



URS SCHALLER

**EPOXY
RESINS
HOW AND WHY**

THE HOW AND WHY OF EPOXY RESINS

English summary - Foreword. The author, a lifelong builder and flyer of models, explains that his effort to make models lighter, stronger and better-looking eventually turned his hobby into his profession. Working with fellow modellers, he tested epoxy resins together with glass, carbon and Kevlar cloth and roving tapes, which made it possible to build foam wings faster, better and more cheaply. A key breakthrough, developed by many people over years, was using vacuum to press wing skins on with high, even pressure; it is still regarded as the best method. He is glad to share these techniques with Italian modellers, sees them as a stage in an ongoing evolution, and invites readers to write to him with any problem. Products are aimed at experienced, demanding modellers and priced for the individual hobbyist.

WHY USE EPOXY RESINS?

Summary - Polyester resin is cheaper, but it has a strong, lingering and unhealthy styrene smell, it is glassy and weak in thin laminates, wets out cloth poorly (giving thick, heavy layups), shrinks by up to about 9% causing micro-cracks, and its styrene attacks foam. Epoxy, by contrast, has little or no odour, is tough without being soft, strong without being brittle, stiff, very strong in thin laminates, wets out cloth well and contains no solvents, so it does not eat foam.

Epoxy also replaces most traditional glues. The author mainly uses 5-minute and 15-minute epoxy (thickened with a thixotropic agent or microballoons when needed), resin 799 for glass-cloth covering and the SUPERFORTE adhesive for highly loaded joints. For instant, tight-fitting joints he uses 10-second cyanoacrylate - but it dissolves foam, so never use it on foam wings.

Cured epoxy is unaffected by water, fuel and chemicals and does not move afterwards, which means fewer warps. It bonds metals, plastics, glass, ceramics, wood and more, and cures by chemical reaction rather than by solvent evaporation, opening up construction and repair possibilities that older glues could not offer.

Summary - Many commercial fuselages are made of polyester: they look good but are brittle and break in a hard landing. Some epoxy fuselages are made without a gel-coat, leaving countless pinholes that make painting almost impossible. The author's fuselages use a special gel-coat outside, aerospace-grade cloth and heat post-curing at 70°C.

INSTRUCTIONS FOR USE

Summary - Resin 721: the number is just an internal code. It is one of only two epoxy systems approved for civil aircraft such as gliders, reaching very high strength in laminates and joints after room-temperature curing. Warm it gently in a water bath if it has thickened in the cold, then let it return to room temperature.

It is a two-part, cold-curing system with liquid hardeners. Temperature is critical: cure at no less than 20°C; most failures (sticky results) come from curing too cold rather than from mixing errors. A heater can speed curing, but do not exceed about 50°C, especially with fuselages, where the laminate may lift from the mould. No pressure is needed. Shrinkage is practically nil, so parts are stable and free of internal stresses (and warps), and they resist dynamic loads very well.

Four hardeners give different working times (from mixing to the start of gelling): S-S very fast (about 8 min), S fast (15 min), L slow (30 min), LG slow-retarded (50-60 min). A thin film stays workable longer than a mass of resin in a cup, because the reaction heat escapes. Mix only just before use.

Reinforcement: use glass, carbon or Kevlar cloth, rovings or tapes - never polyester "mat", which does not bond to epoxy. Strength comes mainly from a high glass content; about 45% resin to 55% glass is achievable.

Colouring: only use the dedicated pigments (5-25%, added before the hardener); colouring the gel-coat only is preferable, though two-part paint gives a better result.

Hardener S.S: repairs and bonding where 5-minute epoxy is too fast (cures in 1-3 h). Hardener S: ideal for the gel-coat in the mould (let it gel about 20 min, then laminate with a slower hardener). Hardener L: large or difficult bonds and small laminates...

Summary (continued) - Hardener L gives very high strength, about 25-35 min working time and 4-10 h cure at 22-30°C. Hardener LG suits large laminates such as one-piece fuselages and tolerates heat curing up to 100°C; working time about 55 min. Always mix resin and hardener thoroughly for one to two minutes, then pour the mix into a flat dish to extend its working time. An accurate scale is essential - never mix by eye. Ratios are by weight and the hardener is added to 100 parts of resin (100:50 = 100 g resin + 50 g hardener). The table below gives the amounts.

Resin qty in g	Hardener quantity in grams							
	100:20	100:25	100:30	100:35	100:40	100:50	100:60	
100 gr.	20 gr	25 gr	30 gr	35 gr	40 gr	50 gr	60 gr	
90 gr.	18 gr	22,5 gr	27 gr	31,5 gr	36 gr	45 gr	54 gr	
80 gr.	16 gr	20 gr	24 gr	28 gr	32 gr	40 gr	48 gr	
70 gr.	14 gr	17,5 gr	21 gr	24,5 gr	28 gr	35 gr	42 gr	
60 gr.	12 gr	15 gr	18 gr	21 gr	24 gr	30 gr	36 gr	
50 gr.	10 gr	12,5 gr	15 gr	17,5 gr	20 gr	25 gr	30 gr	
40 gr.	8 gr	10 gr	12 gr	14 gr	16 gr	20 gr	24 gr	
30 gr.	6 gr	7,5 gr	9 gr	10,5 gr	12 gr	15 gr	18 gr	
20 gr	4 gr	5 gr	6 gr	7 gr	8 gr	10 gr	12 gr	
10 gr	2 gr	2,5 gr	3 gr	3,5 gr	4 gr	5 gr	6 gr	

Summary - Microballoons: a very light white filler of tiny hollow spheres, used to thicken resin into a light filler paste or to form wing-fuselage fillets. Resin 799: very fluid, with a special thinner; long working time (about 100 min), cures in 12 h or more at 23°C; ideal for covering balsa and bonding balsa to foam because it cures even in very thin films. SUPERFORTE: 1:1 structural adhesive, 30 min working time, about 6 h cure. EPOXY 15-min: 1:1, for small repairs and joining foam wing panels. EPOXY 5-min: 1:1, cures fully without staying rubbery.

