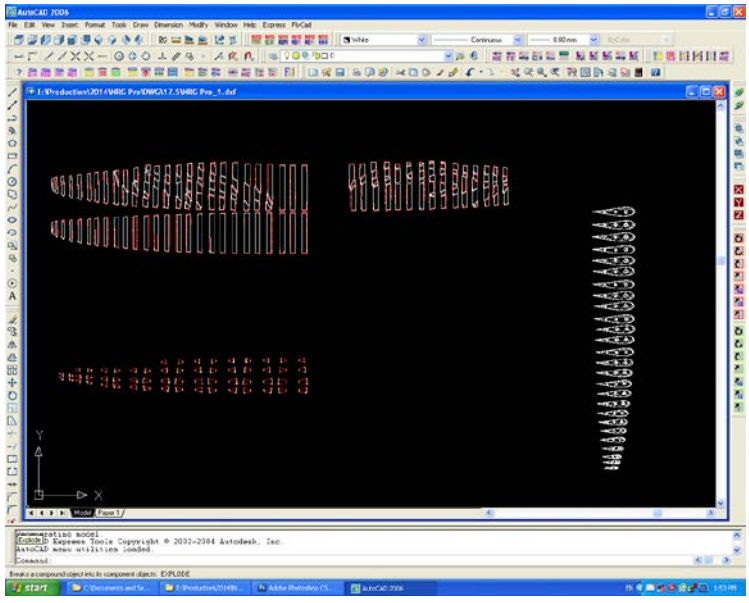


* Wikipedia: Computational fluid dynamics (CFD), involves studying the movement of a fluid or its effect, by the numerical solution of the equations governing the fluid.

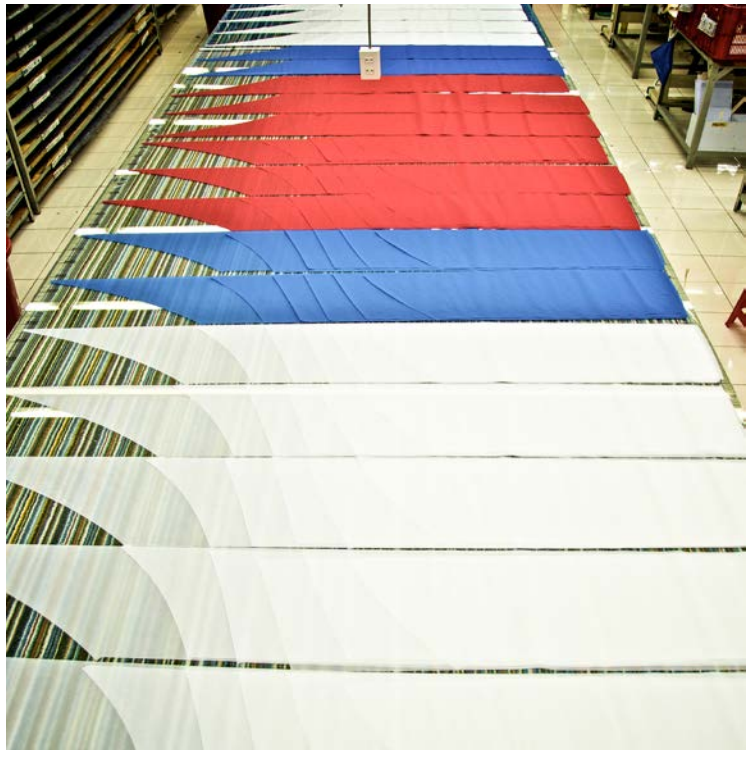
Applications such as Gliderplan are used by all the manufacturers. The designer enters parameters such as the profile used and the width of the cells and the software calculates a 3D visualisation of the wing, here at BDG.



It is then possible to look at each piece used in detail, as seen here at Apco.

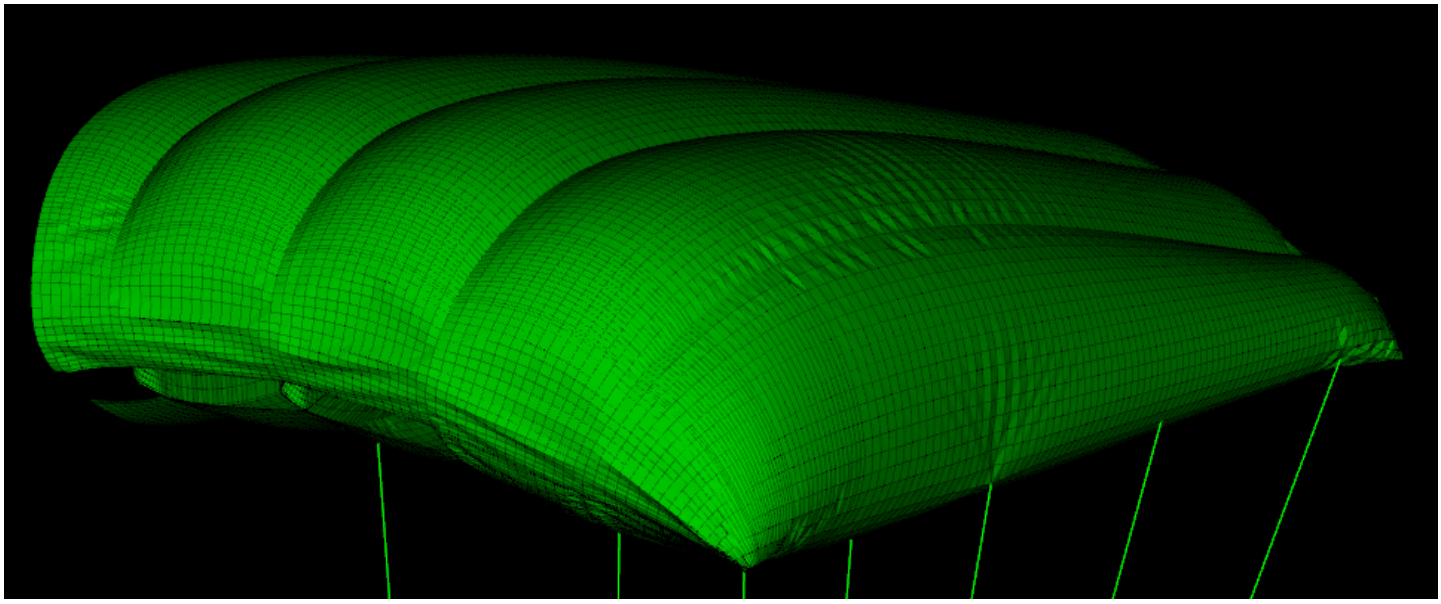


And cut them out, either by hand, or on a laser cutting table. (Photo Loren Cox/Ozone)

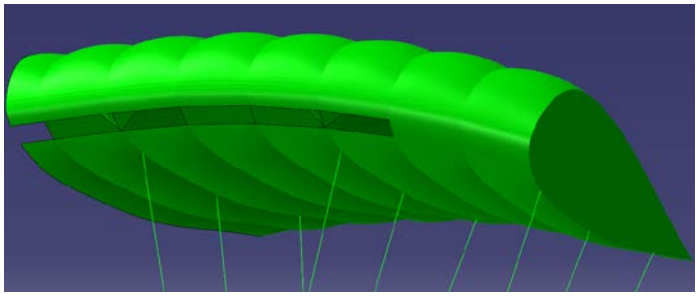


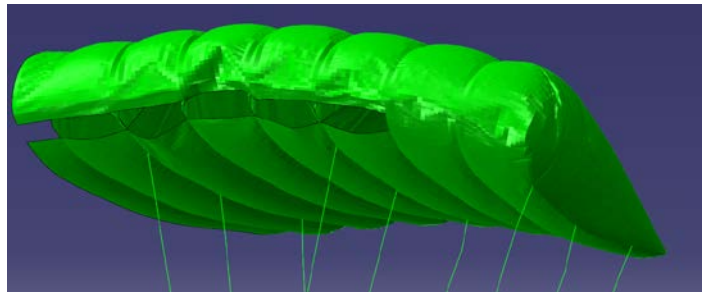
Computerised cutting at Woody Valley the harness manufacturer, using the same principle as for the paraglider profiles. (Photos: Woody Valley)

Previsualisation at Nervures (Photo: Nervures)



With CFD coupled with an FSI (Fluid-Structure Interaction) function, it's possible to calculate certain deformities in the fabric as a function of the airflow around and inside the flexible wing, but it still isn't possible to immediately recalculate the interaction of the deformities with the airflow. This loop is too processor intensive. Just for the calculation of the airflow around a paraglider at one angle of attack, requires four hours. Screen shot: Hannes Papesh/Advance



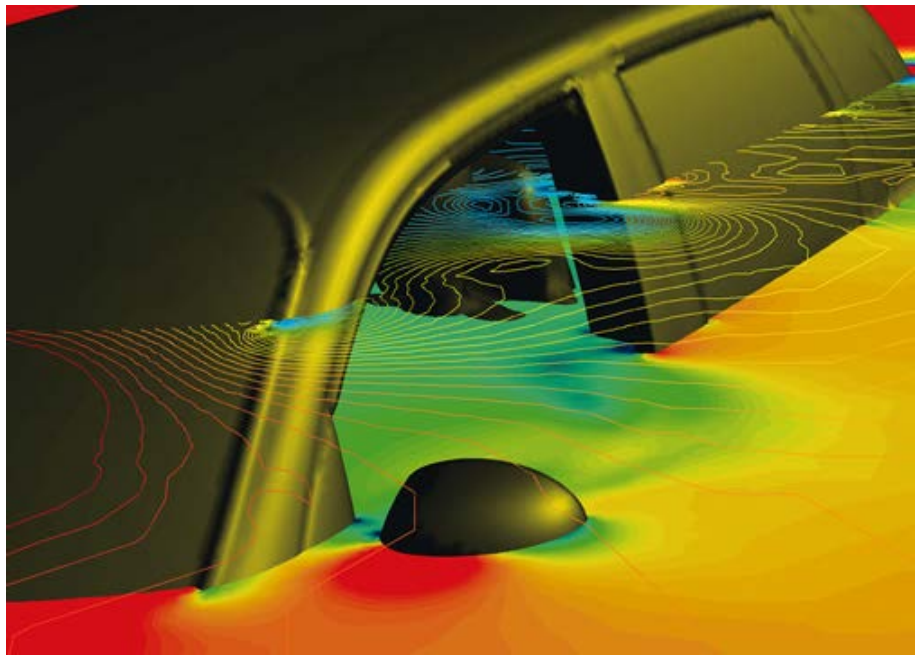


After four hours, it is therefore possible to know where the areas of stress are which aren't sufficiently supported by the structure and to simulate their deformations.
Then the designer works on the model, to get a better result.

Photo: Sascha Burkhardt

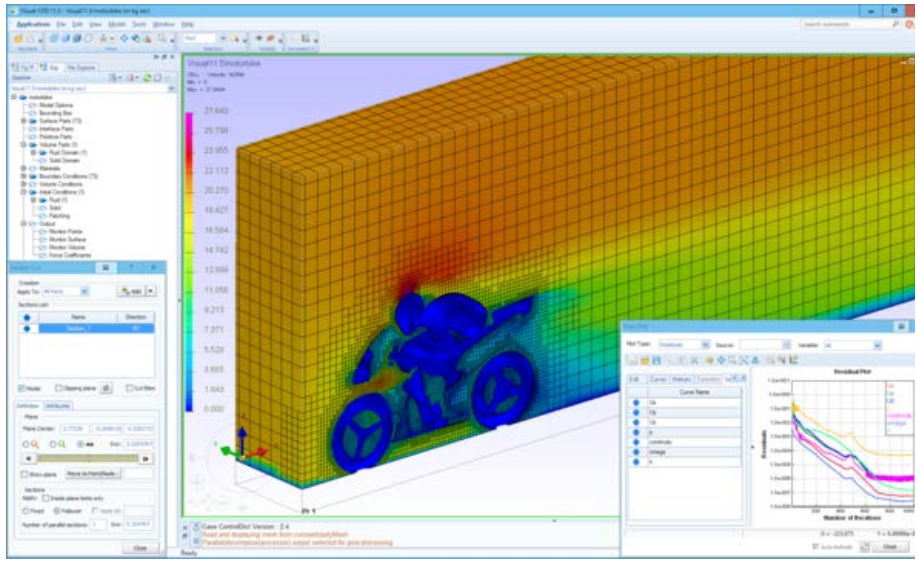
Hannes Papesh, cofounder of Nova and, for the last two years designer for Advance.

There are several tools which provide CFD/FSI in a price range of 15000 euros rental per year. (http://www.ansys.com/Products/Fluids/ANSYS-Fluent) all the way down to Open Source freeware such as OpenFoam. (http://www.openfoam.com/)



One of the difficulties is translating a 3D model obtained from software like Glideplan, or another CAD application, into a model accepted by CFD software. All around the model the 3D resolution must be finer and finer as the flow approaches the surfaces of the model. This is where Hannes Papesh became innovative in 2000, by programming automated links between these programs.

But he was very clear that '*CFD/FSI helps a lot during the design but we are still very far away from being able to simulate a paraglider as simply as we can a motorbike or an Airbus...*'



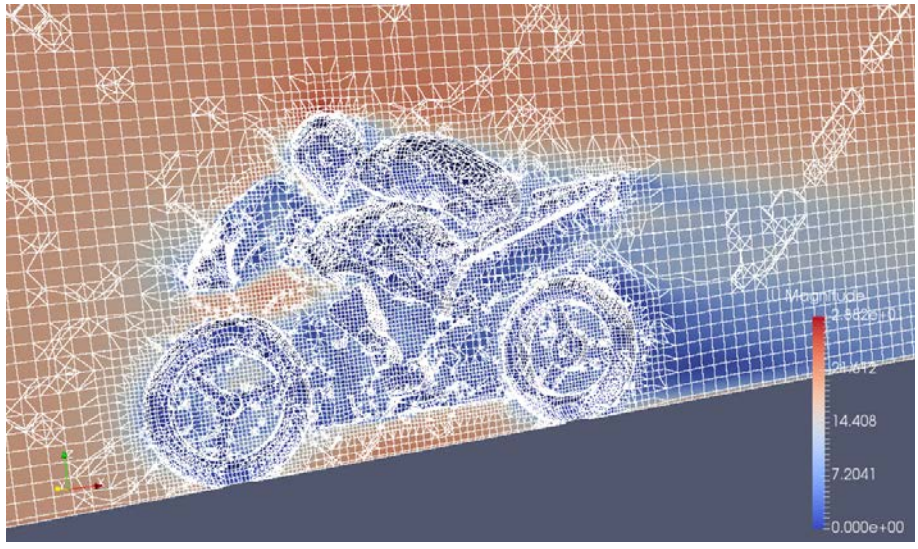


Photo : Karen Skinner

RAW MATERIALS: FABRICS

Photo : Sascha Burkhardt

The fabric is stored and sold on huge rolls.
This photo was taken at Porcher Sport in France.

The fabric is the primary raw material that goes into our dreams and adventures. Here's some information about its manufacture and the current trends.

Photo : Sascha Burkhardt

Increasingly frequently, the manufacturers mix Porcher with Domenico. On this Ozone Jumo, being tested at free.aero, you can recognise the Porcher Skytex 27 with its coarser mesh. The heavier (weighing about 34-35g/m2) Dominico N20D, in green here, is more fine.

For a long time, almost the only supplier of paragliding fabric was Porcher Sport near Lyon. Despite ephemeral competition from other manufacturers like Carrington, Toray and Sofileta as well as the still active South African Gelvenor, the French company held almost a monopoly until the arrival of the Korean company, Dominico Tex, a few years ago.

