NEWSLETTER February 2018

i) FORTHCOMING EVENTS

- **Workshop Morning** 10am- 12 noon. Tuesday 20th February**.**
- **Club Meeting,** Wednesday 7th March - Formulate list of models for Doncaster Show and discussion on stewarding.
- **Annual Dinner** at the Forest and Vale Hotel Pickering. Friday 16th March.
- **Workshop Morning** 10am- 12 noon. Tuesday 20th March.
- **Visit To NYMR Motive Power Depot** ~ Thursday 22nd March (see next page).
- **Club Meeting** Wednesday 4th April. Rebecca Ellis – talk on "Speed on Two Wheels".

ii) Club Meeting Wednesday 7th February

a) Chairman's Comments

This was the first club meeting of the year and David started off by wishing everyone a Happy New Year.

- **Annual Dinner**

This is now arranged for Friday 16th March at the Forest and Vale Hotel in Pickering. It is a little pricier than last year, but the ambience and food quality are good. The price £29 per person. There are quite a few choices for starters, main course and desserts.

Starters:

a. Tomato and Basil Soup **or,**
b. Sauté mushrooms with shallots and asparagus.

Mains :

1. Crackling roast pork, apple and apricot sauce **or**,
2. Roast leg of Ryedale lamb with Yorkshire pudding, redcurrant and rosemary gravy **or**,
3. Baked Haddock wrapped in Parma ham, basil and tomato sauce **or**,
4. Mushroom and cashew nut stroganoff in a filo basket.

Deserts:

i. Sticky Toffee Pudding **or**,
ii. Chocolate Cup filled with Forest Berry Eaton Mess, fruit coulis.

Finish With:

Coffee or Tea

An e-mail was sent out to see if you are coming and with how many. Please email David Proctor on d.c.proctor@gmail.com or phone on 01751 473250 if you did not receive it.

The time is 7.00pm for 7.30pm start. We need names, choices - and money - by Friday 2nd March.

- **Amotherby School Science Week ~ Wednesday 14th March**

There has already been two meetings with the school. For those who have been there before, it is a very similar setup. There will be four separate groups and four separate activity areas. The pupils will move around the groups.
The pupils are of mixed ages, so there will be the same presentation four times. The last time this was done the children loved it. It was inspirational for all of the children, and one in particular went on to study engineering as a consequence.
Ideally, to support this properly, we would like ten people. The plan is to take the equipment there on Tuesday 13th March after 3.30pm, and there is a start at 9pm on Wednesday 14th March. School dinners are provided.

Activities include:

An orrery, a can crusher, a couple of lathes for rocket construction, a Wimshurst machine, a harmonograph, a hot air and a stationary engine. These will grouped logically. The last session will be the rocket launch.

There will be a briefing at some stage for those who wish to attend. A good time will be the workshop meeting on Tuesday 20th February. As of the 7th March there were seven possible volunteers.

- **Workshop Mentoring.**

George Gibb has agreed on principle to mentor members in boiler making, with the caveat that 'boilers are heavy'.

- **Outings.**

The committee is proposing at least three outings this year.

i) The North Yorkshire Moors Railway Motor Power Depot Shed at Grosmont.

David Proctor will be organising this one. The shed manager is very receptive of PEEMS members going as a group, The original plan was to go in April. However, the season will have started by then and all visit days will be running days, which invoke Health and Safety limitations. These limit where we can go.
When the A1 Tornado visit, (this kicks off the season), finishes about 11th March, there are a couple of weeks of 'dead-time' when the shed is active, and there is no running.
The shed manager has proposed Thursday 22nd March for the PEEMS visit.
Around twenty members showed an interest at the meeting. Partners are invited.
It will be a bit messy and dirty, but we can inspect the work being done on diesel and steam locomotives close up.
The visit will commence at 10.00am and last about 2 hours. Joining instructions will be sent via a specific email and announced at the March meeting however expect to meet in the NYMR carpark at 9.45am.
Stout footwear will be required. Whilst there is no formal charge for the visit, Members will be asked and encouraged to make a donation in the tin as we leave.
NYMR needs to raise £4.5 million as part of a matched funding award from the Heritage Lottery Fund and every penny counts.

i) The 'Flowers Of May' Museum (cars, bikes tractors etc.) nr. Scarborough ~ nominally in July

ii) Whitby Shipyard ~ Autumn.

These visits will be posted as soon as arrangements are made.

- **Safety Officer.**

The current Safety Officer, Eric Foot has resigned from the committee and as Safety Officer, for health reasons. We wish him well. This leaves a vacancy for this important role. We are looking for a volunteer for that position. We need a safety officer to do risk assessments when required.

- **Membership**

Membership details are on the membership list. The current list has errors on it, so could members please check and correct.

- **Nuts and bolts**

Some metric stainless steel nuts and bolts are available from Paul Windross. These are supplied by Gabriel Utley who gave us a talk about the 400mph motorbike. They cost £1 a bag

- **Letter from RVS.**

RVS are having a promotional event on Friday 2nd March. They are trying to get all the clubs and societies that meet at the RVS to have a table each to demonstrate what they do. This will give newcomers a chance to see what is available at the RVS. David Hampshire has kindly agreed to help out on this.
It starts at 1pm and will finish around 4pm. David would like another helper. We still have to contact the RVS to say that we can come. We want people to bring projects along.

- **Life Membership.**

Peter Bramley has held the club together for some time, so the committee have voted to confer on Peter Life Membership. The Club thanks Peter for all the dedicated work he has put into the club.

b) Mini Bring And Brag.

Mini 'Bring and Brags' at each club meeting allow members and guests to see the various projects that members are engaged in. Anything of engineering interest is also displayed.
At the last club meeting in December, Mike Sayers started the trend with his 'Wimshurst Machine' and ⅓rd scale Bentley Gearbox, and at this club meeting there were five exhibitors:

i) Paul Hayward ~ "Bing" Vertical Steam Engine

Paul was exhibiting a "Bing" vertical steam engine (approx. 1910), and whilst he didn't build it, it belongs to someone near Whitby, who Mike and Paul know.
The lever that sticks out (arrowed) is some type of safety valve system.
On the internet, weights are shown sliding up and down this lever.
There is also a plunger which fits into the boiler itself.
That is all that is known. Paul didn't know if anyone knows about this type of boiler. Any light that could be shone on this, would be very much appreciated.
There is an ambition to fire up this boiler again. These types of boiler can be seen in operation on YouTube (see below).
The boiler has a 'false' governor (ie. it doesn't do anything), a sight glass on the side, and a burner underneath. There is also a feed pump on the side to top up the boiler.

https://www.youtube.com/watch?v=zYCUDchte7s

Please Note: when playing these videos, click the 'Back' arrow ← at the top left hand corner of the page, to return to the newsletter.

ii) Richard Gretton ~ Framed Picture of Dame Laura Knight's Painting Of Ruby Loftus 'Screw Cutting'

Dame Laura Knight's 'Ruby Loftus Screwing a Breech-Ring', c1943
GETTY IMAGES

Soon after Knight produced what has since become one of her most famous paintings, *Ruby Loftus Screwing a Breech-Ring*, which celebrates the skill of the factory hand Ruby, who helped make the guns that were so vital for the war effort.

Knight drew on her experience of painting ballet dancers and musicians to present Ruby as an athlete, her body carefully poised as she operates her lathe as if playing an exquisite instrument.