Sticky surfaces are caused by too short a cure, temperatures below 20°C, humidity above 60%, a wrong ratio or, most often, poor mixing. Clean with FETTEX or methylene chloride and recoat with 799. Tools are cleaned in methylene chloride (non-flammable but toxic), kept under a layer of water to stop evaporation.

Storage: about 20°C in closed glass containers; crystallised material can be re-liquefied in a hot water bath and cooled before use. Safety: keep away from children, eyes, wounds and food; do not clean skin with solvents - use a skin cleanser (CUPRAN) and gloves if allergic.

Repairing foam wings: they repair quickly and stay light. After a crash, collect every fragment...

Summary - Repairs. Take the pieces home and stay calm. Work on a flat, thick board (about 30 mm chipboard) covered with thin plastic sheet so nothing gets glued to it. Reassemble the wing dry, note where each fragment belongs, then lay the pieces aside in order.

All surfaces to be bonded must be clean and grease-free; use solvent everywhere except on foam, which is only sanded. Metal parts are roughened. Use resin 721 if you repair often, or EPOXY 15-min (1:1, no scale needed) for a one-off job.

To keep weight down, mix the epoxy with microballoons into a paste that no longer runs, and spread it on the broken faces. Fix the root section flat on the board to keep the wing straight - with rubber bands, clamps or simply long thin pins pushed through into the board (leave the heads standing proud for easy removal; the holes are easily filled). Press the pieces together, check alignment at once, wipe off excess resin before it cures and leave for 24 hours.

Sand the repair with wet-and-dry paper (grit 100-150), protecting the surrounding balsa with masking tape, then cover it with a strip of light glass cloth (about 45 g/m²) using resin 799 (or 721 for small areas).

A broken epoxy fuselage is cleaned, sanded back and reinforced with glass cloth of at least 160 g/m² (never mat), wetted with resin but without microballoons; add cloth inside too if you can reach it.

More generally, covering balsa with light cloth (18-80 g/m²) and resin 799 adds a lot of strength for little weight. Seal the wood first with Zapon lacquer (which does not shrink), sand lightly with 220 paper, brush on resin, lay the cloth and work it until it turns transparent; cut out wrinkles or bubbles and patch them. For ultralight cloth (18-27 g/m²) the 799 mix can be thinned (about 100:80 with its thinner) so the covering adds only about 0.5-0.8 g per dm².

EXPANDED POLYSTYRENE (FOAM) WINGS

Summary - Expanded polystyrene (Styropor) is used everywhere, from packaging to insulation and shop displays, and modellers can use it too. Choose the right grade: display-grade foam of about 20-25 kg/m³, with fine, even beads, made for hot-wire cutting, is best; building-insulation grades are too light and coarse. Denser alternatives such as Roofmate (Dow) or Styrodur (BASF) work but weigh about 35 kg/m³. Buy uniform 40-50 mm sheets from a local foam supplier - consistency is the key to matching wings.

THE HOT-WIRE SAW: a bow saw with a heated steel wire in place of a blade (see drawing 1), built from fir strips of about 45x18 mm. Make a short one (about 50 cm) for tails and tips and a long one (1-1.2 m) for wing panels; cut each wing half separately. The 0.4-0.6 mm wire is heated by a 20-40 V transformer of 250-500 W, ideally with a rheostat or triac for fine control. Set it just below the point where the wire glows dull red in a dark room, then fine-tune on scrap. Use a wire that resists heat and stretching, a push-button on the saw so the current is on only while cutting (start at the leading edge; pulse it near thin trailing edges), and a pivot plus tension spring (2 mm steel wire, about 10-12 kg pull) to keep the wire taut as it expands.

CUTTING TEMPLATES: plywood templates pinned to the foam are quick but imprecise. The author prefers aluminium templates (1.5-2 mm), one for the top and one for the bottom surface, fixed to the work board with the foam block between them, since the hot wire cannot cut into metal. Start with a 1:1 drawing of each airfoil (root, break, tip, including any washout) and draw a second line inside it, offset by the sheeting thickness minus 0.5 mm, to allow for the foam melted by the wire. Glue this onto 2 mm ply and cut it out with a fine fretsaw to make a master rib...