The more competitive prices created a minor rush towards this new supplier by manufacturers. Since then, some have come back, perhaps due to problems (real or imagined; the opinions diverge) of resistance to distortion. Others have made Dominico Tex their unique supplier (Independence and Skyman), whilst others like Ozone, focus on Dominico Tex for fabrics with a normal weight and complement it in a lighter weight with the legendary Porcher Skytex 27.

At the moment, many manufacturers use the relatively new Porcher Skytex 32 (g/m^2), a good compromise between Skytex 38 and the more fragile, Skytex 27.

Dominico Tex make Dokdo 20D (about 34-35 g/m^2) which seems to be a very good alternative and less expensive.

Porcher therefore still hold their own pretty well as far as very technical and ultra light fabric is concerned, and the company are even planning to launch a 21 g/m^2 fabric soon.

Photo: Y.Burkhardt, pilote:Sascha Burkhardt

The premises of Porcher Sport in the Rhone Alps in France

The manufacturer doesn't just produce fabric for paragliders (or spinnakers for yachts - nearly the same thing), but also the fabric for airbags or lighting balloons for construction sites.

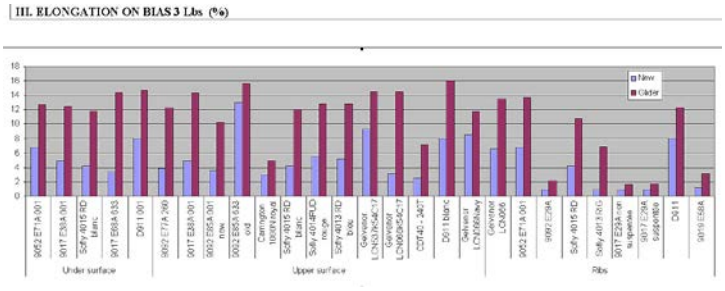
During weaving, the thread called the 'weft' is projected between the perpendicular warp threads, either with the aid of compressed air or with a jet of water!

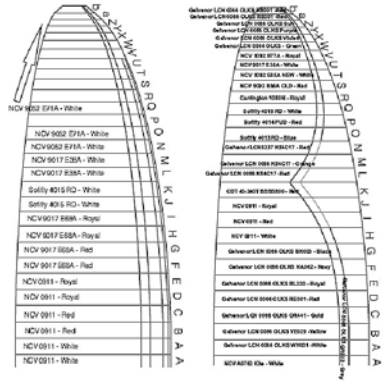
Photo : Sascha Burkhardt

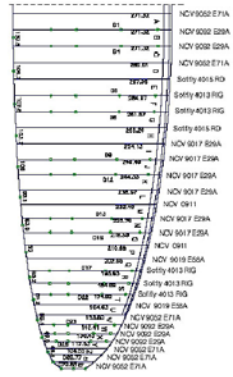
The base of all fabric is the thread. Tens of thousands must be tied manually in the loom. The lighter the fabric, the thinner and more technical the thread and the more you need. That's what, amongst other things, makes lightweight fabric expensive.

Photo : Sascha Burkhardt

Research work at Porcher: more than 10 years ago, a wing was made using all available types of fabric of the time and subjected to the climate on the Australian coast to evaluate the aging of each fabric.



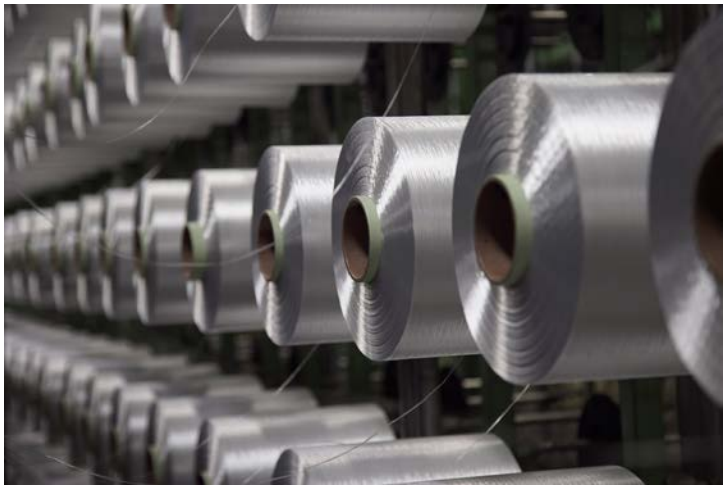




The coating is a mixture which the manufacturers keep a closely guarded secret. Depending on the requirements there are different finishes, for example, 'stiff' or 'universal'. The coating determines the qualities of the fabric.

Some coatings are made from silicone, for example those used by Gelvenor, and give a very silky feel to the fabric. A very stiff coating isn't necessarily better. It can make the fabric brittle. And according to the Trekking designer, Nicolas Brenneur, a fabric coated with silicone will be even less stable in the bias.

Photo : Sascha Burkhardt



It all starts with the thread, shown here at the Gelvenor factory, in South Africa.

Gelvenor supply Apco amongst others.

On the Skyman Cross Country, the Dominico Dokdo (10D and 20D) is very silky and nice, and it seems to be coated on both sides. Normally, a fabric is only coated on one side, which the manufacturers put inside the wing to protect the coating from abrasion.

The Dokdo 10D (weighing about 25g/m2) was, up until now, reserved for Skyman and Independence wings, but Ozone have announced that they will be using it for their future Ultralite 4.

For a reminder of our test of the Skyman Cross Country
http://free.aero/en/contentsHTML/Free_aero_Light_E_150/index.html?page=99

Photo: Véronique Burkhardt / voler.info

RAW MATERIALS: MAILLONS

A small, but very important part: the maillon which links our harnesses to the risers. A large part of the world's production is made by Peguet in Haute Savoie in France...

The maillon was invented in 1923 in Haute Savoie. It was just something to replace a broken link in the chain on an agricultural machine. On most paragliders, you'll find the original maillons made by Peguet in Annemasse, although the competition from Chinese products as well as Dyneema softlinks is being felt.

Photo : Sascha Burkhardt

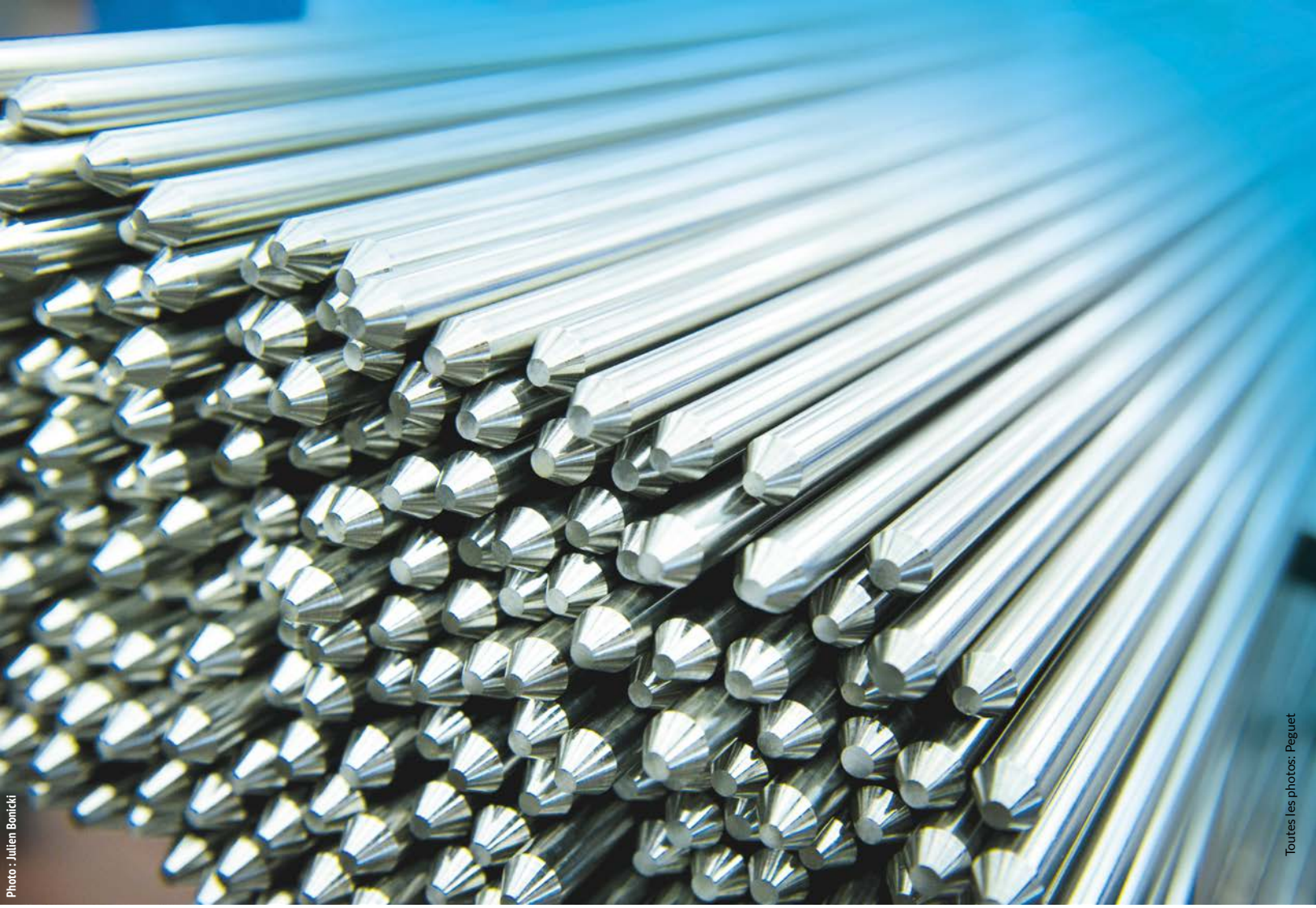
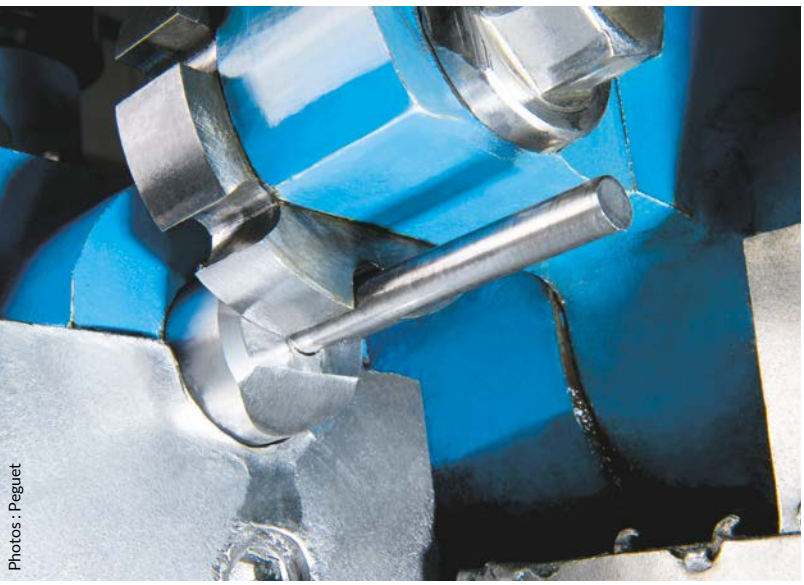


Photo : Julien Bonicki

Toutes les photos: Peguet

In the Peguet factory, the maillons are made from stainless-steel wire or rods...

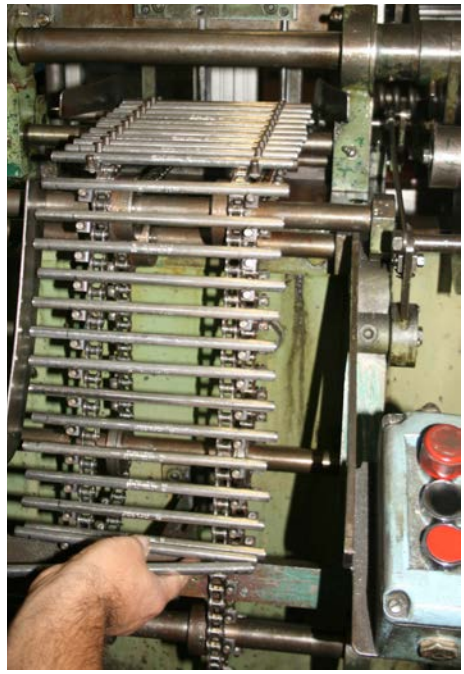


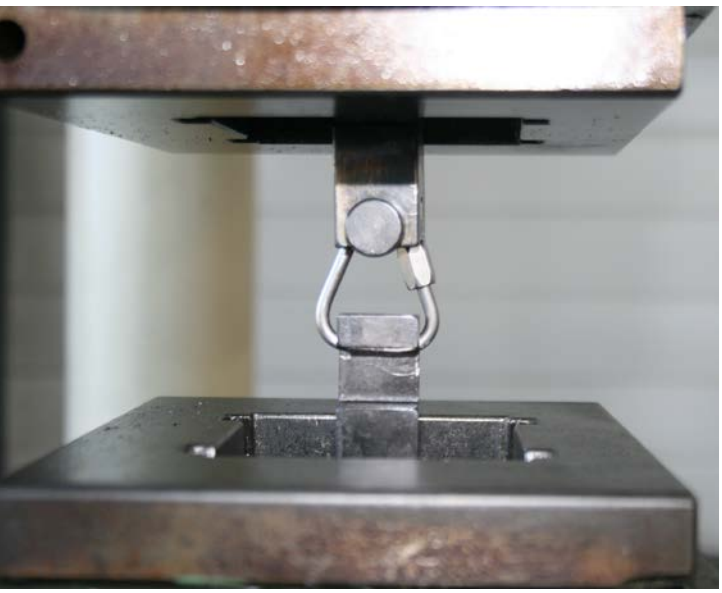
Photos : Peguet

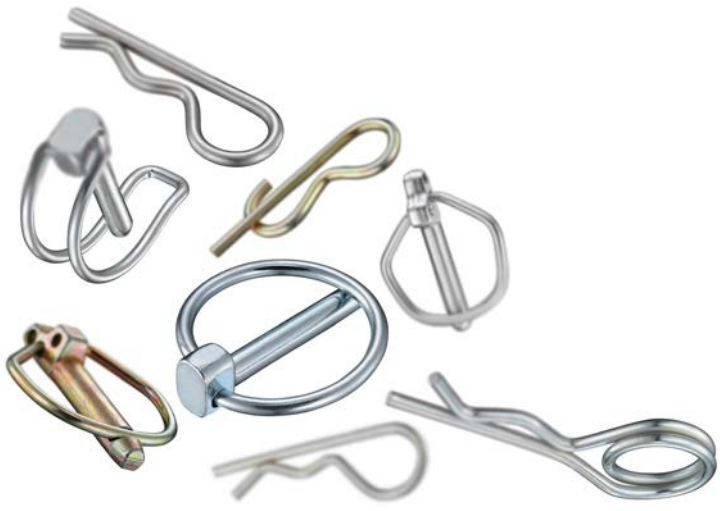
Here's a close-up look at how maillons are made: after cutting it to the required length (left), the rod is compressed longitudinally to increase the diameter in the threaded section. Then it is bent into the required shape.

Production requires a great deal of manual intervention. The strength of samples is regularly tested.

Peguet also produce other parts used in paramotors.







SIMOND

Another company, especially known by climbers, is beneath our wings when we fly at Chamonix: Simond, who make ropes and karabiners. In their team, there are fans of hike and fly who regularly roam the different peaks and glaciers, then fly off on ultralight wings like the Niviuk Skin Plume. We'll publish their advice on belaying techniques in an autumn edition.

Photos N&B: Caroline Houal photo@caroline-houal.com

RAW MATERIALS: LINES

Photo: Matthieu Colin

Photo : Edelrid

Above: in the Edelrid factory, the PES sheath is applied around the Aramid centre of this line. For the vast majority, no matter what the diameter and the type of fibre, whether Aramid or Dyneema, our lines are made by Liros, Edelrid or Cousin, all based in the heart of Europe.