Richard thought this painting would be of interest to PEEMS members. It is a painting by Dame Laura Knight of the "Staithes Group" of painters, showing a woman, Ruby Loftus, on a lathe. What she's actually doing is threading a breech ring for a Bofors double barrelled 40mm anti-aircraft gun.
There has been some interesting correspondence in the Daily Telegraph about this painting. The day after the painting was shown, someone wrote in to say, '*Sir- Ruby Lofthus may well have been an exceptionally skilled turner and borer, but the painting of her by Dame Laura Knight does her no justice. It depicts her resting her hands, in an arbitrary fashion, on parts of her lathe where she has no direct control over the machining operation. This would have not occurred in reality*.'
Two days later, other letters came in from machinists. Richard read out one which said *'Sir- Ruby Loftus's stance is one assumed by most centre lathe turners screw-cutting an internal thread. Her need to see when the cut is ending means she bends forward with her hand ready to disengage the lead screw and wind the cross slide away from the partially completed thread.*
The lathe, incidentally is that Rolls Royce of British Machine Tools, a Dean Smith and Grace, which an unskilled turner would not be allowed to go near.'

Ed. Another interesting letter on the same day said: *'Sir- Dame Laura Knight's painting depicts Ruby Loftus screw-cutting with her left hand resting on a tool post, probably gauging sensory feedback from the cutting tool. Her right hand rests on an item not connected with this particular operation. …… Thread cutting requires the saddle to be mechanically coupled to the headstock, with a fixed ratio of linear and rotary movements. No "direct control" is required while the thread is being cut at a slow speed, so it would have been quite in order for Ruby to have adopted the stance pictured.'*

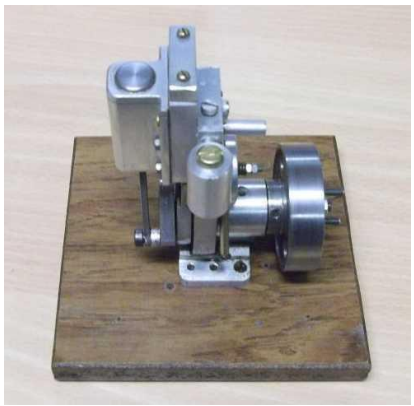
iii) David Hampshire ~ Model Engine, Guard's Van and Log Carrier.

These models are not David's, but belong to his 10 year old grandson. Over the last three years David has been encouraging him to assemble models from kits. This is a kit, where the engine could be built with or without a cabin. The engine doesn't have a cabin, so there was a cabin spare, and his grandson wanted to make a guard's van from it:

The only problem that there was no bottom for the van. On the internet you can get 3mm MDF by the sq ft, but the postage costs about three times the material cost.. He noticed that Wickes were selling 3mm MDF on the internet with an apology that they only supplied it in small sizes. David got his son to pick it up in York, but found that Wickes' idea of a small size was 6ft x 3ft! So he's ended up with a lot of MDF.
His grandson then decided to build a log carrier. David already has one on his track, so he decided to make a kit. This is only held together with friction. It can be dismantled and put in a box, with build instructions, for his grandson.

iv) John Heeley ~ Oscillating Engine.

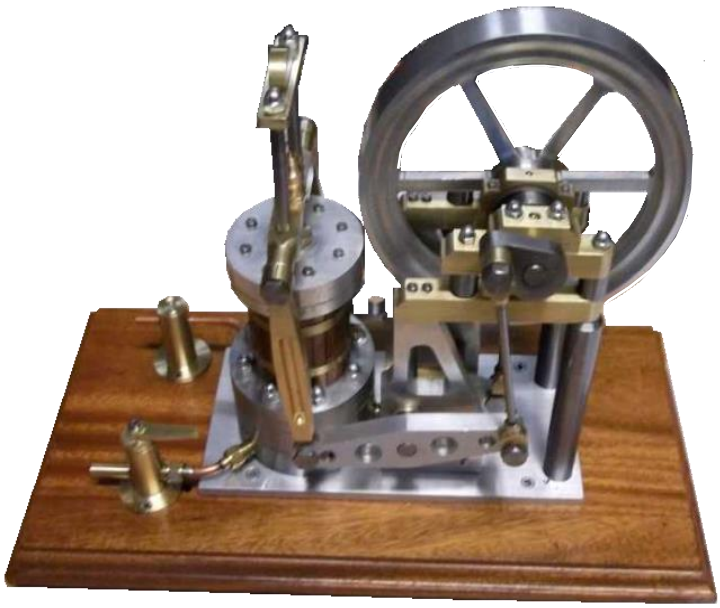
John had a brass built oscillating engine which is now installed in a model boat. John decided to move on and improve the design. This is the Mark 2, which is an aluminium engine with ball races on the crank-shaft. It has a stainless steel liner, and an alloy piston with a cast iron piston ring. It has a horizontal boiler, with four vertical fire tubes which fan out in a 'Vee', so there can be a stay running through it. The stay also acts as the mounting into what looks like a 'tea caddy'.
John can get 3,000 rpm out of this, which it will sustain for 5 minutes without 'mortgaging' the boiler. At 1800 rpm it will run for 20 minutes.
The lamp goes out before the water supply is exhausted. A boiler cannot be damaged by a little burner like the one used here. There is no way it will melt the silver solder, so it is safe enough which is why it does not have a pressure or water gauge. A pressure gauge, however can be connected to it. It runs at 25psi, and 3,000rpm. It makes a noise like a 1922 motor cycle engine when it runs, (John's neighbour showed a friendly interest when he heard it through the wall!).
The problem with an oscillator is that you cannot admit the steam until you are well past 'top dead centre', so John developed the Mark 3 :

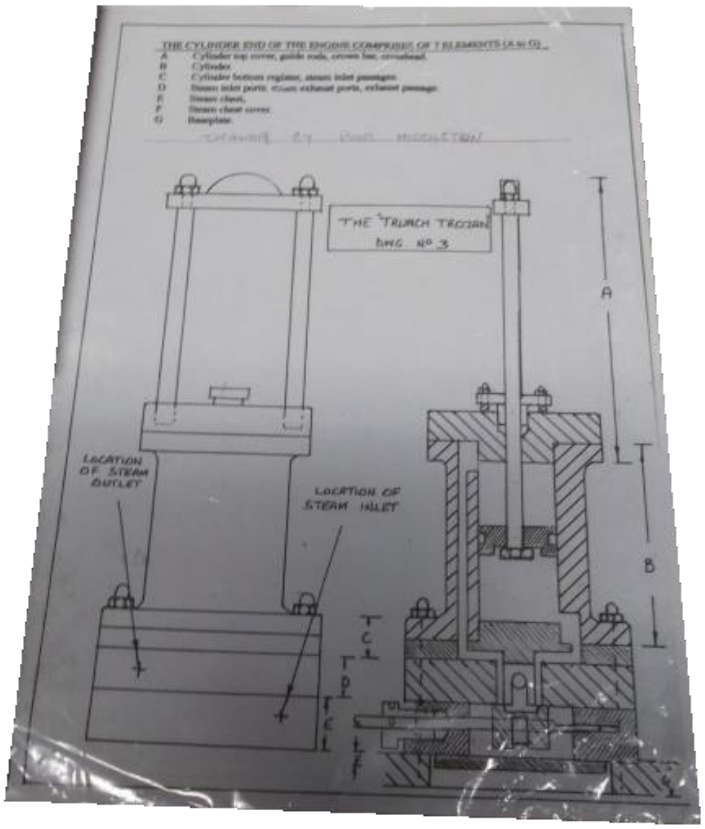


The Mark 3. This is virtually the same engine, it still has the one inch stroke, and the half inch bore like the Mark 2, but it incorporates a little piston valve in the 10mm block fitted between the upright and the cylinder. The cylinder has had to be raised to provide clearance for the con-rods. It needs 35psi to run it and uses four times as much steam as the Mark 2. The Mark 2 will run down to 6 psi. John has played with the Mark 2's timing etc. but this represents a 'dead-end' in the development.