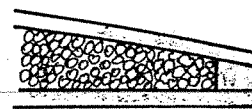
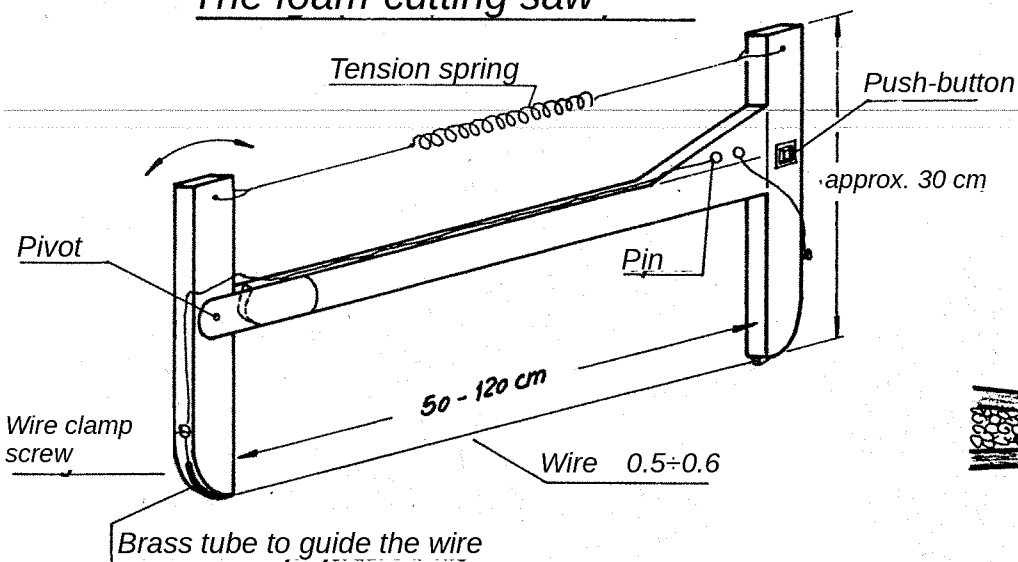
Summary - Making the templates: smooth the master rib carefully (about 20 minutes). Take aluminium 1.5-2 mm thick and 60 mm longer than the airfoil, with one perfectly straight edge; scribe a reference line 10 mm from it, place the master rib on the line and trace the upper surface on one sheet and the lower surface on another. Cut with a fretsaw (a little oil or beeswax helps) and finish with a fine file and 220 paper, working lengthwise and avoiding nicks where the wire could catch.

A straight or tapered wing needs two pairs of templates (root and tip), a double-tapered wing three. Always cut each half separately. Draw the planform on a 20 mm chipboard board and fix the templates at the root, break and tip with small angle brackets and self-tapping screws. Cutting: saw foam blocks to the planform, allowing for the obeche leading edge (8-10 mm), and make each block exactly as long as the distance between templates. Weight the block down, cut the upper surface first, then move it to the lower templates for the second cut. One person can cut up to about 1 m; longer panels need two people, who keep in step by calling out the 0-10 marks on the templates. Pulse the current near the trailing edge, or shim the template 0.5-0.8 mm there, to avoid a burnt or curled edge.

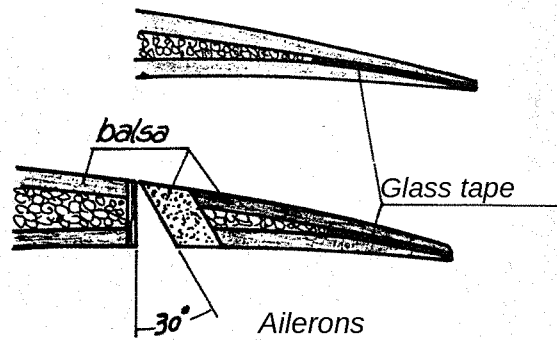
FINISHING THE CORE: for a double-tapered scale glider wing, glue the foam panels together with 5-minute epoxy, together with the top and bottom cradles (the offcuts), which are later used for sheeting and as transport protection. For ailerons, route channels for Bowden cable sleeves with a 3 mm cutter, avoiding tight bends; fit airbrake boxes at this stage too.

GLUING THE SHEETING TO THE FOAM: the core must be sheeted with balsa (or obeche). Common glues such as contact cement or PVA stay rubbery, must be laid on thick and can add as much as 100 g per wing half without making the bond stronger - the skins must be rigidly locked to the core for the wing to be stiff. Modern adhesives work in very thin films, and the author argues that modellers should finally adopt epoxy resins, which his firm supplies in small hobby quantities together with all the reinforcing materials...

The foam-cutting saw

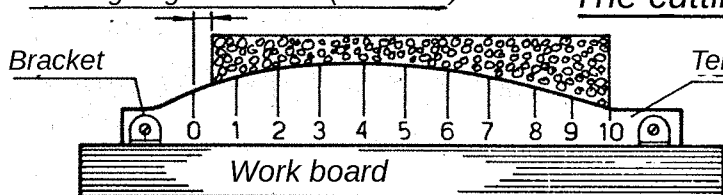


Trailing edges

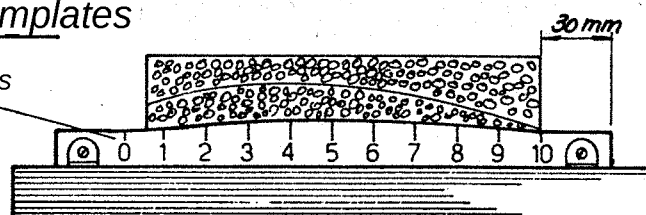


Leading-edge thickness (8-10 mm)

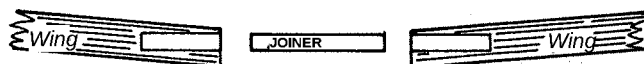
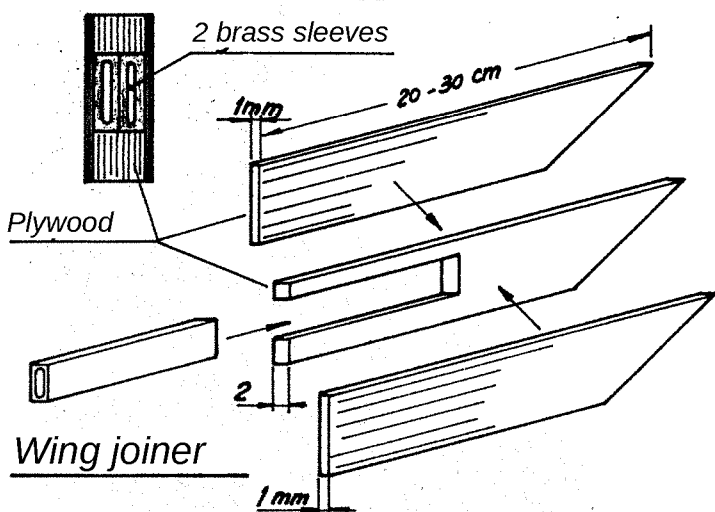
The cutting templates