The lines are often subjected to cycles of load and unload, especially in a manoeuvre like a wingover. Photo: Jérôme Maupoint/GIN

FIBRE COMPARISONS

The company Liros has published this comparison of fibres used for making ropes and lines. Although it comes from one of the competing manufacturers, it gives an idea of the advantages and disadvantages in general, of each fibre. For paragliders, Dyneema and Kevlar (Aramid) are mainly used, as well as, in smaller quantities, Vectran.

Technical and Chemical Specifications

Comparing Summary of Synthetic fibres

	Material							
	Polyamide (PA) 6 und 6.6	Polyester (PES)	High-tenacity Polypropylene multifilament (PP)	Polyethylene (PE)	High-tenacity Polyethylene (HMPE)	Aramid	LCP	PBO
Brand name	Perlon Nylon				Dyneema® Spectra®	Twaron® Kevlar® Technora®	Vectran®	Zylon®
Yarn strength (cN/dtex)	7 – 8	7 – 8.4	ca. 7	ca. 4.5	28 – 38	20 – 25	22 – 25	ca. 37
Specific gravity (kg/dm³)	1.14	1.38	0.91	0.96	0.96	1.44	1.41	1.52
Strength loss due to humidity %	5 – 10	0	0	0	0	0	0	0
Water absorption %	1 – 7	0.5 – 2	0	0	0	2 – 5	1	0.6
Knot tenacity %	60 – 65	55 – 60	55 - 65	50 – 60	35 – 50	30 – 40	30 – 35	35 – 55
Light resistance %	good	very good	only good when quipped	good	good	poor	poor	poor
Breaking stretch %	16 – 27	10 – 16	12 – 20	15 – 30	3,8	2 – 4	3,3	2,5
Abrasion resistance	very good	very good	fair	fair	good	adequate	good	poor

Photos: Reinhard Feldrapp/Liros

Liros was founded in about 1850 and specialised in ropes for tethering cattle. Today, Liros produces many types of technical and sports ropes. All paraglider lines are made in Germany.

Photos: Reinhard Feldrapp/Liros

Liros use all the usual fibres for paraglider lines, except for Vectran.

Photo: Reinhard Feldrapp

The French company Cousin had to recently cope with a big fire at their manufacturing premises but, despite this setback, Cousin remain one of the main suppliers for paraglider lines. Below, producing a Dyneema cord.

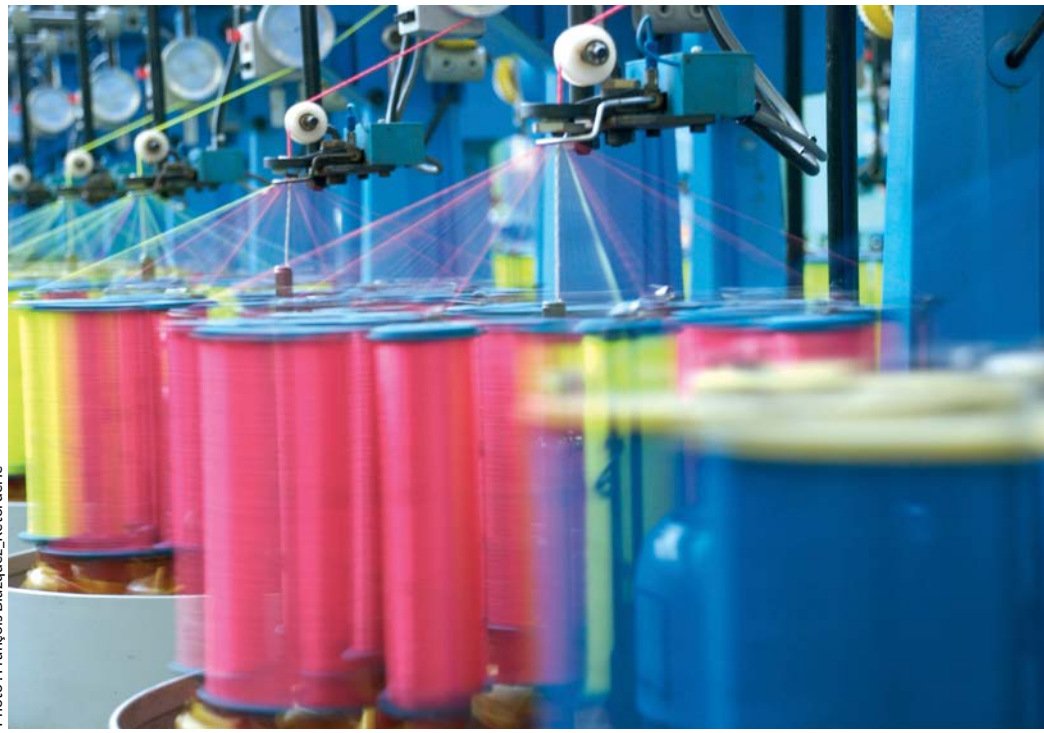


Photo : François Blazquez_Retorderie

Photo : François Blazquez_Retorderie

The company Edelrid is well known and active in the climbing world. All the lines produced for paragliders are made in Germany.

Photos : Edelrid

Aramid is more sensitive to abrasion. Here, a protective sheath is applied.

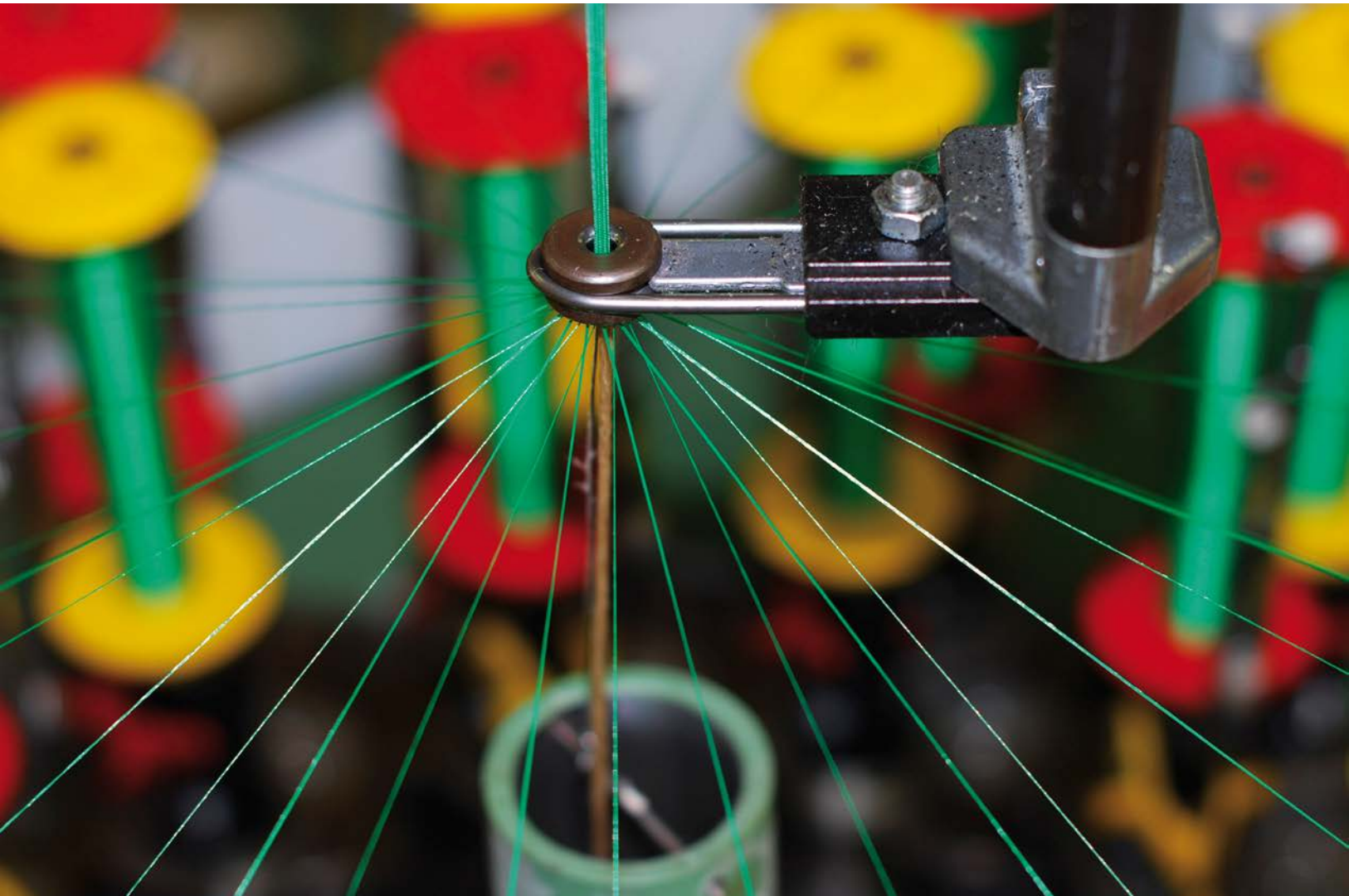


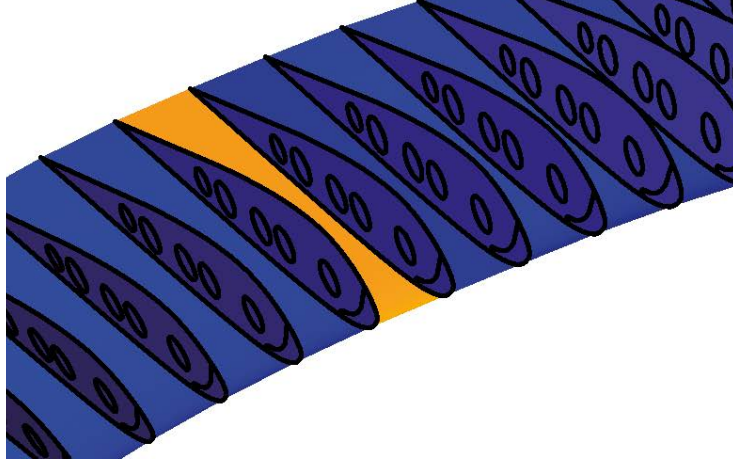
Photo : Tristan Shu

THE PARTS OF A PARAGLIDER WING

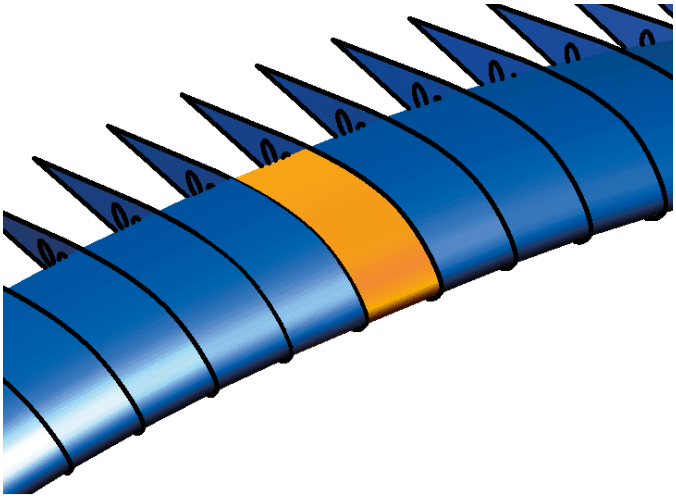
Numerous elements make up a modern paraglider: different fabrics make up the surfaces and also the reinforcements. Other components like the rods are added and bent into innovative shapes to improve safety and performance. Here's a review of the important parts of the wing as well as the technology used.

LOWER SURFACE

The fabric for the lower surface is relatively unstressed in the air and on the ground so lighter fabric can be chosen with a classic coating. This is where 27 g/m^2, 32 g/m^2 or 35 g/m^2 is often found.



The lower surface of this Yeti 4 is in Skytex 27. Photo: Jérôme Maupoint/GIN



UPPER LEADING EDGE

This is the area where the maximum aerodynamic and mechanical forces such as the tension on the arc, are applied. Here, each deformity decreases the performance and aging is most significant. As a consequence, fabric which is thicker and more resistant is used.

On this Ozone LM6, the front part of the upper surface is in Dominico N20D which weighs about 34-35g/m^2. The rest is in Skytex 27g/m^2. Photo: Loren Cox/Ozone

3D-SHAPING

To further increase the rigidity of the leading edge and prevent it ballooning (each cell inflating in a sausage shape), this part can be made from several pieces with carefully placed stitching. Since 2013, almost all the manufacturers have used this technology and they each have their own name and technique for it.

The leading edge on the Skywalk Chili 4. The 2 rows of stitching along the wingspan represent the Double 3D-Shaping. On this prototype, the extra stitching placed above the openings and oriented in the same direction as the cells could have been part of a 3D-Shaping strategy. But in the end, turned out not to be necessary. Photo: Tristan Shu/Skywalk

Progression EN/LTF A

KOYOT 3

Adventurer-to-be

Flying is in you. Now it is the time to take off and finally enjoy the magic of surfing the sky. The Koyot 3 is a simple and emotive glider for any new adventurer to discover. It is the ideal partner for leisurely flights.

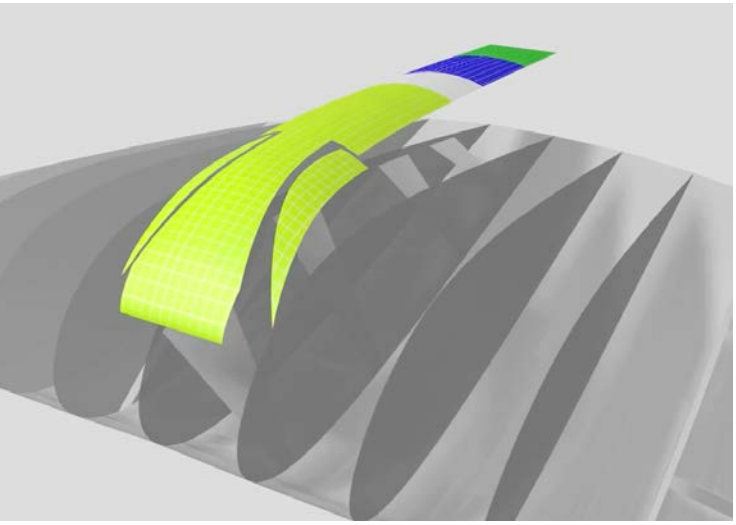
niviuk.com

3D-SHAPING

At Niviuk, they call 3D-Shaping "3DL", which is just another name for the same technique. In this photo of the Ikuma, you can see the effect of a single line of stitching; it visibly reduces the ballooning effect on each cell.

Niviuk added yet another technique which they call "3DP". It involves orientating the pieces of fabric very precisely as a function of the direction of the fibres (warp/weft), to obtain the minimum elastic deformity. Photo: Véronique Burkhardt

Here's a reminder of our test of the Ikuma:
http://www.free.aero/en/contentsHTML/Trends-E-150/index.html?page=77



3D-SHAPING: CCB

Bruce Goldsmith's CCB is another form of 3D-Shaping. The illustration showing the panels helps us to understand how 3D-Shaping, in general, prevents ballooning.