The Mark 4 was started the previous Thursday. This has the same one inch stroke, and half inch bore as the previous engines but there are two cylinders. The reason for building this engine is to find out if twice as much power can be generated, or half as much again as the Mark 2. Does it use twice as much steam? John wants to prove this as a fact rather than theory. These engines are made by the same person in the same workshop, using the same materials.
None of the engines shown self start, because John wants to keep them simple. They are single acting cylinders, which only go in the "Rolls Royce" direction, that is clockwise when viewed from the fly wheel end. This is different to everyone else.
It means, however, when you put them in a boat you have to make your own propeller. The Mark 1 prop can only be 1¼", and the original Mark 1 is running at over 1000 rpm, but it doesn't have the power. John needs bigger propellers and would prefer to go up to 2".

v) Brian Stephenson ~ ‘The Trunch Trojan’





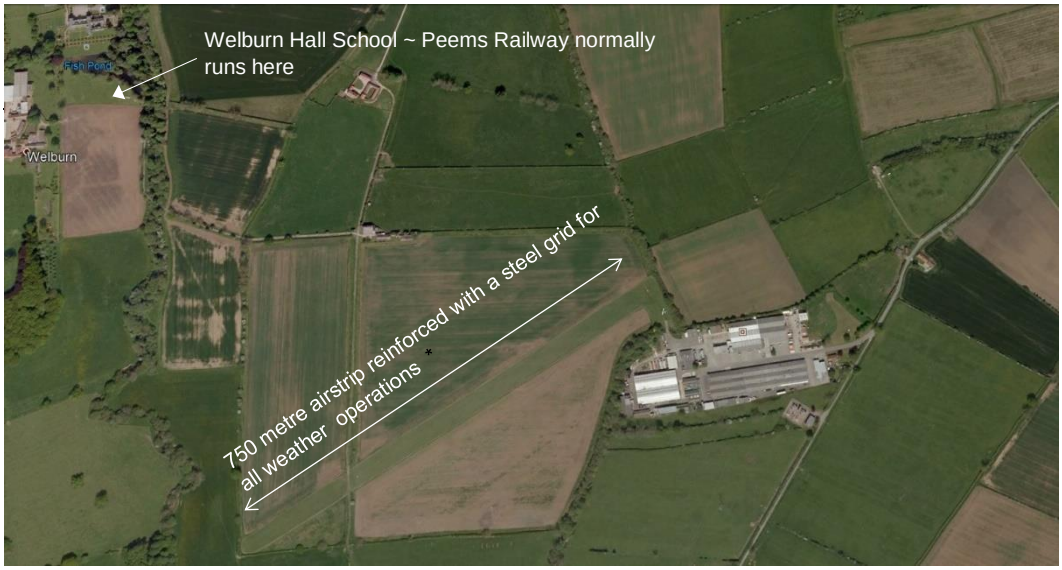
This was the latest model Brian has made. His friend designs these and tries to think of a concept which hasn’t been used before. He has an idea in his mind and then trawls the internet and sees if anyone has made it. This ‘Trunch Trojan’ is an idea he had, where the valve is at the bottom, as shown in the drawing. It works very successfully. His friend doesn’t know that yet, as Brian took the drawing home, and he went to India. They couldn’t find anything like it on the internet, so if anyone finds something with the valve on the bottom, Brian would like to know.

c) Design and Manufacture of Composite Structures – Nevile Foster

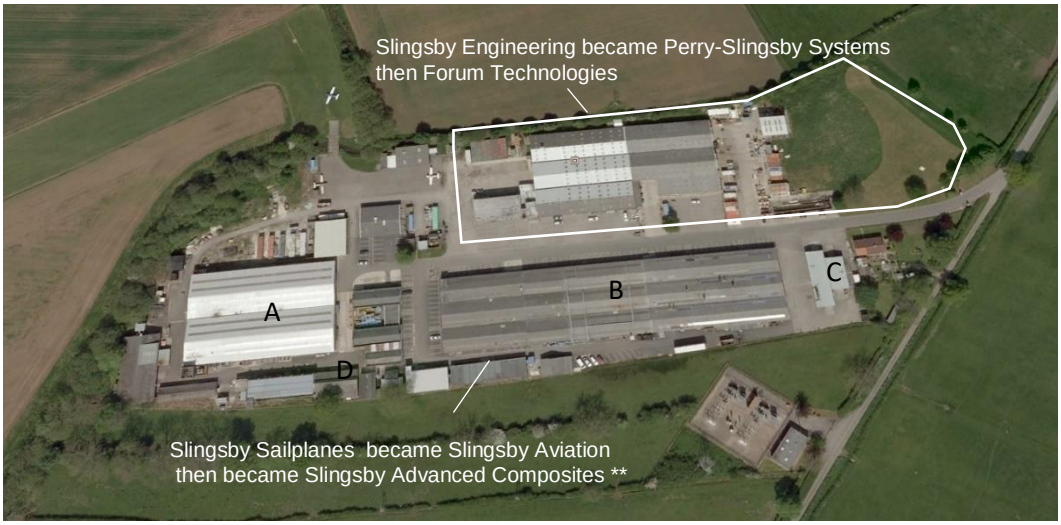
Nevile Foster gave a talk on his experience with the design and manufacture of composite structures during his time with Slingsby Aviation and Slingsby Advanced Composites. Slingsby manufactured a range of products in the time Nevile was there ranging from aircraft, hovercraft and parts for airships and marine structures.

- **History Of Slingsby Aviation and Site Plan.**

Slingsby Sailplanes was founded on the site in Kirkbymoorside in1939, by Fred Slingsby, a First World War Pilot. After the war, in 1920, he bought a partnership in a woodworking and furniture business in Queen's Street, Scarborough. He, however kept flying and founded the Scarborough Gliding Club in 1930 and started building, and selling gliders from 1931 onwards, finally establishing Slingsby Sailplanes.



Note: this airstrip no longer exists ~ it returned to agricultural land five years ago.



A - Marine Shop, Prepreg Dept. and Autoclave
B - Main Assembly Area
C – Spray Bake Facility
D – Support Machine Shop

Slingsby Engineering produced underwater trenching tolls for internet cables, remotely operated vehicles for maintaining underwater oil and gas facilities and the LR5 submarine, which was the only sub that was capable of rescue in the case of the Kursk disaster.

** This area in now Marshall Aerospace and Defence Group

Fifty gliders were designed, and a lot of them built by Slingsby Sailplanes. One of these was the T7 Kirkby Cadet. This was constructed from wood/doped fabric and first flew in 1936. It was used throughout the 1950s, 1960s and 1970s, especially by the Air Cadets:

- **Slingsby Aviation/Slingsby Advanced Composites ~ Core Products 1987**

When Nevile joined Slingsby Aviation in 1987, there were three main products :

i) T67 'Firefly' Two seat Training Aircraft

ii) SAH 2200 Hovercraft

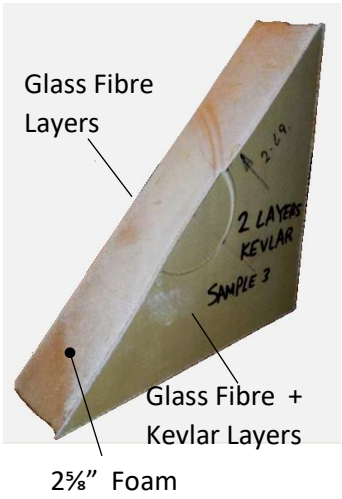
iii) Nose Cone and Battens, Gondola and Prop Duct, and Control Surfaces for the Airship Industries Skyships 500 and 600

All three products are produced by the 'Wet Layup' method of manufacture, which everyone is familiar with. It is nicknamed 'bucket and brush'. In this process, unlike for metals, the laminator manufactures the material as well as the component.

This method of construction is very labour intensive, and in the 1990s onwards, manufacturing techniques at Slingsby, used the less labour intensive and more efficient methods of Resin Transfer and Autoclave and 'Out Of Autoclave' Prepregs. In the case of prepregs the fabric comes already impregnated with resin, and the product allows weight reduction with stronger laminates.