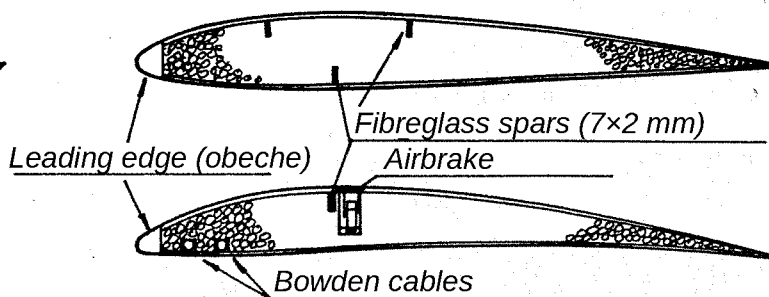
Templates



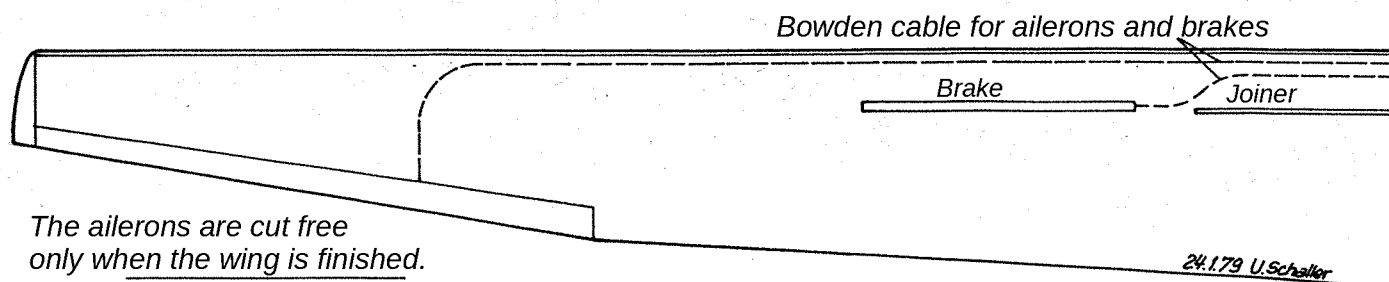
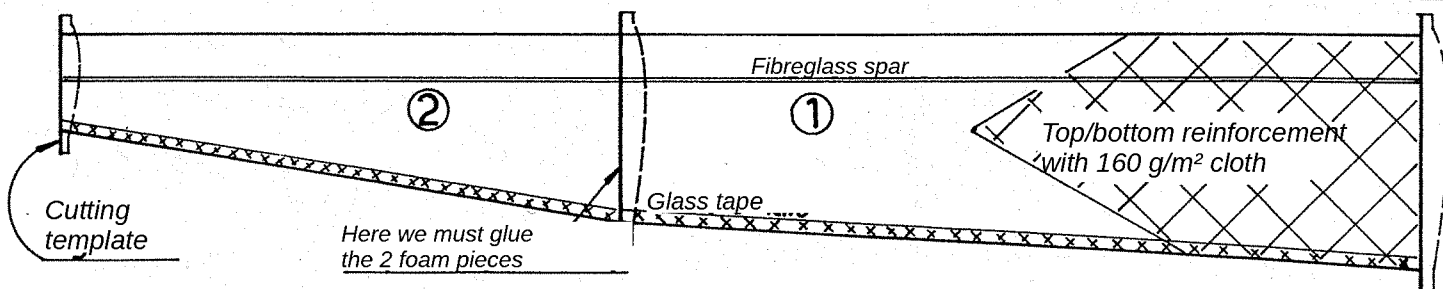
Joiner for 5 m spans



By tilting the sleeve in the wing you can get the wing dihedral with a straight joiner!



① + ② Cut 2 separate pieces of STYROPOR and glue them together afterwards!



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Summary - Epoxies contain no solvents and cure by chemical reaction, attack no other material and bond almost anything except grease, so they are ideal for skinning foam wings. Resin 799 is the recommended type: its working time is generous, a little colourant shows where resin has been applied, an accurate gram scale is essential and work should never be done below 20°C. Because the core is curved and the balsa flat, pressure is needed to make the skin follow the shape (the epoxy itself needs none). Simple method: two 40 mm chipboard boards, about 20 cm larger than the wing half, drilled every 12-15 cm around the outline for long coach bolts with wing nuts. The sheeted core goes between the foam cradles inside this sandwich; tighten evenly (not too hard), checking the gap all round, and use the same gap for both halves or the wing will warp or the halves will differ.

Better method - vacuum, first tried in Munich in 1970: an old refrigerator compressor (bought cheaply from a scrap dealer) serves as the pump. Spread resin on the balsa (not the foam), tape the skins to the core, seal it in a plastic bag with a brass tube sealed with putty, and connect the pump. The bag presses the skins on with perfectly even pressure; rest the wing in its cradles under some weight. An old carburettor in the line can be used to regulate the vacuum. With 799 keep the pump running about 12 hours.

Reinforcement: the author prefers a heat-cured 7x2 mm fibreglass spar set into a slot routed in the foam, glass cloth (160 g/m²) between foam and balsa at the root over 40-60 cm, cut to a triangular shape to avoid stress points, and a 25 mm glass tape inside the trailing edge so it can be sanded sharp. Alternatively, unidirectional tape (60-90 mm) top and bottom forms a stiff but heavier spar.