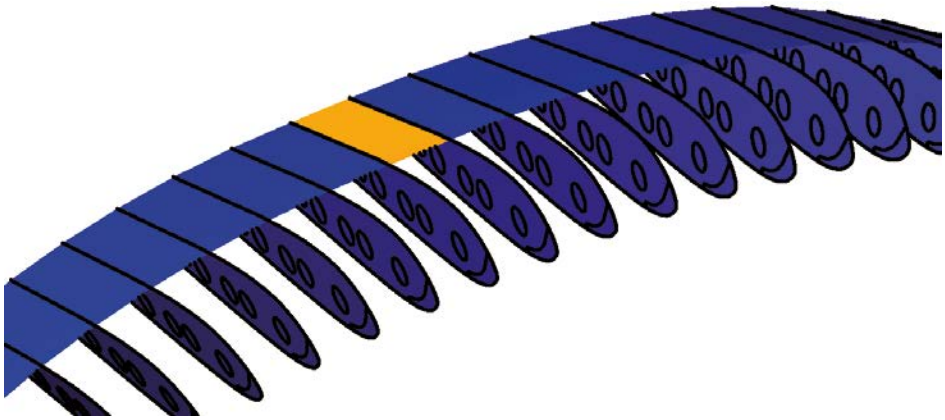
Efficient 3D-Shaping doesn't just increase the performance, but also the stability of the wing in terms of its flyable limits.

When testing the BGD Cure for free.aero, Cédric Nieddu particularly noted the efficiency of the leading edge. Reread the test here: http://en.free.aero/contentsHTML/Season2016/?page=65
Photo: Cédric Nieddu.

3D-SHAPING: THE TRAILING EDGE

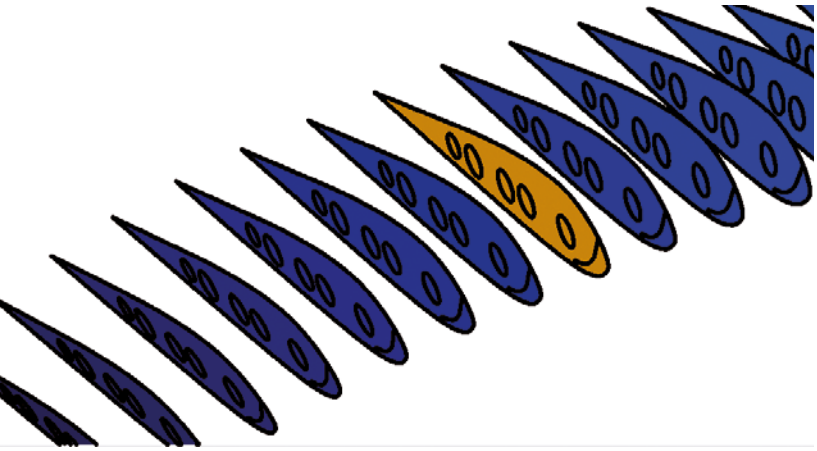
On the Swing Mito, the designer Michael Nesler added 3D-Shaping to the trailing edge. The stitching along the wingspan can be seen in this photo. Together with the Mini-Ribs, this technique allows the trailing edge to be optimised. Some manufacturers also add 3D-Shaping to the lower surface.
Photo: Véronique Burkhardt

Reread the Swing Mito test:
http://en.free.aero/contentsHTML/Season2016/?page=71



UPPER TRAILING EDGE

In the air, this part is a little less stressed and can be made from lighter fabric. However this area nevertheless suffers abrasion on the ground. For beginner and school wings, thicker fabric is therefore used with a more resistant coating than for a top of the range wing.



RIBS

The ribs give the profile its shape and maintain it. They are an essential part of a paraglider. Before, relatively heavy, rigid fabric was often used. Now, this area has been lightened as well. The Gradient Denali in this photo is made entirely from Skytex 32 including the ribs which can be seen through the surface.

The difference is in the coating: the finish is stiffer on the ribs, whilst the upper and lower surfaces are just universal 32 g/m².

Quick test of the Gradient Denali:
http://free.aero/en/contentsHTML/Free_aero_Light_E_150/index.html?page=103

On the ribs, the forces from the lines are often taken up by this type of attachment. Here, on the ribs of an Ozone Ultralite 3 in Skytex 27 fabric with a 'Hard' finish.
Report on the Ultralite 3 in free.aero.:
http://free.aero/en/contentsHTML/Free_aero_Light_E_150/index.html?page=96

Photo : Véronique Burkhardt

Photo : Sascha Burkhardt

Today, the ribs are more and more open to save weight: above, the inside of the Nova Ion 3 light. This doesn't stop it from keeping its profile very well and having very good performance. (Ion 3 light test in free.aero http://free.aero/en/contentsHTML/Free_aero_Light_E_150/index.html?page=111

Below, a model of the ribs on an Ion 4.

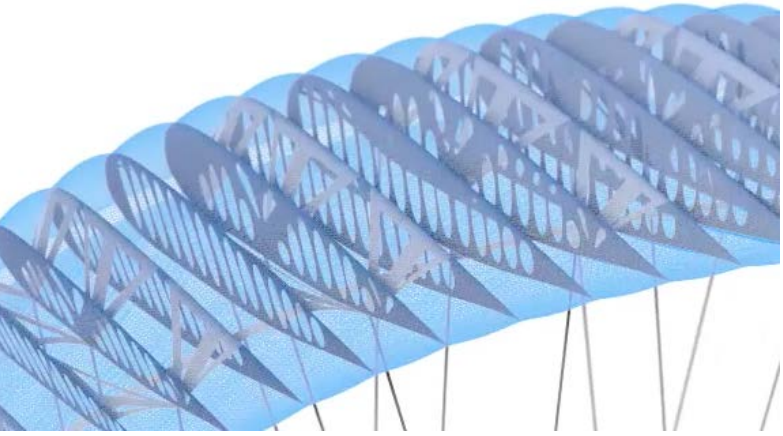
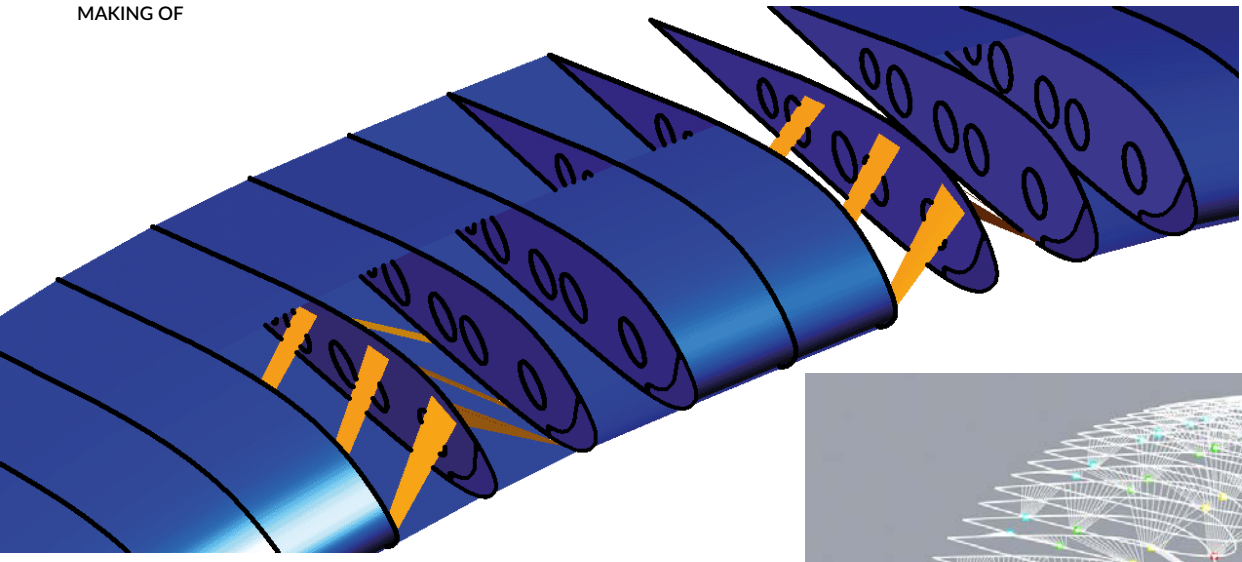
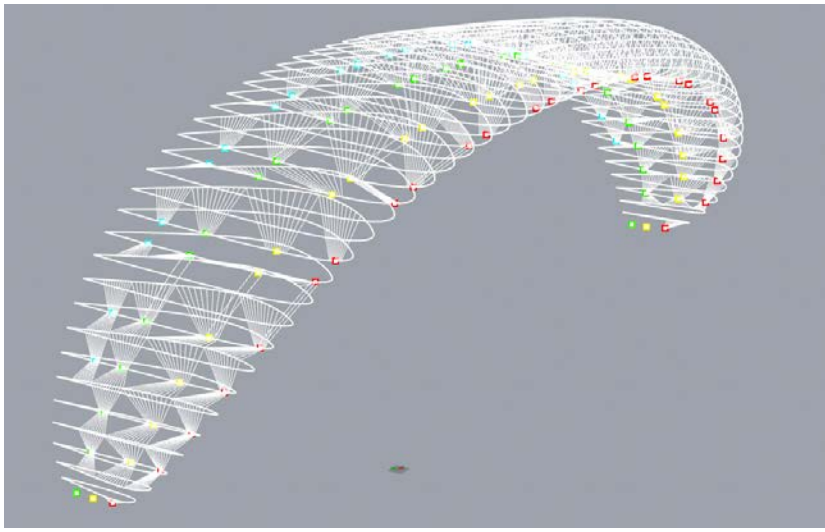


Photo : V. Burkhardt





DIAGONAL RIBS

The diagonal ribs maintain the stability and the geometry of the wing. They support the upper surface on the ribs which don't have lines, and thus reduce the overall number of drag-generating lines.

An example of ribs: above on the diagram of a Trekking Senso, below a Trekking Senso Sport flying. The diagonal ribs are essential for the stability of the wing.

Photo : V. Burkhardt

A reminder of the Senso Sport test: http://en.free.aero/media/Test-senso-sport-E.pdf

Nova's Needle-Eye-Ribs add more sophistication to the diagonals; they go through a rib via a hole so that they can work across the width of two cells. They are heavily used in the new Phantom wing: 804 Needle-Eye-Ribs cross the 99 cells...

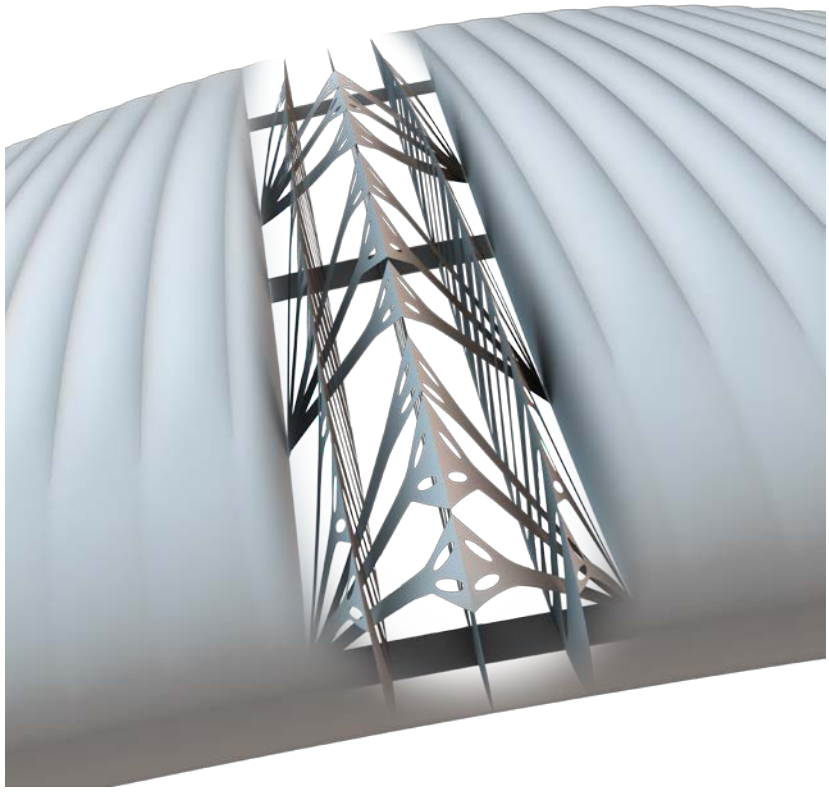
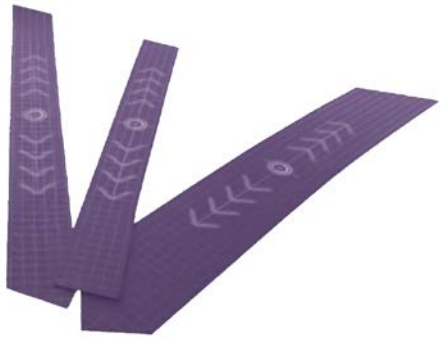
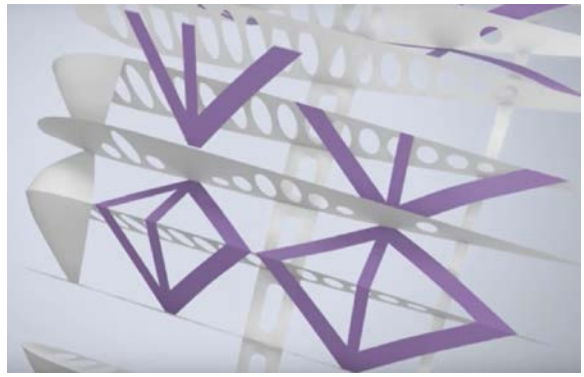


Photo : Nova

Photo: Sascha Burkhardt





Another new way of constructing the diagonals: on the Omega X-Alps, the Pi2 (photos) as well as on the Epsilon 8, the "sliced diagonals" are cut in fine strips along the straight grain of the fabric and not across the bias so as to give better strength.

In addition, the anchor points are made from three layers of fabric rather than just one.

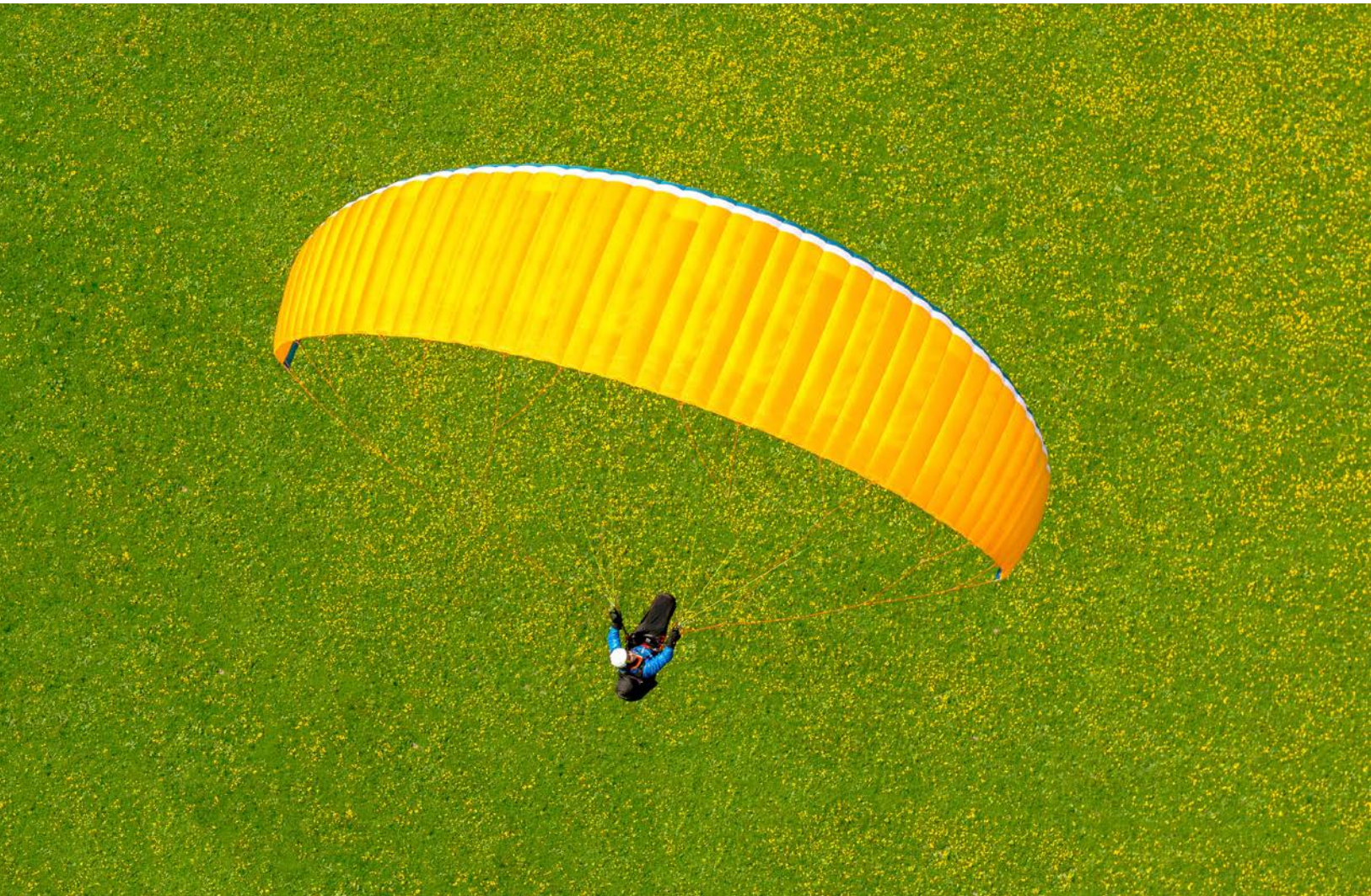
Photo: Andreas Busslinger

SMART CELLS

New technology used by Nova: the cells aren't the same width; their size depends on their position and the way the cell is connected to the lines. It's more complicated to manufacture, but no doubt efficient.