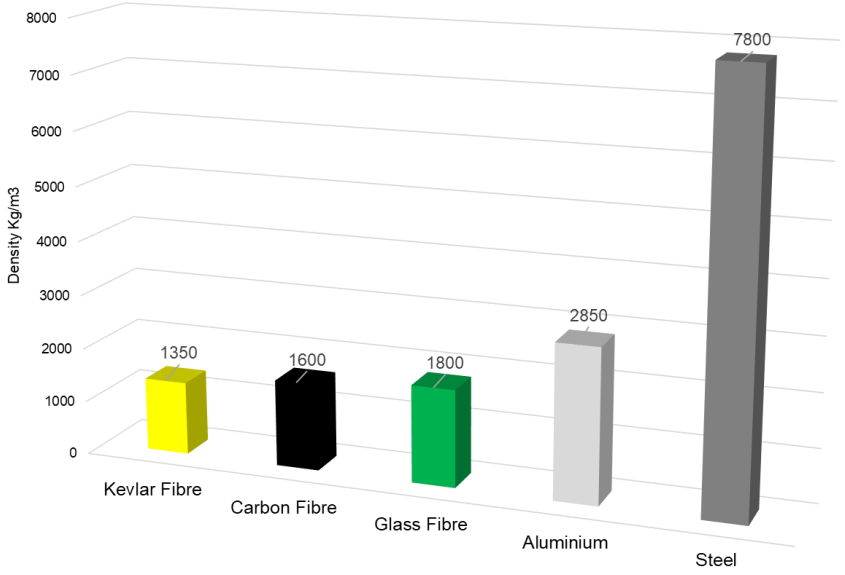
Each of the above products, which were designed and built at Slingsby, have some interesting features. The Firefly is discussed in more detail later,.

a) SAH 2200. The hovercraft has operated in many environments, with the Royal Marines, Swedish Coast Guard, and the Saudi Arabian Coast Guard. The one pictured above is with the Finnish Border Force.



A design requirement for these hovercraft, was they 'land' on ice fields which consist of ice pinnacles which can exert very high local pressures on the underside of the floors. These floors are of a glass/foam/glass sandwich construction, with kevlar on the bottom surface for impact protection. For the Finnish design, extra floor beams were required, and the kevlar was thickened. Kevlar is an aramid with very good impact resistance, hence its use in bullet proof vests. It was important to keep weight increase to a minimum when reinforcing the floor, as performance is a function of weight. Here is an example of a test specimen used to determine how many layers of kevlar were required on the lower surface to rest the required pressure exerted by the ice.

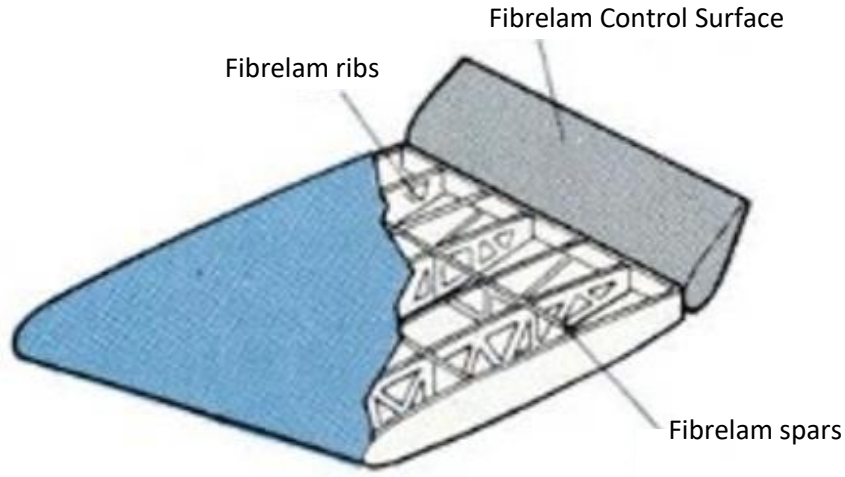
b) Airship Industries Skyship. The nose cones and battens are manufactured from glass fibre. The radial battens help distribute the mooring mast loads into the envelope, and also help to maintain the nose shape during high speed flight.
The gondola which is manufactured from kevlar carries two pilots and eight passengers. Kevlar is lighter than carbon fibre, and is very strong in tension, but not so much in compression. The gondola is suspended from the inside of the envelope with kevlar cables. The prop ducts are glass fibre construction.
The Air Cadets at RAF Syreston have been experimenting with Dynema (another aramid, similar to kevlar) instead of steel cables for the winch launch of their gliders. This allows the gliders to get to greater altitude thus allowing longer flights. The following graph shows the densities of cured laminates.



The construction of the four fins and control surfaces is interesting, because they represent minimum weight design. The ribs and spars are manufactured using 'Fibrelam' boards slotted and cleated together. Fibrelam boards are used in airliner floors and galleys and can be bought 'off the shelf'. Fibrelam consists of two skins consisting of two layers of glass fibre at 0°/90° separated by a phenolic coated aramid honeycomb core.

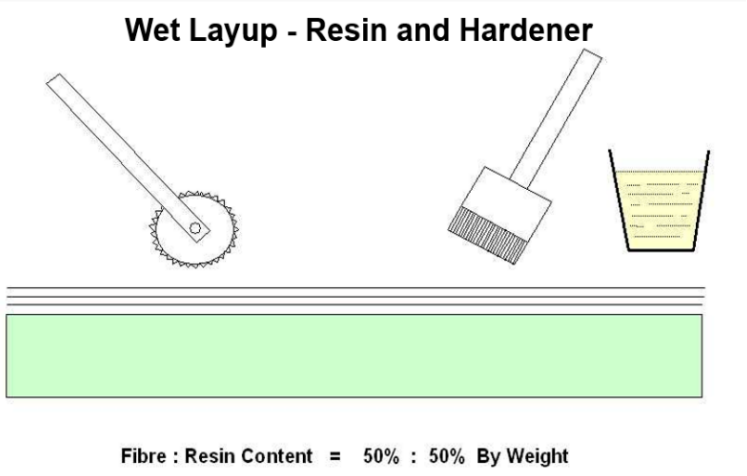
Fibrelam :

To reduce the weight of the kevlar spars and ribs further, there are cutouts. The fins are covered in 'ceconite', a plastic coated fabric, and the control surfaces are fibrelam bent over to form an aerofoil shape.



- **Composite Manufacturing Techniques Used At Slingsby Advanced Composites.**.

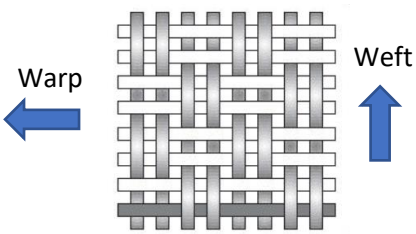
The important factor in laying up composites is to consolidate the laminate, removing as much air as possible, and removing excess resin. The aim is to increase the fibre content and reduce resin content as much as possible. Consolidation of wet layup laminates is done by the laminator dabbing the laminate with a brush to remove excess resin and by using a roller. With prepregs (cloth preimpregnated with resin), vacuum bags or an autoclave are used to consolidate the laminate.
Epoxy resin is used for aircraft projects, because it is stable under cure, and vinyl ester for marine products as it is a good resin for Resin Transfer.
Here are some details of the various composite layup techniques used at Slingsby, and the resulting fibre/resin content.



Post Cure: After laminating is completed, the moulding is post cured in a hot box. This ensures that the resin chemistry is optimised and completed, and this also ensures that a good 'glass transition temperature' is the result. If a composite structure heats up due to solar gain, and the surface temperature exceeds the glass transition temperature, the resin will break down and structural integrity will be lost. This is important when choosing what colour to paint the upper surfaces. The designer needs to know the amount of solar gain for each colour in order to predict the surface temperature of the laminate for a given ambient temperature.