Use very light balsa for the skins (a 1.5 x 100 x 1000 mm sheet should weigh no more than about 15 g)...

Summary - Edge-join several balsa sheets with tape on one side and glue the seams with cyanoacrylate (keeping it away from the foam); lengthen sheets with scarf joints of at least 45°. Glue an 8-10 mm obeche leading edge with SUPERFORTE.

WING JOINERS FOR GLIDERS: for round steel joiners, cut a 15 mm slot 20-30 cm long into the root, glue in a balsa insert, plane it flush, and drill for the brass sleeve after the wing is finished. Technically better is a rectangular joiner, tall in the direction of lift and slimmer sideways so it absorbs landing shocks: after finishing, cut a 4 mm slot 20-30 cm long and glue in a small plywood box (see drawing). It also allows a straight joiner with dihedral; above 4 m span use two sleeves side by side.

FINISHING THE WING: sand with 220 paper, sharpen the trailing edge (possible thanks to the glass tape) and round the leading edge evenly, checking with a template. The author dislikes iron-on film as dead weight; if used, choose a low-temperature film to protect the foam. For a light mirror finish, cover with 18 g/m² cloth and resin 799 thinned up to 80% (mix with hardener first), after sealing with Zapon, one side at a time; curing in the vacuum bag gives a mirror surface without sanding, ready for two-part paint.

Read the instructions supplied with the resins before starting; the methods described have been proven over many years.

TIPS: 5-minute epoxy for quick bonds; cyanoacrylate for very fast, tight joints in wood or metal (not foam); 15-minute epoxy (1:1) for leading edges, tips and root ribs; make your own light filler with resin and microballoons. The firm also supplies fibreglass airbrakes (Schempp-Hirth type, 300, 370 and 450 mm), 3 m low-friction Bowden cables with magnetic servo connectors, and heat-cured fibreglass spars up to 3 m long in several sections (7x2, 4x1, 5x1.5, 12.2x2 mm) - samples on request.

THE SURE WAY TO BUILD YOUR OWN FIBREGLASS FUSELAGE

Summary - Every RC flyer eventually collects his model's pieces from the field. Balsa is not the strongest fuselage material, and a wooden fuselage gets heavier with every repair until the balance point can no longer be corrected. A fibreglass fuselage is the answer, but shop-bought ones are rare and may be polyester, which shatters like glass. Even "epoxy" is no guarantee, since some epoxies are meant for road markings.

Aviation-approved resins are the safe choice; the author's own fuselages also receive a high-temperature post-cure.

The solution is to build the fuselage yourself. Mould-making has long been treated as a secret in modelling circles; the author wants to share it, both because a perfect outer surface requires a female (negative) mould and because professionals would charge a lot for the know-how. A home-made epoxy fuselage costs only a few thousand lire in materials.

Mould materials: plaster is good for one fuselage only. Polyester resin is cheaper, but it smells strongly (styrene, up to 40% of the mix, which is also harmful) and shrinks up to 9%, cracking the part - which is why professional mould-makers avoid it. Epoxy is odourless, bonds almost everything except grease, Teflon and dust, and does not shrink. The starting point is a fuselage plug: an existing model, a solid wooden plug made for the purpose, or an existing fibreglass fuselage. Note that copying a fuselage for commercial production is not allowed; it may only be done for your own use...

Summary - A new plug is best made in two halves: cut two plywood side profiles, glue on balsa, pine or obeche blocks (one left, one right half), tack the halves together with 5-minute epoxy and shape them. Whatever the plug, it must be filled, painted and polished to a flawless mirror finish, because every defect is copied into the mould and every fuselage made from it.

Equipment: an accurate letter scale, wooden stirrers, paper cups, wax release agent and release lacquer, 5-minute epoxy, methylene chloride for cleaning tools, rubber gloves and a thermometer (never work below 20°C).

Release: surfaces to be bonded are roughened and degreased; surfaces that must separate later are treated with release agent. The wrong release agent has ruined more moulds than anything else. Apply it only on non-porous surfaces (seal bare wood with two coats of Zapon): two coats of wax 5 minutes apart, about 20 minutes' drying, then a thin coat of water-soluble release lacquer, which gives a glossier surface and washes off with warm water - important because any residue would spoil later painting.

Setting up: screw one plug half from underneath onto a flat Formica-faced board. Glue 15x5 mm strips about 30 mm from the plug as a 15 mm dam around the mould edge, and add vertical chipboard supports at the fin and nose (and canopy) so the finished mould sits steadily. Seal all wood and treat everything with release agent and lacquer.

Joining the halves: the fuselage will be laminated in one operation with the halves joined while the resin is still wet, so the mould must be designed for it. The halves are bolted with M6 socket screws (special anchoring nut, guide bush and screw) placed about every 15 cm around the plug, and aligned by locating dowels with bushes (2 at the canopy, 2 at the fin, perhaps 2 at mid-fuselage, never more than 6). Glue the nuts and bushes to the board, plug their holes with Plasticine and degrease their outsides.

First mould layer: a special tooling resin containing about 70% steel powder for a hard, wear-resistant surface. Stir the settled powder back in thoroughly, mix 300-400 g with hardener and brush it over plug, board, dam, bushes and supports with a stiff brush (trim soft bristles shorter)...

Summary - The first metal-filled coat must not cure: after 30-50 minutes it should still be tacky and take a fingernail mark - that is the moment to continue. Work it carefully to avoid trapped air, especially in the corner between plug and board.