Photos: Sascha Burkhardt

Photo: Mario Eder www.photography.aero



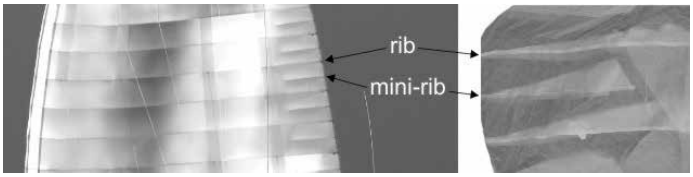


Photo: Dudek

MINI RIBS

It isn't just the leading edge which counts. The manufacturers realised that the trailing edge is also an important factor for the performance and the coherence of a wing.

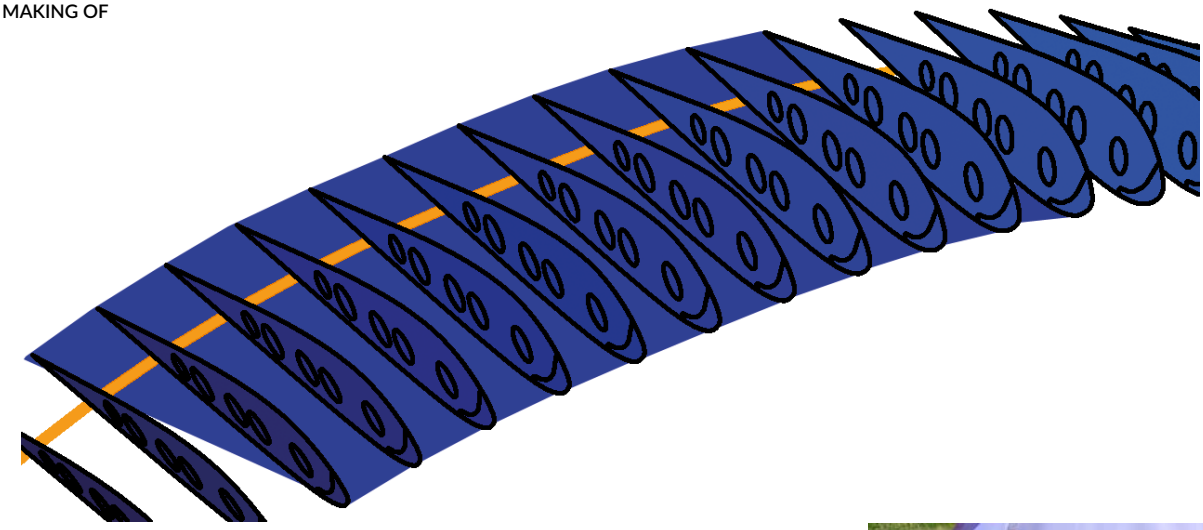
The mini ribs reduce the ballooning in the trailing edge, and thus improve the glide at high speed.

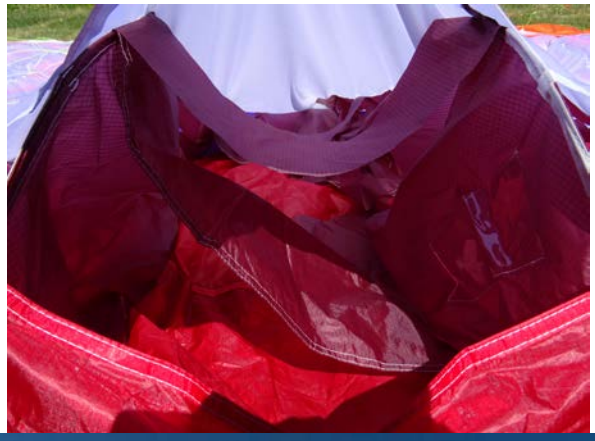
On some wings, the manufacturer Air Design uses a sewing technique called "Razor Edge" to replace the mini ribs. The trailing edge becomes very fine at the end.

Photo: Tristan Shu / Skywalk

Photo: Niviuk

Photo: Niviuk





A tension band and a diagonal in an Independence Zippy.

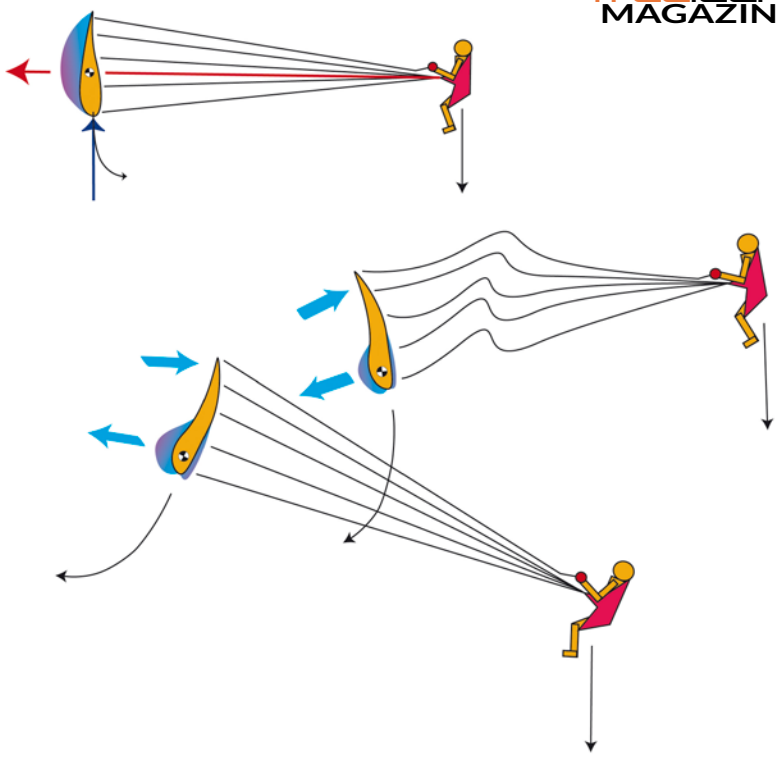
TENSION BANDS

The bands of fabric parallel to the lower surface maintain the wing's stability. Often, these bands are above or near the anchor points for the lines, whether at the front or the back, and prevent creases forming, especially when braking and accelerating.

Photo: Dudek

Sometimes the bands are thinner as on this U-Turn Blacklight.
Photo: Véronique Burkhardt /voler.info

REFLEX PROFILE



For about twelve years another type of technology has increased the speed of wings: the auto stable or reflex profile with an S shaped curve (the camber line of the profile goes up at the back). Mike Campbell-Jones from Paramania is primarily considered as the pioneer of 'full reflex' in paramotoring. Dudek followed in his footsteps and then the majority of other manufacturers integrated this type of profile into their paramotor models. For two years manufacturers have successfully combined reflex and SharkNose profiles (see further on).

A reminder: Reflex or 'auto stable' profiles have the characteristic that their centre of effort only moves very slightly and, contrary to a classic profile, they 'auto regulate'; if the angle of attack decreases, the reflex profile opposes it by pitching backwards. If the angle of attack increases too much, it dives. Put simply, they can be compared to a weather vane which constantly orientates itself according to the wind direction.

This type of profile doesn't necessarily give a lower pre-collapse angle of attack than a classic profile would, but the manufacturer can trim the wing nearer to the critical angle of attack, as the wing will hardly pass the expected angle, whilst a classic profile needs to be trimmed with more margin.
The reflex wing can therefore go faster: with trimmers open and using the foot accelerator, 60 km/h - 65 km/h can be achieved on most 'full reflex' models.

It's impressive to note to what extent these profiles seem 'uncollapsable'. But they have more drag and therefore have less performance and so are less adapted to thermic flying and use more fuel when paramotoring.

The Kougar 2 was one of the first wings to cross a reflex profile with a SharkNose.

REINFORCEMENTS IN THE LEADING EDGE

They keep the air intakes open during inflation and maintain the shape of the profile in this area which comes under a lot of pressure in flight. For a long time the reinforcements were made from Dacron or other fabrics which were very stiff and heavy.

Since leading edge rods became common, almost all manufacturers have reduced the amount of stiff fabric used such as Mylar or Dacron.

But as a general rule, the reinforcements in Mylar or Dacron have been additional to the rods or have been completely replaced by them.

Photo: Sascha Burkhardt

RODS

Even back in 1999, some competitors reinforced their leading edges with nylon wires. And on some production gliders, they used the same wire that is used on a strimmer. These pieces of wire are very strong and can be inserted into a fabric sleeve thus holding it in shape. The big advantage is their light weight. On the other hand, some rods can go out of shape, to such an extent that they change the behaviour of the wing. When a servicing workshop takes a rod out of its sleeve, it must be either straight or in the shape of the sleeve, but never totally bent, which is sometimes the case. Moreover, without rods, very lightweight wings, Single Skins and those with SharkNose profiles would be scarcely possible.

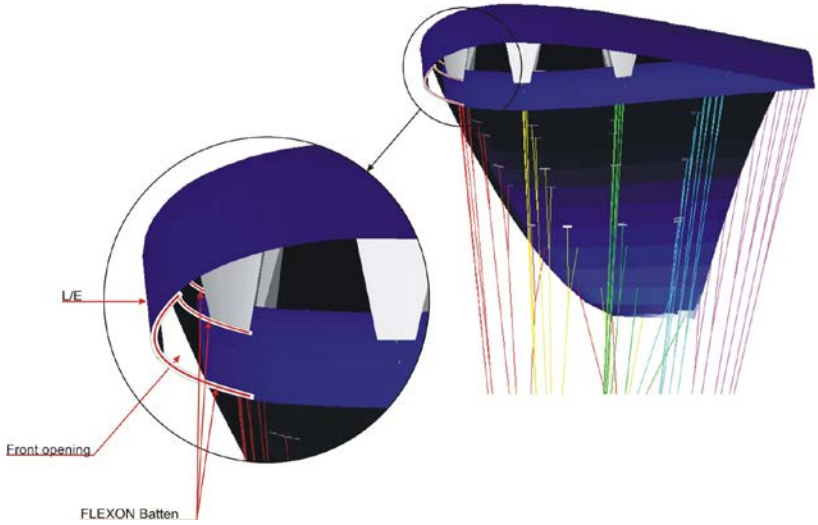
Photo: Jérome Maupoint /GIN

A rod about to be inserted into a wing at the Gin factory in Korea. Photo: Jérôme Maupoint/GIN
Rods have become ubiquitous. Photo below.: Photo : http://albarsark.com/wordpress

This type of 'orange' rod, chosen by Nova, here on the Ion 3 light, withstands being folded. Photo: S. Burkhardt

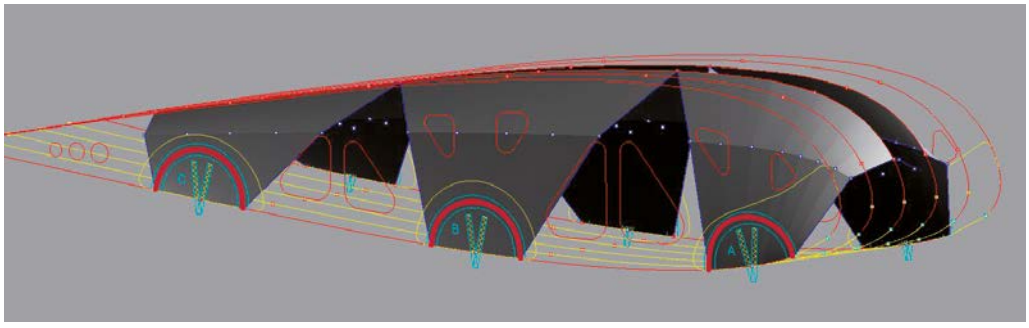
Without rods, SharkNose profiles would hardly be possible. This photo shows the nose of a Swing Mito. Photo: S. Burkhardt

Making inflation quicker: the leading edge rods on an Air Design Ramaflex. Photo: S. Burkhardt

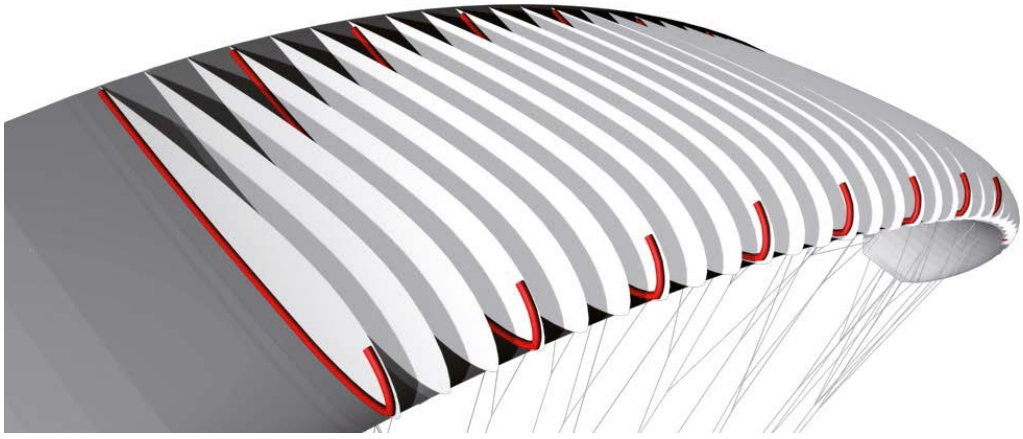


In 2002, Apco were already using 'Flexon Battens' on the Keara.

For the 'C-Wire' strengtheners in the upper surface, above the anchors for the Cs, nylon rods are also used.



One of the precursors to rods: the designer Gibus placed them around the anchor points on the AirCross U3.



Very quickly, the manufacturers using rods covered the whole lower surface on the very top of the range wings like this Icepeak 3.

NITINOL RODS

Nitinol is an alloy of nickel and titanium in approximately equal parts. This alloy has properties which are very useful for replacing nylon rods. It is relatively light and has a very good shape memory.
When you change the shape of a rod in this way, it goes back to its original shape. Remember that certain plastic rods can change shape under duress, and from then on, they give the profile a shape which wasn't the one intended by the manufacturer.