Glass and carbon rovings consist of parallel fibres, whereas a yarn consists of fibres twisted together.
The fibres can be woven into a cloth to form "woven rovings". The cloths used for the aircraft are normally 'twill' weaves which consist of two weft fibres over and under two warp or 'straight' fibre's which run along the length of the roll. This makes them more drapeable over curved surfaces.
Pultruded rovings are produced by pulling glass or carbon fibres through an epoxy resin bath. The resulting rovings are very strong and are used in the spar caps in the T67 wings, and the longerons in the T67 fuselage.

Twill Weave Cloth

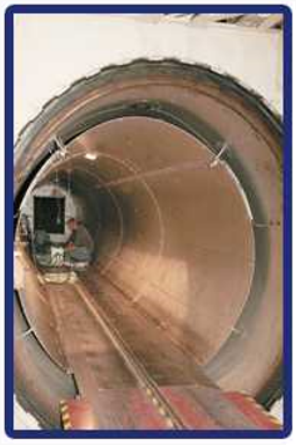


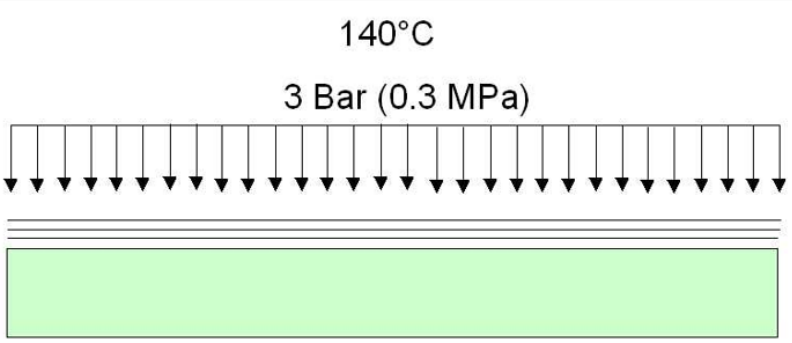
Glass and Carbon Rovings

The best laminates are processed in an autoclave. Slingsby had a Sholtz autoclave. The autoclave is expensive to operate, and to make the process more efficient, shop loading has to be highly organised so that as many jobs as possible are in the autoclave when it is running.

Here is an animation of the autoclave process: https://www.youtube.com/watch?v=3Wy8L6PHAkU

Full Autoclave Cure Prepreg





Fibre : Resin Content = >70% : 30% By Weight

2.5m Diameter

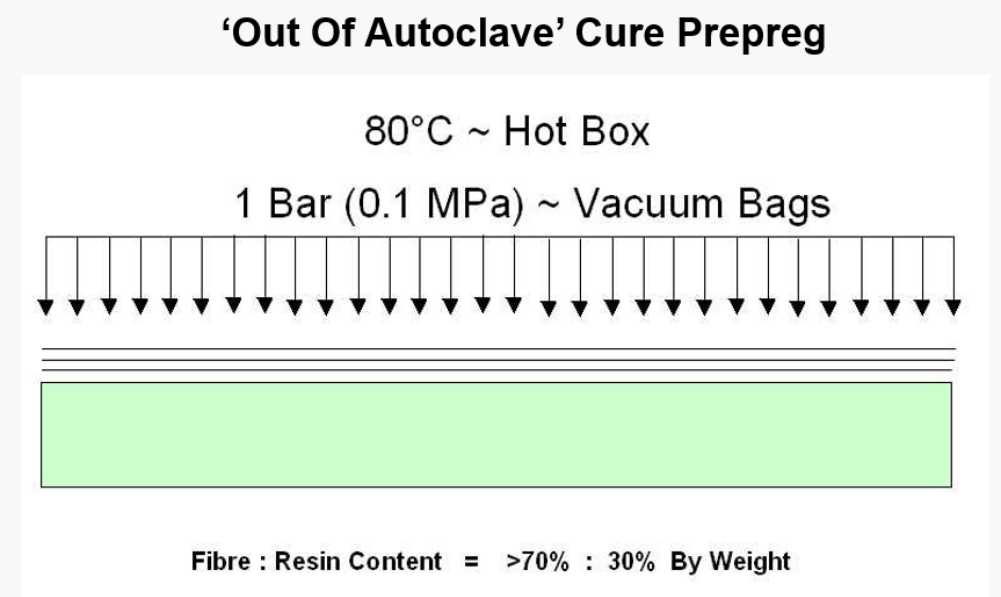
15m Long

This is the spinner cone for the Bombardier Dash 8 Q400. The original spinner cone was aluminium, but using glass prepreg there was a 40% weight saving (19 lbs, 8.6 Kg).

Glass Prepreg + Epoxy Resin

In order to reduce the reliance on the autoclave, the ‘Out Of Autoclave’ (OoA) curing process was pursued at Slingsby. The epoxy resin system in these prepregs has been developed for low temperature mouldings (LTM). Consolidation of the laminate is by vacuum bags, and the resin is processed in a ‘hotbox’ or oven.
Tests carried out at Slingsby demonstrated, that although mechanical properties were not as good as the autoclave cured laminates, the results for OoA were within 10-15%.

The OoA process was used for the autonomous unmanned air vehicles (UAV) airframes designed and manufactured at Slingsby for BAe Systems.

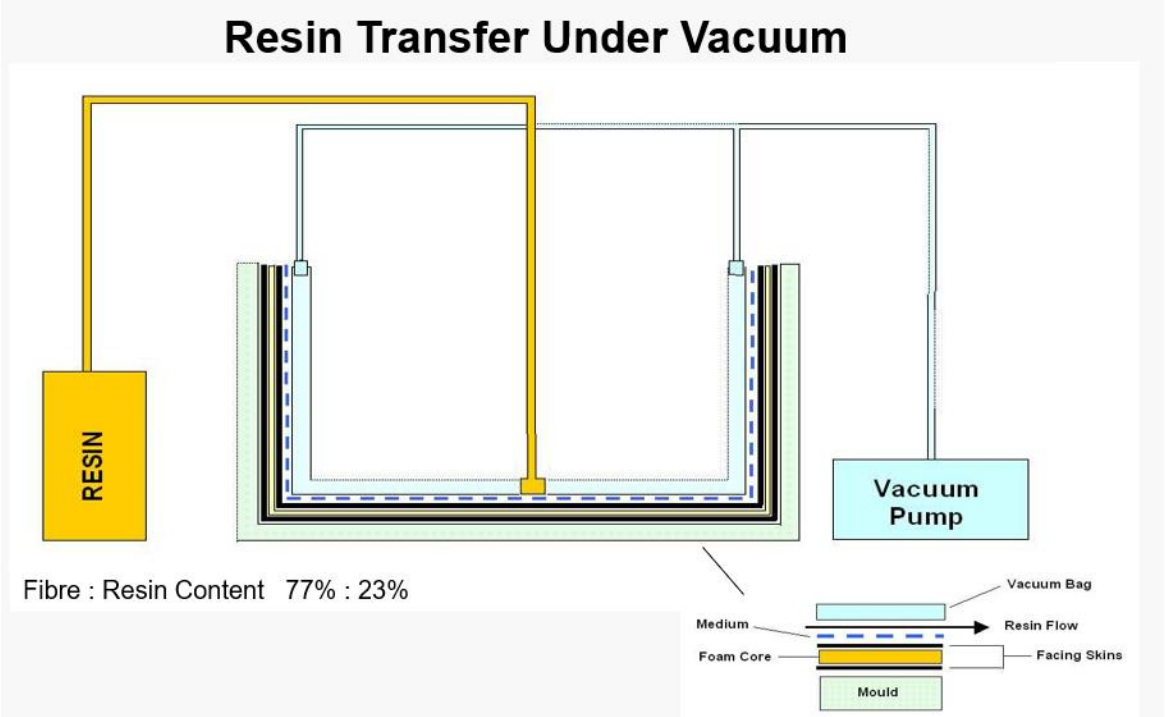


The airframes were post cured in a hot box at a higher temperature than 80°C to make sure the ‘glass transition temperature was as high as the chemistry allowed. This was important as these airframes were painted grey and were operating in hot climes.