Next comes a bonding layer of resin 721 with LG hardener (60 + 15 g) mixed with 25-30 g of chopped glass, brushed on without bubbles. From here on the work continues without interruption until the mould is complete: strips of heavy glass cloth (200-300 g/m², about 50 mm wide) laid into fresh resin and stippled until transparent; then resin mixed with dry sand (from a pet-supply shop, dried in the oven, since moisture spoils the hardener); then cloth and sand alternately until the shell is 7-8 mm thick, with extra thickness at the wing mounting and at least 5 mm on the side supports.

After at least 12 hours remove the screws, lift mould and plug off the board with a chisel, knock off the dam and supports, and ease the plug out without breaking the edges; good release lets it pop out easily. Wash off the release lacquer with warm water.

Rejoin the plug halves, apply release agent to the plug and to the first mould half, seat the plug, fit the dowels and screw bushes, rebuild the dam and supports, and build the second mould half the same way (the only pause being while the first coat gels). When it has cured, open the mould: the two halves always register perfectly - a truly professional mould.

If you have a finished fuselage you do not want to cut in half, build a chipboard box with a top board cut to the fuselage's side outline (see the drawing on the last page). Mount the fuselage with spacers so that its centre line is level with the board, seal the gap with Plasticine from below and candle wax from above, trimmed flush. Use the box only for the first half; continue as with the split plug. The result is the same: a mould that makes building fuselages for yourself and your friends easy and accurate.

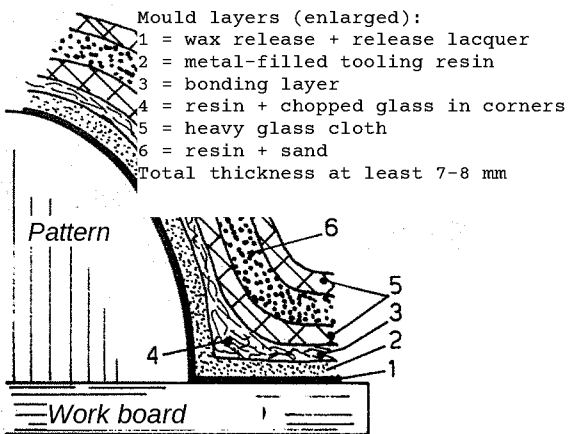
Summary - A follow-up article will explain the "wet-on-wet" method for seamless one-piece fuselages; ready-made fuselages are also available from the firm for those who prefer not to build the mould.



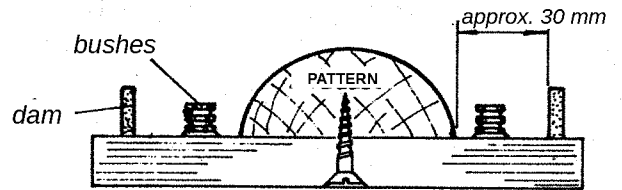
This is the locating dowel with its bush



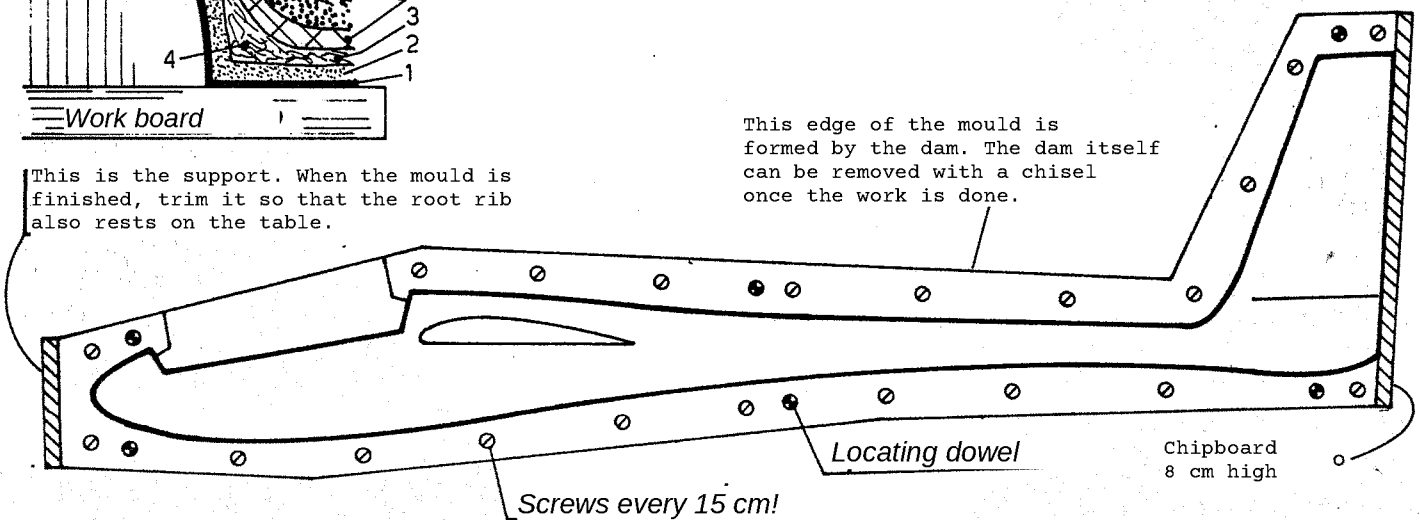
This is the Allen screw with the plain bush and the threaded one. Fit the threaded one first.



This is the support. When the mould is finished, trim it so that the root rib also rests on the table.

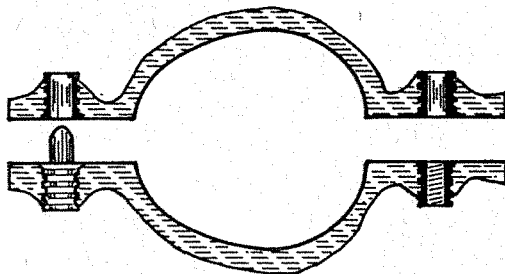


This is how the split pattern is prepared



This edge of the mould is formed by the dam. The dam itself can be removed with a chisel once the work is done.