The disadvantage of Nitinol is that it's very expensive. The designer and Nitinol pioneer Michael Nesler explains: '*The additional cost depends a lot on where the materials come from! For a competition wing with many cells, the cost of the PVC rods is about five euros and in nylon (Polyamide 6.6) about 15 euros. When made from Chinese Nitinol, the rods add up to about 200 euros, and if German Nitinol is used, they cost about 350 euros.*'

A big roll of Nitinol at the Niviuk headquarters: although it's expensive, this material is becoming popular with the Spanish manufacturer.
Photos: Sascha Burkhardt

Nitinol no doubt contributes towards the Niviuk Skin and the Skin Plume's very good performance. For a reminder of our test: http://free.aero/en/contentsHTML/Free_aero_Light_E_150/index.html?page=35

Photo : Sascha Burkhardt

In 2013 the first Nitinol rods on production wings were launched at the Coupe Icare. Photo: Sascha Burkhardt

SHARKNOSE

The SharkNose has no doubt been the most successful feature introduced recently. Launched in its current version by Ozone in 2010-2011, it is now present on a very large number of models from almost all manufacturers.

Different manufacturers give it different names. Normally the SharkNose is part of a larger concept. It isn't enough to change just the nose; lots of parameters need to follow.

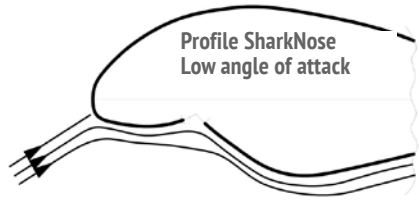
At Niviuk the system is called the RAM Air Intake, at GIN, EPT (Equalized Pressure Technology), at Advance, the Air Scoop, at 777, BPI (Back Positioned Intake)...

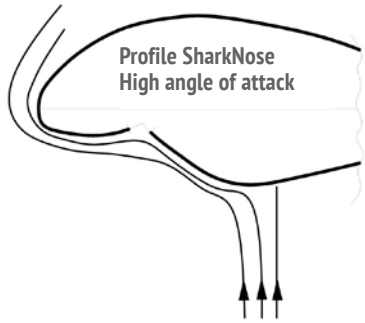
The SharkNose maintains the internal pressure better across the whole range of angles of attack. Put simply, whether flying slow or fast, the inside of the wing is always 'as well inflated' (or almost).

There are many advantages:

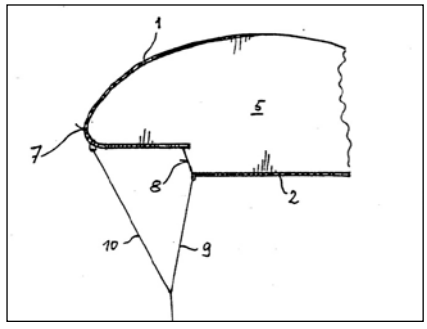
- An increase in the range of usable speeds.
- Low speeds are therefore also safer (good for all wings, including those for beginners!)
- The travel in the controls is increased.
- The tendency to go negative is reduced.
- The stability at high speed is better.
- Inflation is perhaps easier.

On the other hand, some pilots like our colleague Cédric Nieddu, consider that it was following the introduction of this technology at all levels, that turning started to change: slightly steeper initially after applying the brake.





In 1989, the German Gernot Leibe registered the invention of a Haifischmaul 'Shark's mouth'. Only at first glance does it look like a SharkNose. In reality, due to its lack of concave shapes, it functions differently, at high angles of attack, for example.



In November 2010, Luc Armant displaying and supervising the manufacture of Ozone's first SharkNoses in the Vietnamese factory.

Photo: Loren Cox / Ozone

We explained all the SharkNose technology in detail in our January 2014 edition:
http://www.free.aero/en/media/sharknose-E.pdf

A nice SharkNose on the GIN Sprint 3 which we are currently testing. The rods crossing one another is necessary: The two rods need to have a certain amount of curvature to provide sufficient force.

Photos : Sascha Burkhardt

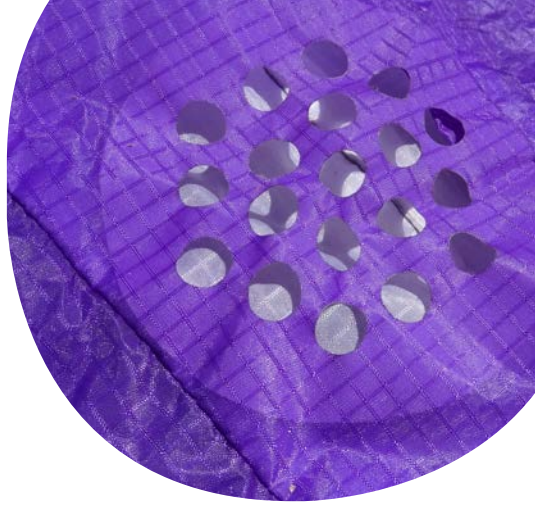
Photo: Jérome Maupoint /GIN

SWING MINOA

The Swing Minoa in 1993 had lots of the features of modern wings. The nose even resembled a SharkNose, although different from an Ozone SharkNose. One of the most surprising inventions was the addition of an extra skin above the stitching between the cells. This greatly reduced ballooning: Prehistoric 3D-Shaping!

The Minoa also had the first system for braking which worked by differentiating the stabilos from the trailing edge, well before reflex paramotor wings.

Ground handling a museum piece that we acquired. Clearly a wing that was ahead of its time, but not sufficiently so to sweep the podiums back then. And not very nice during inflation and take off. Photo: Véronique Burkhardt



An opening on the upper surface feeds the space between the extra skin and the upper surface above.

Two brake lines for one handle: one line goes to the trailing edge, the other to the stabilo...

Above each rib there is a real little extra cell.

Extra bands and tension folds: a prehistoric wing, but also a precursor. The fold under the opening could be considered as 3D-Shaping twenty years ahead of its time!

These cells are also visible from inside the wing.

SKYWALK JETFLAPS

Jet Flaps are a feature of Skywalk paragliders: an efficient mechanism for lowering the minimum speed.

This technology was initially developed for the make's kite wings, then for the very first Mescal. The principal, when flying slowly, was to 'restick' the airflow onto the upper surface at the back.

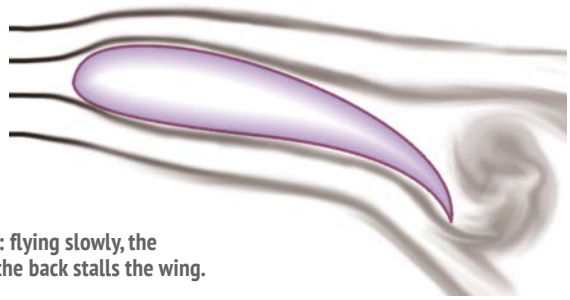
By doing this, the stall will happen later and be gentler. This therefore increases safety at the lower speeds: the minimum speed decreases by about 15%, the equivalent of several kilometres an hour. This is good in thermals and during take off and landing. It also mellows the behaviour outwith normal flight.

Since then, Jet Flaps have been put on all Skywalk's models, including the top of the range wings.

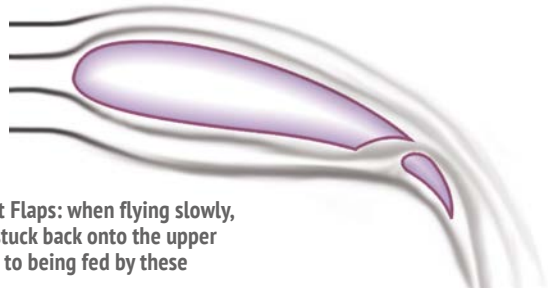
October 2003: Sascha tried the first wing thus equipped, Skywalk's Mescal. Photo: Véronique Burkhardt

The first prototypes, here are some photos taken in 2003. Photos: Skywalk

Skywalk is very big in kites, under the brand name "Flysurfer". These parafoil wings were the forerunner to the Jet Flaps system.



A normal wing: flying slowly, the turbulence at the back stalls the wing.



A wing with Jet Flaps: when flying slowly, the airflow is stuck back onto the upper surface thanks to being fed by these openings.

Jet Flaps have been systematically integrated across the whole Skywalk range. Here, the all new Poison X-Alps, which is a certified version of the X-Alps 2. The Poison X-Alps has just won the Airtour 2016 with Maxime Pinot at the controls. Photo: Tristan Shu/Skywalk.

Photo : Véronique Burkhardt/ Pilote Sascha Burkhardt

BIONIC

The Bionic by Olivier Caldara has some unusual features, but is very aesthetic. The stabilos are curved upwards to reduce induced drag. As a consequence, the middle of the wing needs to be lower to stabilise the arc and the yaw axis. During our test in 2004, it seemed novel, but the yawing turn was disconcerting. Nevertheless, the tension forces in the arc didn't seem to be enough to give good stability and better performance than normal wings.

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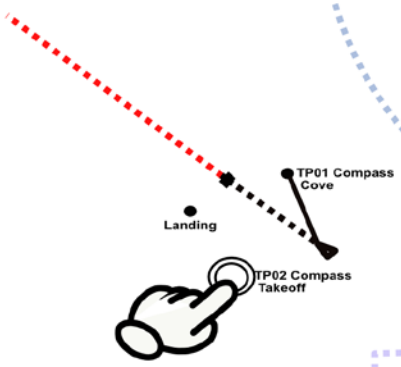
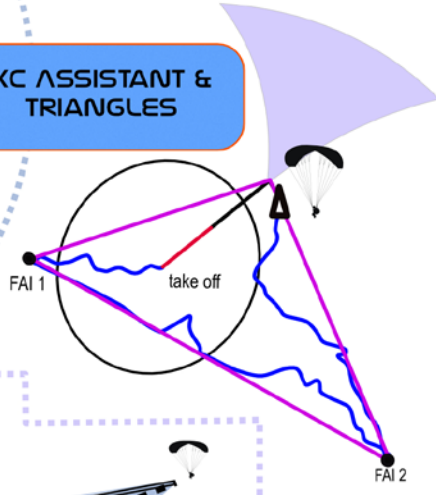
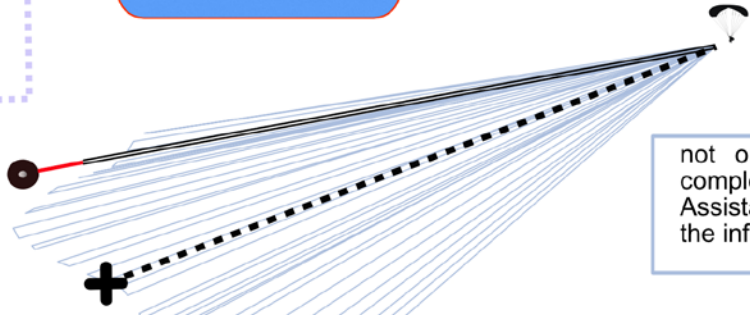


choose a "goto" by a simple touch in the map. Move and zoom the maps



GLIDE OVER TERRAIN



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VALVES IN THE LOWER SURFACE

Another feature on some wings: valves on the lower surface, aimed at feeding the interior of the wing (and not the upper surface) at high angles of attack. This system is very different to Jet Flaps and was used on the Furyo d'Air Slide in 1993 as well as on U-Turn's acro wings.

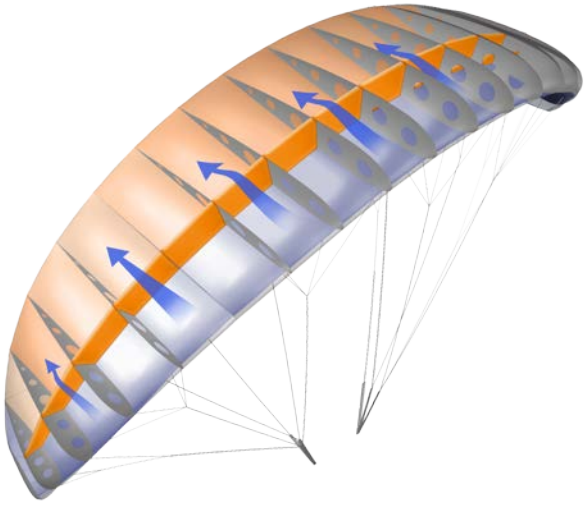
Pictured here, Niviuk's all new N-Gravity 4 acro wing, with a new version of the valves to increase the supply of air to the interior. The aim: assist 'stall' manoeuvres with a high angle of attack such as a helicopter.

Keeping and maintaining a good distribution of pressure inside the wing should make the transition between each manoeuvre very efficient.

ZIPPY, RAST, HIT VALVES...

Free.aero regularly tests wings including new technology like RAST (Swing Mito), Hit Design valves (Apco Lift EZ, coming soon) or the airbrakes on Independence's Zippy (coming soon).

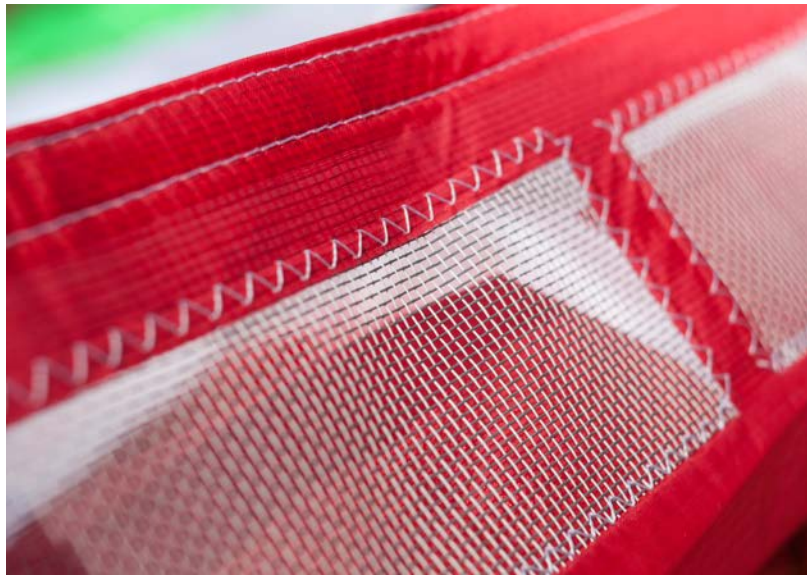
Sometimes described as gimmicks, numerous technologies have shown a certain amount of efficiency. To be continued.



The airbrakes system on the Independence Zippy.

The HIT Valves by Apco are supposed to increase the internal pressure at low angles of attack

Photo : S. Burkhardt



PHANTOM: THE REVOLUTIONARY EN B?

Offering the performance of a competition wing on an EN B available to everyone; is that possible? Nova claim that it is and explain the concept to us.

The new Nova Phantom, twenty five years after the first Phantom, (1991, DHV 3, 47 cells), is a completely atypical wing, but very interesting. Nova took the opportunity to make a wing without looking at the final price tag, and they integrated all the possible techniques to maximise the performance. To keep the profile perfectly in shape, the wing was made with 99 cells. The glider is assembled from 3000 different pieces. Including, amongst others, 804 "Needle Ribs". These are diagonal ribs, which cross the vertical ribs to stabilise several cells at the same time.

The most interesting feature: this 99 cell paraglider doesn't' have a higher aspect ratio than the Nova Ion 4. And it is just as accessible, amongst other things, thanks to its certification "easy EN B".

This wing is in fact based on the Ion 4, but all the sophistication of its manufacture has reduced the drag and increased the coherence of its profile to the point where, according to Nova, its performance is above that of the Triton 2. The managing director of Nova, Wolfgang Lechner announced 'this EN B will be the best performing wing that we have ever made'. Like the Ion 4, it will be very easy to launch and fly.