The OoA process is excellent for ‘home build’ or small workshop manufacture. Ivan Shaw is developing his economy aircraft in his workshop, with a hotbox under the work bench, and vacuum bags for consolidation of the carbon fibre laminate. The OoA process has allowed the whole airframe to be manufactured with the minimum of personnel.

For large marine structures, laminates with high fibre content can be achieved with the Resin Transfer process. Here resin is pulled through the cloth under vacuum. Vinyl Ester resin is the preferred resin system for resin transfer

The structure below is the gun shield for the Type 45 Destroyer. This was manufactured in one piece with no joints, in a split mould.



The structure of the shield consists of two glass fibre skins, separated by a foam core, and this can be seen in the diagram above. The medium used is a mesh structure (polypropylene) and is used in order to distribute resin within a fibre layup structure and to increase the injection speed of the resin into the fibre layup structure.

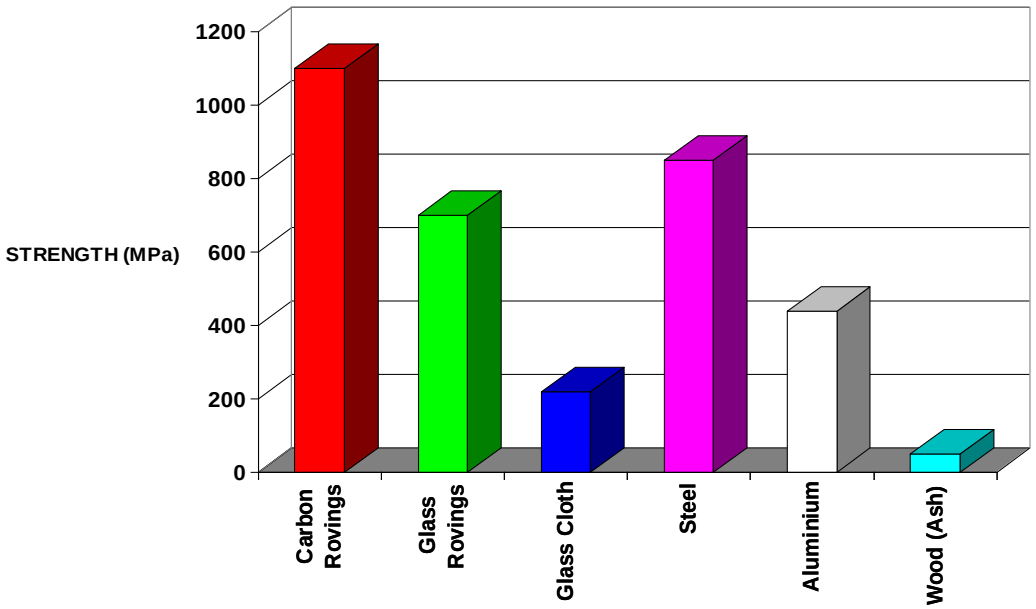
Here is an animation of the Resin Transfer process: https://www.youtube.com/watch?v=YT7G0yrQ5Eo

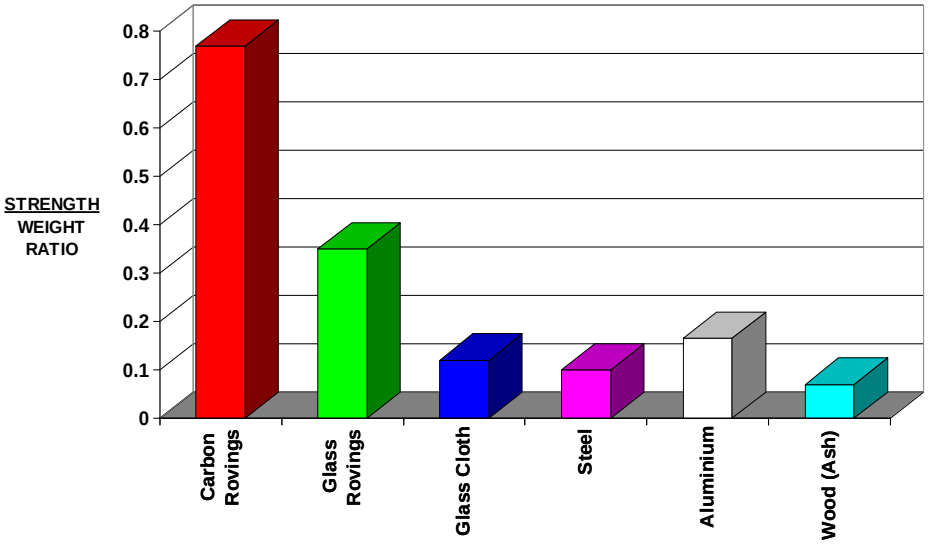
The glass cloth is a knitted, or stitched fabric. In the twill weave glass cloths for the T67 firefly the weft fibres are woven over and under the warp factors which remain straight. Because the weft fibres are not straight they lose a little strength. This is known as the crimp factor. In knitted fabrics, layers of unidirectional fibres lie on top of each other, for example a layer at 0° and the other at 90°. The layers are then stitched together. These types of cloth are ideal for Resin Infusion and Resin Transfer.

- **Advantages And Disadvantages Of Using Composites When Compared With Metals**

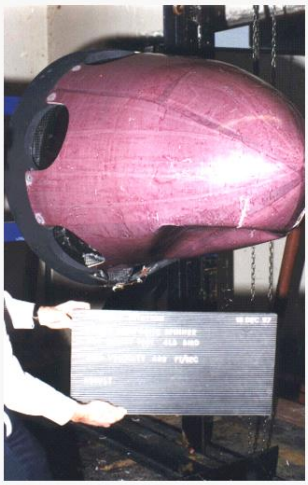
  i) Advantages

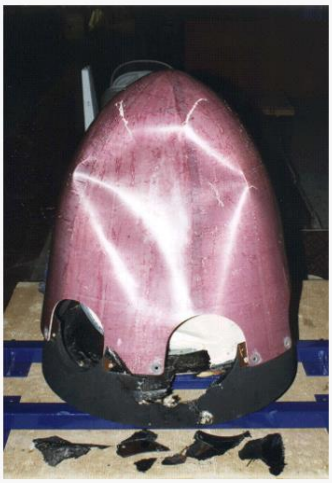
  - Good Strength to Weight Ratio. A comparison of composite and metal strength to weight ratios is shown below.
  - No Corrosion
  - Strength and Stiffness can be tailored where it is required. This has allowed the manufacture of light weight forward swept wings for aircraft.
  - Laminates can be moulded to form complex shapes
  - Damage Tolerant
  - Kevlar and glass laminates have good impact resistance. Kevlar is used in bullet proof vests. The spinner cone for the Bombardier Dash 8 Q400 was manufactured using glass prepreg. It is only 1.3mm thick yet sustained a 300mph bird strike test, with a dent and two small cracks. Although the internally stiffener diaphragm was displaced, and 50% of the fasteners were lost, the cone sustained a 20 minutes overspeed, representing the aircraft going around and landing.