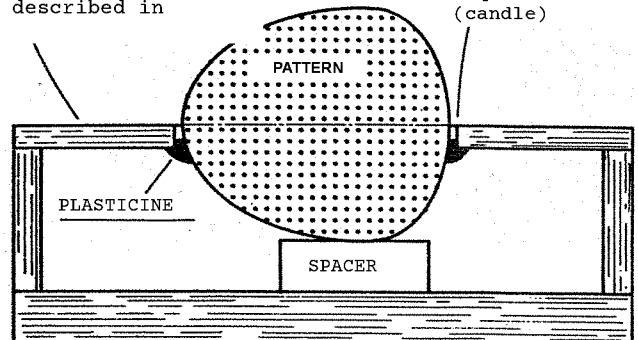
Here we have a section through the chipboard box for building the mould without having to use a pattern split in half.



Here is a section through the finished mould. It shows how the locating dowels and the bushes for the M6 screws are fitted.

On this board we build the first mould half as described in the text

Here we fill with liquid wax (candle)



Summary - The author hopes the reader now sees that anyone can build a mould, and offers to answer further questions. Good luck with your work!

HOW TO MAKE THE FUSELAGE IN THE FEMALE MOULD WITH THE SEAMLESS "WET-ON-WET" SYSTEM

Summary - The author argues that better knowledge of materials would save modellers many failures, money and effort. Traditional materials (plywood, pine, balsa) now compete with synthetics, but for load-bearing structures only epoxy resins have proved themselves, and only when combined with reinforcing fibres - most commonly glass, giving GRP (glass-reinforced plastic).

EPOXY RESIN - WHAT IS IT? Epoxies were first patented in Switzerland in 1938 and soon after in the USA; commercial production began in the mid-to-late 1940s, and today hundreds of patents and many producers exist. They are mostly made from epichlorohydrin and bisphenol. Their key qualities: excellent adhesion to very different materials including metals, resistance to chemicals and weather, good mechanical properties, dimensional stability with minimal shrinkage, and no smell or taste.

Epoxy needs a hardener that takes part in the reaction (unlike the catalyst used with polyester), so it must be added in the exact proportion - extra hardener does not speed curing but leaves it incomplete. On its own the resin is not strong enough for fuselages; it is combined with glass, carbon or Kevlar fibres. Resins range from very thin to very thick; there are laminating, bonding and casting types. Gel-coat resin is a laminating resin thickened so it does not run down vertical mould walls. The firm's resins are formulated for genuinely thin laminates (under 2 mm), which is reflected in their price.

GLASS FIBRE AS REINFORCEMENT: the fibre is what gives the laminate its strength, like steel in reinforced concrete. Ordinary glass wool is unsuitable; only alkali-free "E-glass" is compatible with epoxy. The fibres are drawn at high speed from molten glass (about 1250°C) through nozzles with many tiny holes, which stretches them to diameters of only a few thousandths of a millimetre, and they are then coated with a protective size...

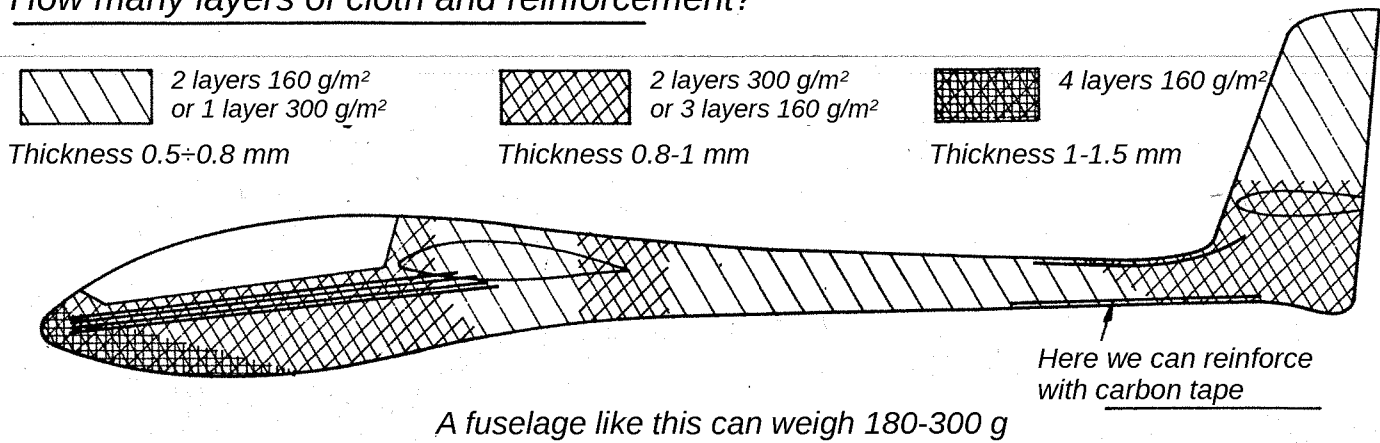
Summary - The size protects the fibres during weaving and is later replaced by a finish that improves adhesion to resin. Elementary fibres are gathered into strands and strands into rovings (continuous, untwisted bundles). Glass carries the load because it stretches far less than epoxy before breaking.