And it isn't much heavier, despite the impressive number of pieces: less than 5 kg in size S. This is possible thanks to a very 'airy' manufacture, with numerous large openings in the ribs and by using 27 g/m2 fabric. The only disadvantage with this wing, which will soon be available in four sizes, from XS to L, will be its price: 6,490 €
www.nova.eu

THE EDITOR'S OPINION

The Phantom should actually be a pretty revolutionary paraglider if the promises have been kept, which we'll check as soon as possible. It will be very interesting to see whether making a wing so sophisticated increases the performance to the point of being better than the manufacturer's 'hottest' wings. It will also be very interesting to see if the concept can be applied to competition wings as well: gaining so much performance whilst keeping the same aspect ratio could lead to the manufacture of impressive racing machines. With the Phantom, to offer more power than the Triton 2 to pilots used to 'easy EN Bs', with the same level of safety as the Ion 4, is an important step in the development of paragliders. But there are, all the same, two features which mustn't be forgotten: the aspect ratio will always remain a performance criterion.

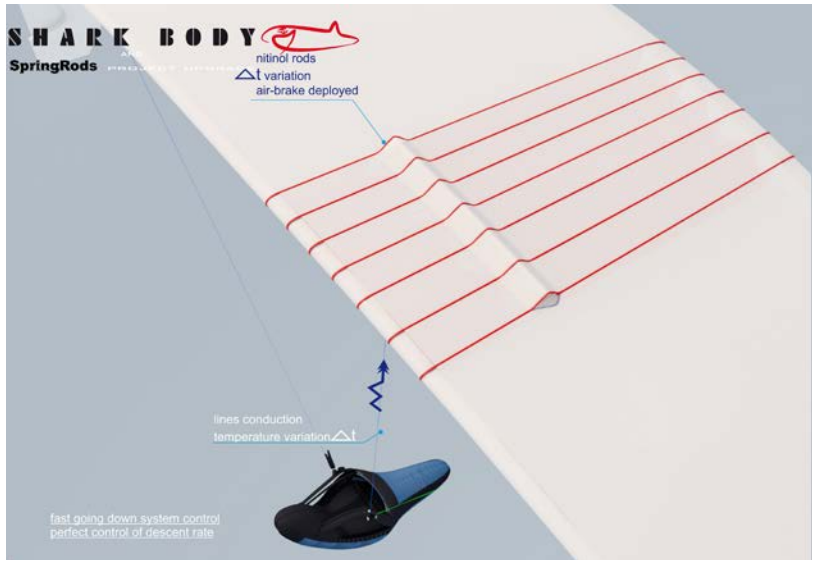
And even with 'easy EN B' behaviour for collapses and stalls, the power and very high level of glide inevitably make the wing a bit more difficult to handle when landing in spaces which are short and narrow. And an inexperienced pilot could quickly find himself in new aerology, high and very far away, without being sufficiently prepared. And then, obviously, the long and difficult assembly as well as the high price will prevent its widespread appeal.

SHARKBODY
THE ELECTRIC SHARK

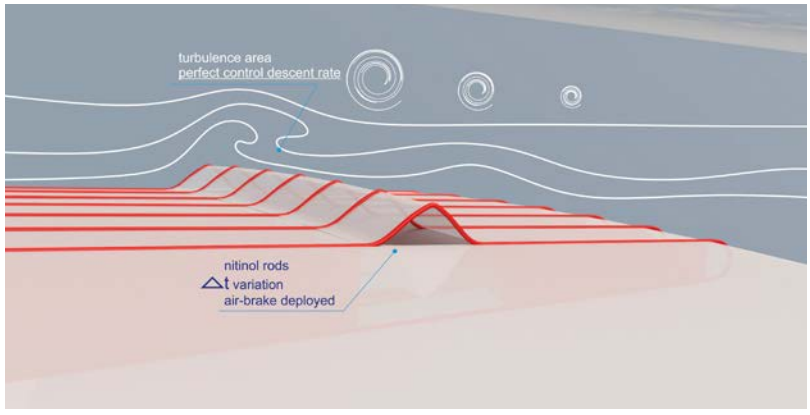
The Italian architect and paraglider pilot Luciano Buono introduces some novel ideas of what can be done thanks to Nitinol…

This enthusiast has ideas which initially seem mad, but when examined a bit more closely, are avenues to explore.
His idea is to combine new shapes of profiles like the SharkNose with different geometries.

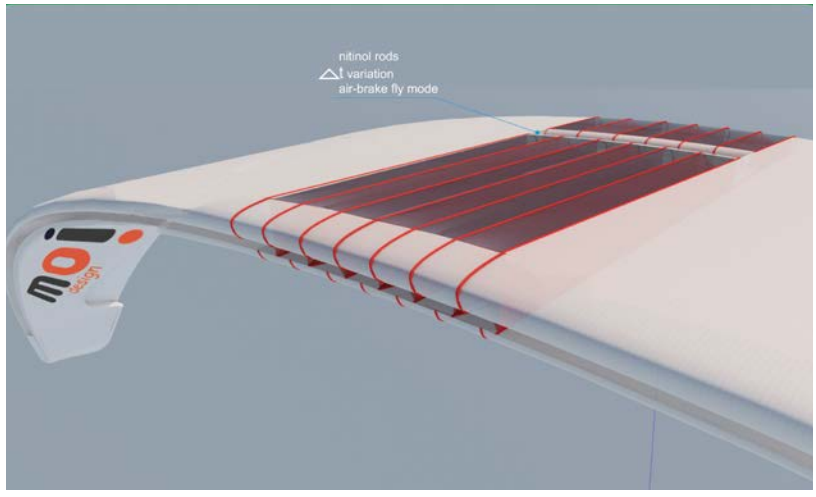
As we've seen, Nitinol, a nickel titanium alloy, reverts to its initial shape after being deformed. At the same time, it can change shape due to temperature.
Luciano's idea: the pilot, whose cocoon is equipped with solar panels and a battery, presses a button when he wants to cut his glide ratio to descend above a demanding landing field or under a cumulonimbus.Both cases are problematic with todays wings which are 'too' high performance. A current is thus applied to the Nitinol rods on the upper surface of the wing. If the system is well designed, according to Luciano, the rods deform after being heated by the current in such a way that they form airbrakes.



The idea: an airbrake which deploys at the push of a button…



…thanks to a slight increase in the temperature after applying a current through the Nitinol rods…



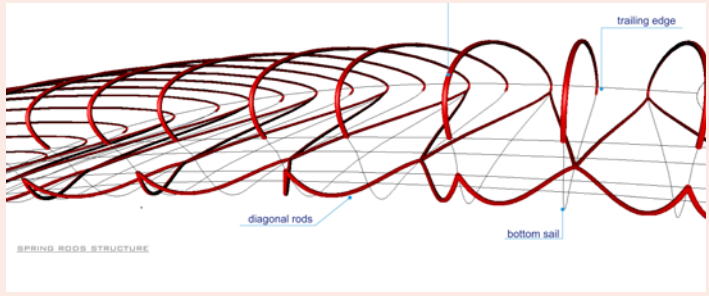
…all coupled with a modern design based, amongst other things, on the SharkNose.

This will, no doubt, require very precise development. During our interview with the architect, he conceded that a problem would be to stop the system working all by itself when the sun was very strong.

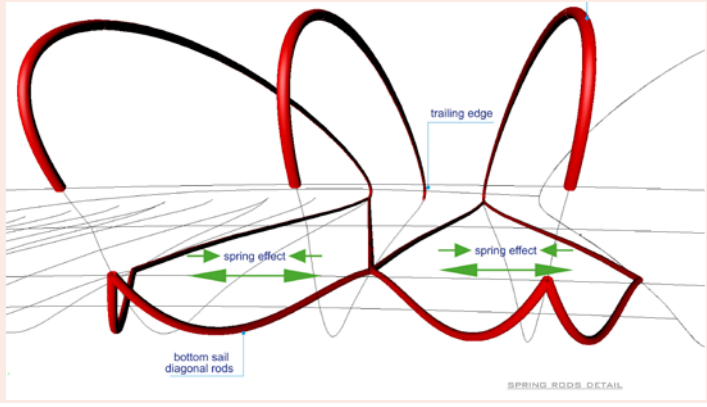
Another idea is to use the elasticity of the rods and their 'spring' effect to make collapses more gentle (see right).

According to Luciano, some of the manufacturers contacted found it interesting in principle, but difficult to apply.
Watch this space…

Contact par email :
arch.luciano.buono@gmail.com

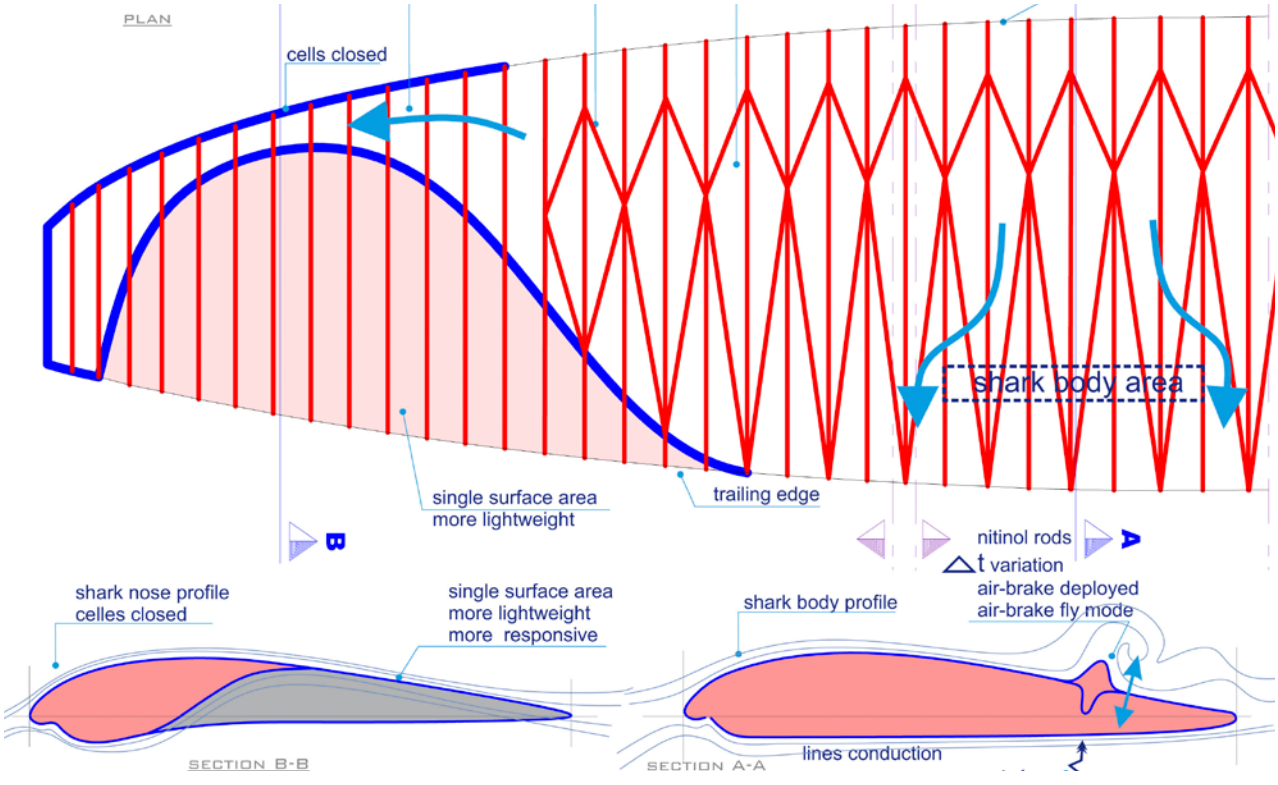


Another idea: rods the length of the wingspan could serve as a spring…



…which would compress when the other part of the wing collapses and then help it to reinflate.

All of these techniques could be combined with the more promising principles of single skins, at least in certain parts of the wing.



MANUFACTURE

Here's an unusual portfolio which explores the different places where our toys are assembled, starting with the rolls of fabric and the bobbins of wire...

Photo : Jérôme Maupoint/ Gin

Photo : Gin

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Illustration de Valérie DUMAS

Photo : Loren Cox/Ozone

The inside of an Ozone wing being assembled; the ribs and mini ribs are clearly visible.

Preparing a machine to sew SOL harness in Brazil.

Photo : Mario Arqué /Revista parapente

Photo : Mario Arqué /Revista parapente

Photo : Jérôme Maupoint/ Gin

Photos taken in a GIN factory: from sewing to final control, making a paraglider is, and will remain, a very manual job.

Photo: Gin

Photo : Quinn Ryan Mattingly/Advance

The size of the Advance factory in Vietnam is impressive: 220 employees are involved in the manufacturing side. This new factory was inaugurated in time for Advance's twenty fifth anniversary in 2013.

Nova produce a large part of their wings in Europe, in Hungary to be precise. Amongst the seamstresses there are some keen pilots. On the other hand, to cope with the orders Nova are having to turn more and more to their factory in Vietnam. Below: laser cutting (here in Hungary) is mandatory for shapes which are becoming increasingly complex. Even if it only allows six layers of fabric to be cut at a time, Nova prefer this very precise technique for almost all their work. Photos: Nova.

At Gradient, all the stages of development including manufacturing are carried out at the same place in the Czech Republic, therefore in Europe too.

Photos : Gradient

At Dudek in Poland, design and manufacture are also both done at the same site.

Photos : Jörg Maaß

Photo : Niviuk

For the very big paragliding manufacturers with their massive annual production, this can only be achieved in factories of a corresponding size like those found in Asia. This photo shows Niviuk's factory in China.

Photo : Niviuk

The Niviuk workshop in Spain can produce prototypes but it is mainly used for repairs and modifications.

Photo : Sascha Burkhardt

A paraglider is made up of 1000 to 2000 parts, or even more. This requires well-honed, meticulous, methods of manufacturing with employees who are responsible for their work, as well as checks every step of the way. Here are some photos taken by Niviuk in their factory in China.

The Nervures paragliders and harnesses are made entirely in the French Pyrennes.