DOWTY R408 SPINNER CONE ~ BIRD STRIKE TEST
J.A.R 4lb Chicken At 300 mph



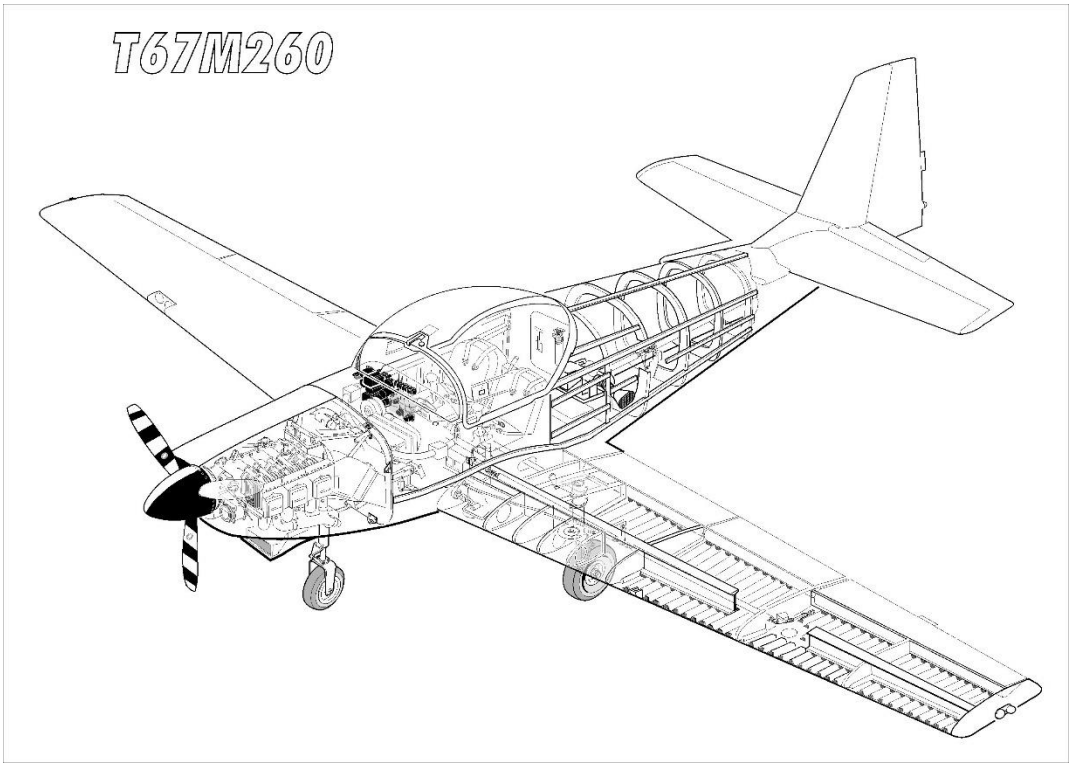


- Glass cloth / rovings are relatively inexpensive. The cost of glass laminates is between 6% to 9% that for carbon laminates.
- Glass cloth / rovings have good fatigue performance
- Good smooth aerodynamic surfaces. All the aircraft structures produced at Slingsby are fully bonded. That means the skins of the wings are bonded to the ribs and spars with araldite adhesive. Similarly, the fuselage skins are bonded to the frames and longerons. This means that there are no countersunk rivet or fastener heads on the aerodynamic surfaces
- Repairs well maintaining smooth surface. Using scarfing repair techniques, after the repair has been performed and the surface painted, the repair can't be seen. No 'repair' patches required.
- Can be used for aircraft, marine and terrestrial structures.
- Can be used worldwide. The T67 Firefly has been cleared for operation in climates as diverse as Canada, Norway, Jordan and Hong Kong.

ii) Disadvantages

- Hygrothermal degradation under temperature and humidity. As long as the material is understood, say by testing the material 'hot and wet', any lifetime reduction in strength, due to moisture and heat, can be taken into account by the engineer when designing the structure.
- Wetlayup is labour intensive. For example, the T67 Firefly wing span is 11 metres, and the resin when mixed with a hardener has a limited 'pot life'. The wing required eight laminators at a time. This problem has gone away however, with the greater use of prepregs and the resin transfer process.
- Weight variance can be greater than for prepregs. The final weight of a wetlayed up laminate is dependent on the experience of individual laminators. As was said earlier, unlike metals, the laminator manufactures the material as well as the component. Use of prepregs and resin transfer reduces this uncertainty
- Structural integrity is limited by Tg (Glass Transition Temperature). Structural integrity is lost when the temperature increases beyond Tg. Post curing temperature determines Tg, so this can be set.
- UV causes resin to degrade. The laminates are protected from UV by polyurethane paint which contains UV blockers
- Kevlar ~ poor compression properties and difficult to cut
- Kevlar is a hygroscopic aramid. This means it takes on moisture faster than glass or carbon laminates. Heat and moisture are the enemies of composites, reducing their strengths (see above).
- Carbon ~ expensive and poor impact performance
- Carbon requires electrical bonding against lightning strike

- **The T67 Firefly Aircraft**



The T67 Firefly is a two seat composite aircraft, developed from the wooden Fournier RF6B, and manufactured with glass fibre and epoxy resin. It has a fixed tricycle undercarriage. The tailplane is bolted to the two aft frames.

The aircraft is fully aerobatic and is cleared for 6G to -3G with a life of 18,000 hours.

The fuselage and wing have been statically tested at 60°C (to cover a certification temperature of 54°C), and were loaded to the equivalent of 11g before failing. The static test followed a fatigue test of 105,000 hours, 30,000 hours of which included induced damage. The fatigue test was carried out at ambient temperature.

There are a number of variants powered by the 160, 200 and 260 Hp Lycoming engines.

The Firefly is cleared for worldwide use. The Firefly has operated with the RAF as a primary trainer, the Canadian Aviation Training Centre, the KLM Flying Academy of the Netherlands, the Turkish Air League and the Jordanian Airforce.

The fuselage is a closed box section with a cutout for the wing and canopy. The fuselage carries bending, shear and torsion loads. The vertical and lateral fuselage bending loads are carried by the longerons in tension and compression. The longerons are glass rovings (see previous). The fuselage skins carry the shear loads and consist of glass cloth layed up at ±45°. The fin is integral to the fuselage, like the Spitfire.

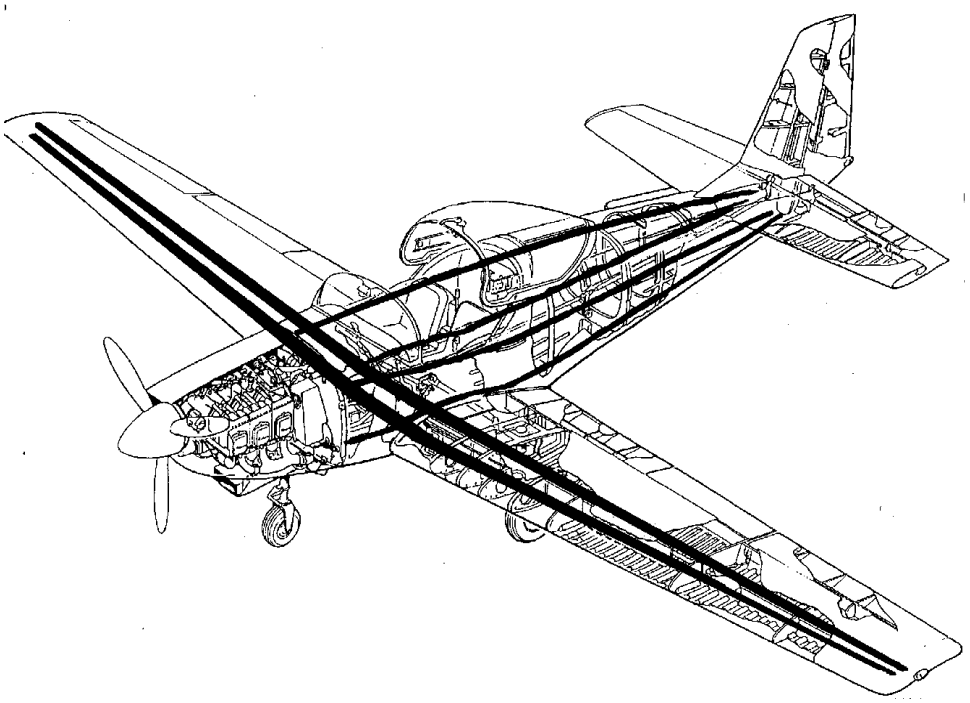
The wing also carries bending, shear and torsion loads, and has two spars, the main, and the rear which helps to distribute the main gear loads into the wing. The wing and main spar are continuous from wing tip to wing tip, with a wing span of 11 metres. If fact the pilots sit on top of the wing.