Photos : Nervure

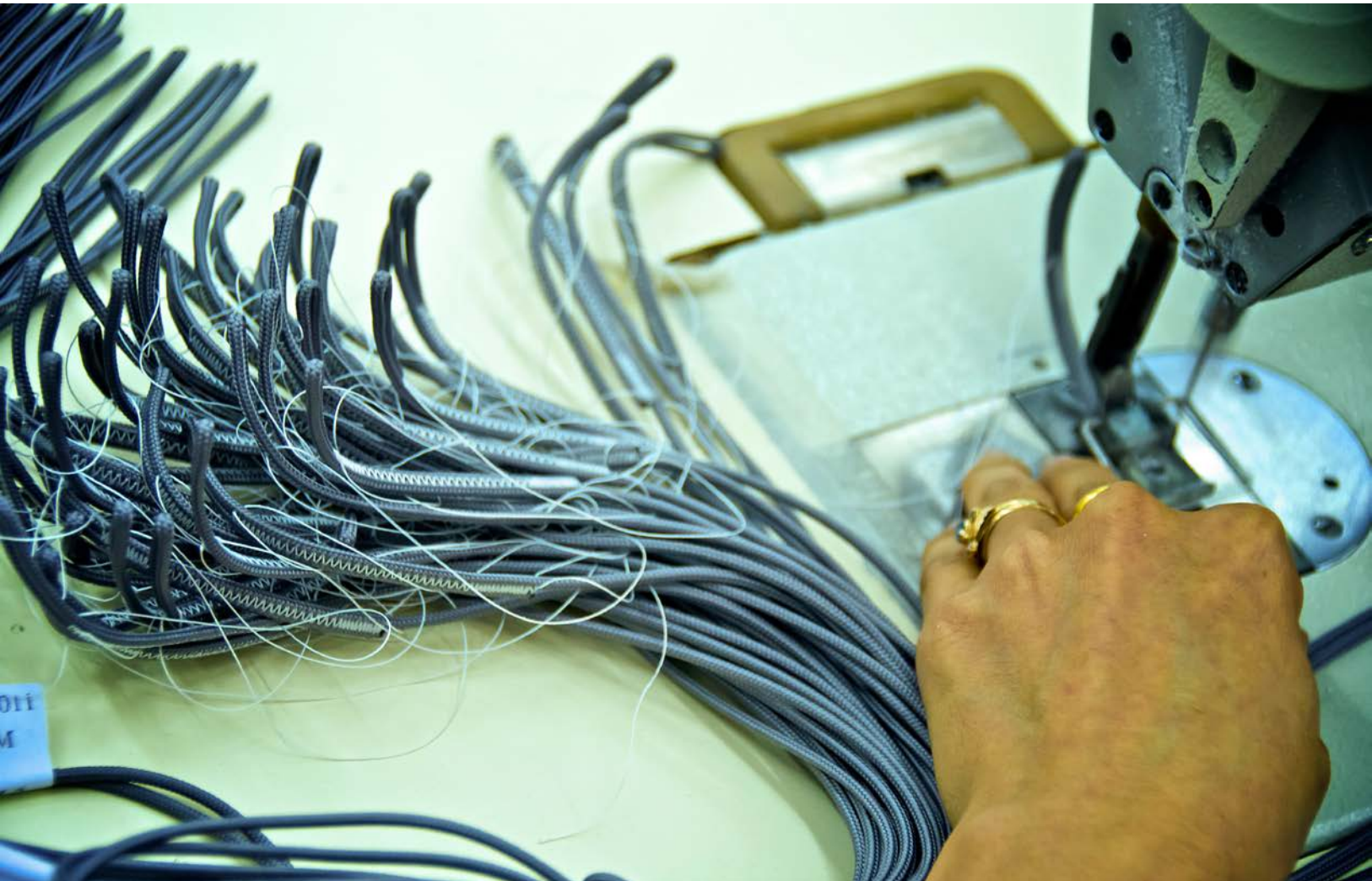
Photos : LorenCox/Ozone

The salaries in the Asian countries are constantly on the increase. If you add the cost of transportation, cheap labour starts to lose its credibility as an argument for manufacturing in these areas. But production is efficient with competent, responsible, well-established teams. The working conditions seem, moreover, to be much better than those who are prejudiced would have you believe. Here are a few photos of life in Ozone's Parapex factory in Vietnam. Right Mr Khanh, managing director, below Mr Phongh, product manager.

Above, Russel Ogden during a visit to the factory. A close and constant link with the production team is essential. Right, cutting the ribs by hand.

To cut lots of identical ribs at the same time, a Stanley knife is unbeatable. Below, sewing the lines is a very responsible and demanding job.

Photos : LorenCox/Ozone



Photos : Trekking

Made in France: Trekking's production premises are near Montpellier, where almost the whole range is made. A brave choice! Only the tandem is still made in Croatia.

Another company who have taken up the challenge is Neo who produce their whole range (harnesses and speed riding wings) in Haute Savoie, France.

Photos: Jérôme Maupoint / Neo

Scenes from the SOL factory in Bresil (paragliders, harnesses and accessories). Templates are used to cut the fabric for the harnesses.

Photos : Mario Arqué/Revista Parapente

Photos : Jörg Maaß/Dudek

**When the Dudek factory was set up in Poland in 1995, forty wings were made a year. Today, that's sometimes the weekly production.
Dudek also carry out their after-sales service, including checking wings, at the same premises.**

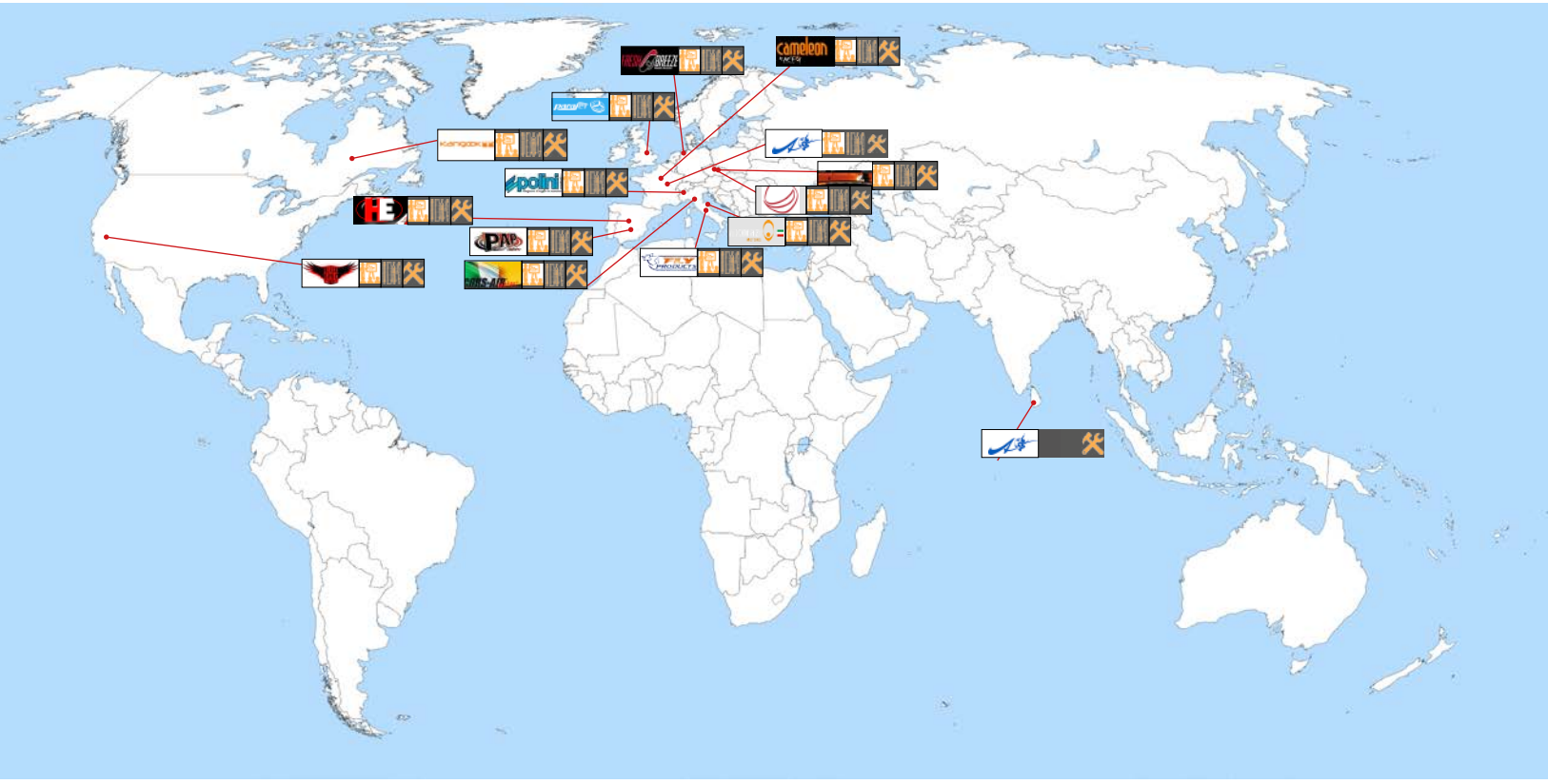
Apco produce all their paragliders and harnesses in Israel.

Photos :Apco

Attaching the lines in the GIN factory in Qingdao, China.
Photo: GIN

A final check at the Advance factory in Vietnam.
Photo: Quinn Ryan Mattingly/Advance

The wing will soon be delivered to the pilot: final checks and folding at the Ozone factory.



SOME PARAMOTOR MANUFACTURERS AROUND THE WORLD

The photographs over the following pages give a glimpse inside the premises of the companies which make the machines which propel us. There are a lot more, especially in France, but we don't have space to show them all…

Photo : David Rouault/Kangook

KANGOOK

Kangook was cofounded in Canada by Frenchman David Rouault (on the right in the photo), who is now the sole owner of the Quebec based company situated on the edge of the famous 'endless forest'.

Photo : David Rouault/Kangook

Kangook's success is, in particular, due to the versatility of their chassis: the manufacturer offers almost all the attachment systems possible (pictured here, swan necks) and chassis adapted to nearly every available engine.

Photo : David Rouault/Kangook

Photo : David Rouault/Kangook

Fire and brute force: constructing a paramotor chassis is, by nature, completely different to making a paraglider...

Photo : Adventure

ADVENTURE

The French manufacturer isn't just one of the pioneers of paramotoring, but still also one of the market leaders. Adventure have a large network of schools who market their motors, buggies and wings.

In addition, they regularly use their experience gained on the ground. Adventure are therefore very close to those who fly their machines.

Photo : Adventure

Adventure's new managing director, Andrea Testoni, is an aeronautical engineer with ETH in Zurick and paramotor pilot. He took over Adventure in the Spring of 2015.

Photo : Adventure

**Guy-Léon Dufour founded Adventure, but retired last year. Emmanuel Layan is the make's designer as well as co-owner since the departure of GLD.
Champion pilot Pascal Vallée also became co-owner at the same time.**

Photo : S.Burkhardt

Photo : S.Burkhardt

Adventure's most recent model: the Funflyer buggy 2, available in solo and tandem.

One of Adventure's biggest strengths, from the very first model, was the shell for the chassis. This shell fits pilots much better than a square aluminium tube chassis. And it's very practical for travelling, pictured here in 2000, whilst we were doing a photo report in the Aeolian Islands.

Photo : Sascha Burkhardt

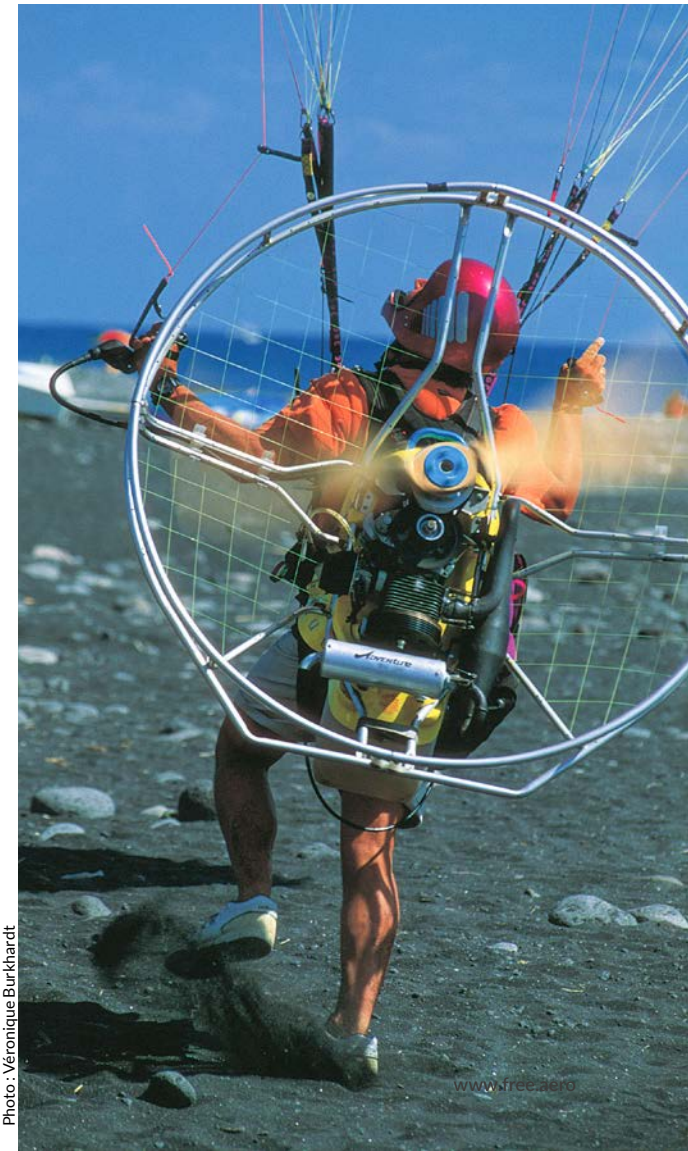


Photo : Véronique Burkhardt

Subsequently, Adventure took a bit of time to start making cages which fully dismantle. With the X-Race series, shown here being tested in 2011, they were successful. Then two years ago, in addition, Adventure went very light with the X-Race LT (photo below). Adventure also design their own wings, which can obviously be used with other motors as well, like this Flex-One which we tested in 2015.

The Italian manufacturer makes solid machines, which are becoming increasingly lightweight, such as the Rider chassis in 2012.
Photo: Véronique Burkhardt

FLYPRODUCTS

Welding the cage on a buggy.
Photo : Wolfgang Ehn/www.wolfgang-ehn.de/

Enrico Vignini (right), owner of Fly Products, was also one of the first to understand that the ideal paramotor setup lets the attachment system change as the pilot progresses: in the pictures below, three possibilities that were already available several years ago.

Photo - Wolfgang Ehn / www.wolfgangehn.de

FRESH BREEZE

Fresh Breeze are another pioneer and market leader. They work in the north of Germany, and have just increased the size of their production plant again.

Fresh Breeze isn't particularly oriented towards 'light and transportable', but are going more and more for 'robust buggies'. They still sell their flying bicycle (below left).

Photo: Franck Simonnet/Fresh Breeze

Photo : Franck Simonnet/Fresh Breeze

Aviation in all its forms is in the genes of the owner of Fresh Breeze.

Photo: Franck Simonnet/Fresh Breeze

In the Fresh Breeze workshop there is a real air of Germanic discipline.

Photo: Franck Simonnet / Fresh Breeze

Photo: Francis Cormon

Photo: Francis Cormon

H&E

The Spanish company H&E makes their own motors, but they are also, and primarily, suppliers of engines for other makes like PAP. The means of production are very modern like this CNC router.

Photo: Francis Cormon

PAP

Unfortunately we don't have any photos of the PAP workshops in Andalusia. Pierre Aubert (left) who founded the company invented low swing arms on paramotors as on the machine on the left. Thanks to him, lots of paraglider pilots have been bitten by the paramotoring bug.

NIRVANA

Nor do we have any photos of the actual production site for the Czech company Nirvana. Although they do have a certain taste for aesthetics.

They started their business off by making an exact copy of an Adventure chassis with a few modifications, which worked well. Below, the evolution 'Instinct' with a Simonini 230, on the make's 4Fun buggy.

Photo : Sascha Burkhardt

Photo : Véronique Burkhardt

POLINI

Polini are one of the Italian motor manufacturers who have come from motorbike racing and have successfully invested in motors for paramotors. Their engines are the 'raw material' for numerous paramotor manufacturers.

Photo : S.Burkhardt

Gathered around a Polini Thor 80, from left to right, Roberta Camozzi, Saimon Polini and Iuri Polini. Below, Polini's prestigious ambassador, World Champion, Alex Mateos.

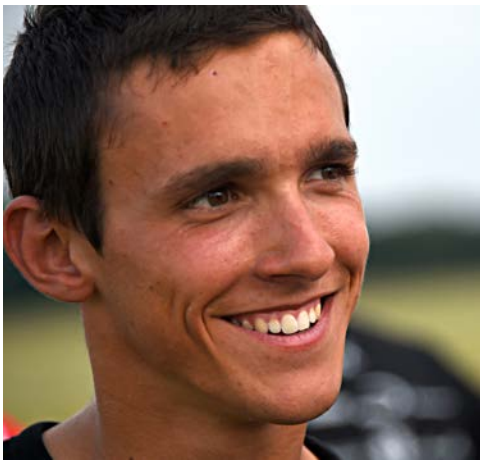


Photo : Polini

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