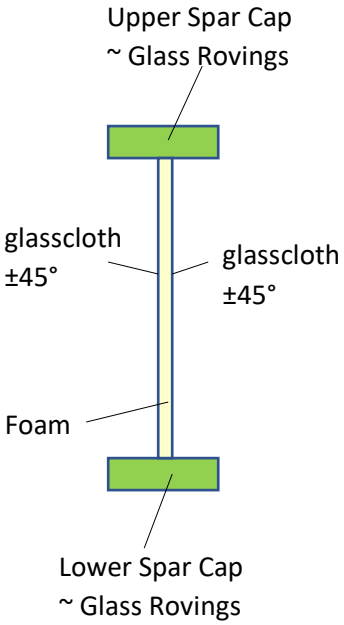
The main spar carries the wing bending loads. The main spar consists of an upper and lower spar cap made from pultruded glass rovings. For positive G the upper spar caps carry compression loads, and the lower tension loads. The loads in the caps increase towards the aircraft centre, and therefore the rovings increase in cross sectional area because of this.

The vertical shear in the wing is carried by a vertical shear web between the two spar caps. The shear web consists of two skins each side of a foam core. Each skin consists of glasscloth at ±45°, which is the optimum layup for shear loads.

The canopy is two piece (windscreen+canopy) and is stiffened with carbon rovings. The flaps have kevlar skins because stones can be thrown up by the main landing gear. The other control surfaces such as elevator, ailerons and rudder consist of a glassfibre substructure, and are covered by doped fabric.

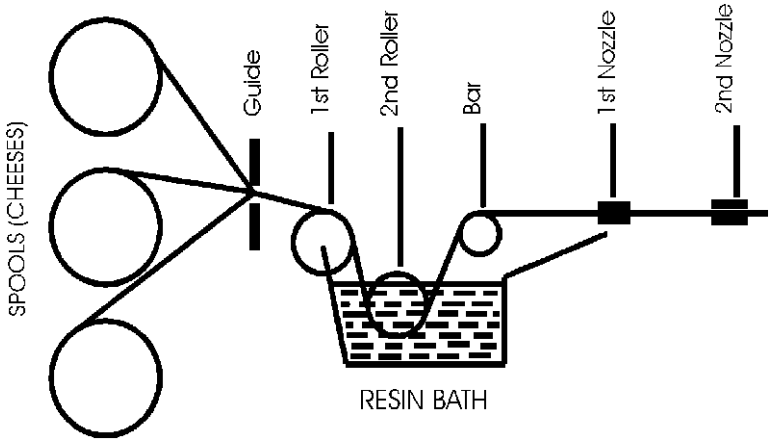
Glass Rovings Carry The Bending Loads In Fuselage and Wing in Tension and Compression.





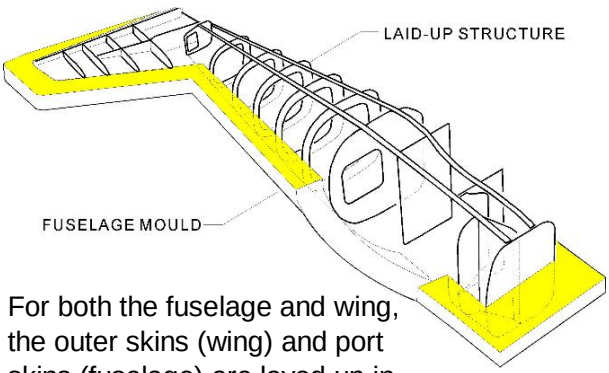
Wing Main Spar

Carbon and glass rovings are manufactured by pulling glass fibres through an epoxy resin bath.

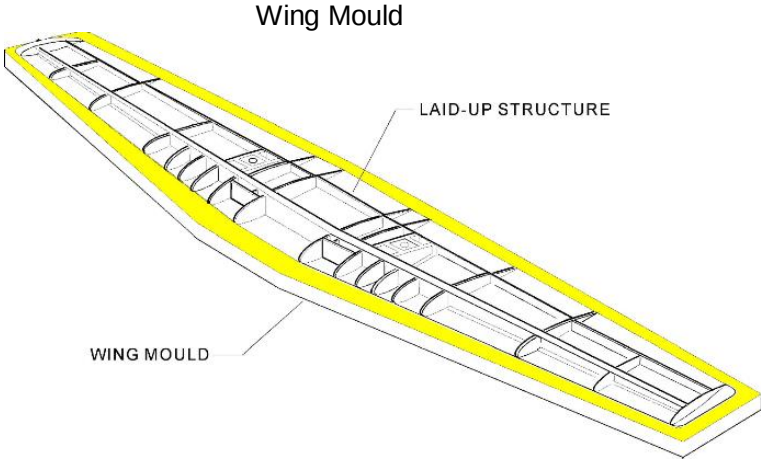


There are 28 spools or cheeses, and the fibres are pulled through the rig with a tensioning device to prevent kinks. The first nozzle removes excess resin back to the bath and the second nozzle gives the rovings a radius of 6mm. The resin impregnated rovings are then placed together in a mould to produce the required shape of longeron or spar cap.

Fuselage Mould



Wing Mould



For both the fuselage and wing, the outer skins (wing) and port skins (fuselage) are layed up in the closing moulds.

Newcomen Society

The Newcomen Society have sent us a list of their upcoming events for 2018:

As last year, meetings are held at Kelham Island Industrial Museum starting at 6:30pm. Tea and coffee will be available from 6:00pm and we look forward to welcoming you to what we hope will be an interesting talk and discussion.
Meetings are free and open to all and there is no need to book seats in advance, however, if you will be attending as a group and wish to sit together please let me know and I will reserve a block of seats for you.

John Suter Meeting Secretary, Newcomen Society South Yorkshire.

Forthcoming Meetings and Events 2018

Monday 26th February, 6:30pm Kelham Island Industrial Museum
Michael Bailey:- Brunel's Fan. This is a joint meeting with the Stephenson Locomotive Society

Tuesday 13th March 2018, 5:30pm Ken Barraclough Memorial Lecture Holiday Inn Royal Victoria, Sheffield
Norman Bonnor:- History of Satellite Navigation. This is a joint meeting with the Sheffield Metallurgical and Engineering Association and the South Yorkshire Industrial History Society

Monday 23rd April 2018, Kelham Island Museum
Robert Kerry and Andrew Gordon:- Hip and knee replacement - a surgeon's perspective.

Monday 21st May 2018 Society Visits to AMRC and AESSEAL, Rotherham.

- AMRC~ Sheffield University's Advanced Materials Research Centre

- AESSEAL ~ A specialist in the design and manufacture of mechanical seals and support systems.

This year the Society's Annual Conference and Tour is to Teesside between Friday 13th and Tuesday 17th July and full details are given in the latest edition of Newcomen Links.

Contact:
If you would like to contribute to the Newsletter, the contact is:
Nevile Foster Tel 01751 474137 or e-mail nevf123@outlook.com