ROVINGS give the highest strength, but only along the fibre direction, so they are used for glider spars and propellers. GLASS MAT (randomly laid chopped fibres held by a binder) is meant for polyester only: weaker and incompatible with epoxy. GLASS CLOTH is the right reinforcement for models; choosing among the many weights and weaves takes experience, which the firm provides. Mat laminates reach only about 25% glass, whereas epoxy and cloth reach roughly 60% glass to 40% resin by weight - and strength comes from the glass. A practical check: weigh the cut cloth for a fuselage; you should need about the same weight of mixed resin.

APPLYING THE GEL-COAT: clean the mould of old release residue, check for defects, apply two coats of wax release and a coat of water-soluble release lacquer. Then brush on the gel-coat, which becomes the thin, pure-resin outer skin of the fuselage, so the surface can be sanded and polished without exposing cloth. The gel-coat is resin 721 thickened so it does not run; let it begin to gel (but not cure) before continuing, so the brush and cloth do not disturb it. It can be pigmented (2-10%), but painting is recommended: coloured gel-coats streak and hide air bubbles. Its type S hardener allows continuing after 30-40 minutes at 20°C or more - test with a fingernail.

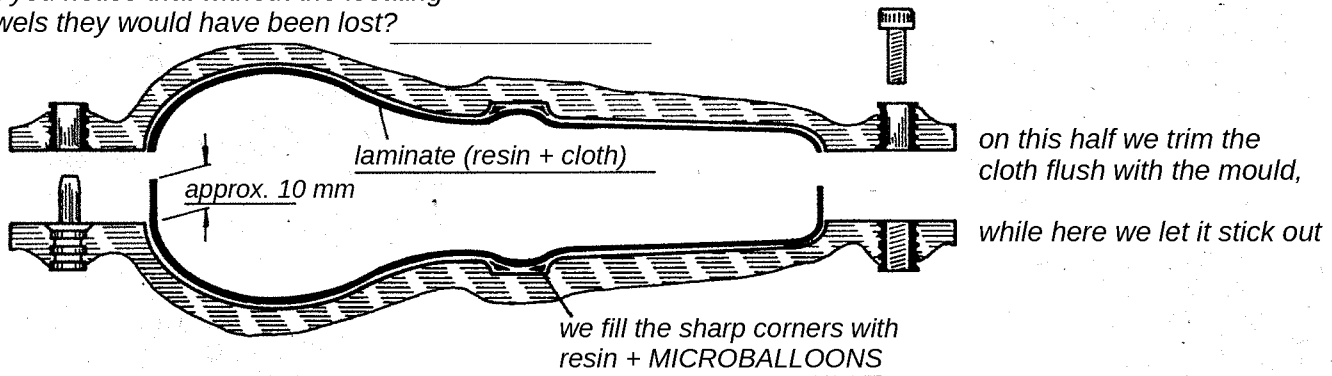
BUILDING THE LAMINATE: first, very sharp inside corners must be filled...

How many layers of cloth and reinforcement?



Section of the mould

Did you notice that without the locating dowels they would have been lost?

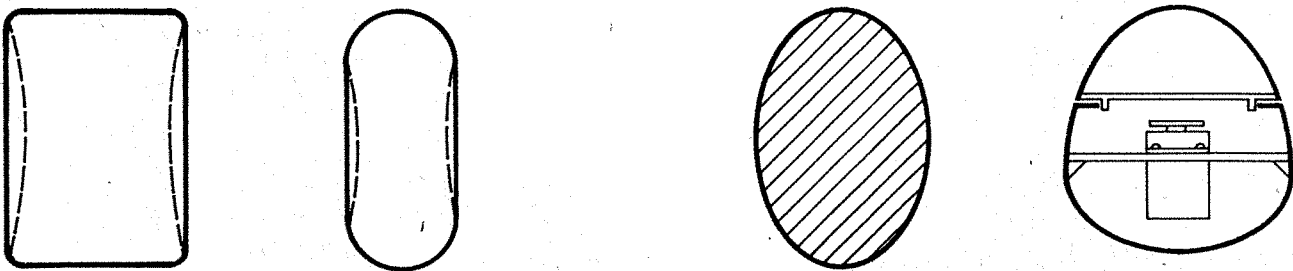


Take care not to smear resin on the mould's parting face!

What is the best fuselage cross-section to build in fibreglass?

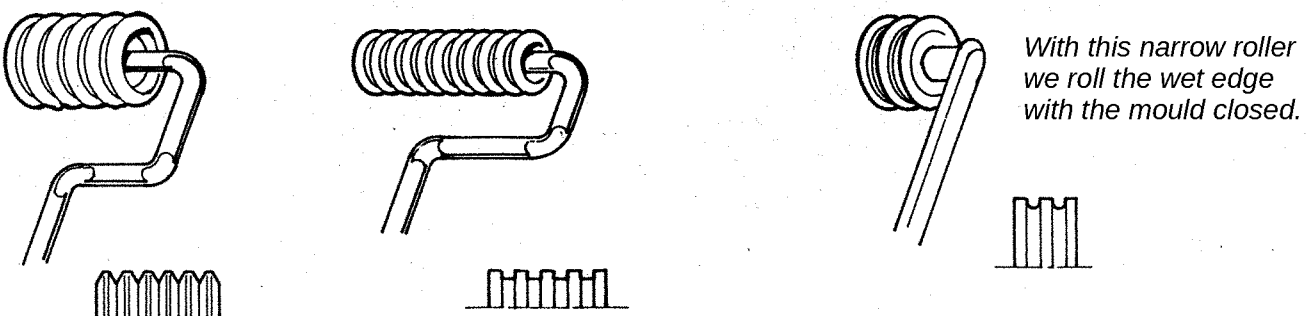
not advisable, because we have a hole

Excellent - in fact, always think of the shape of an egg!



Roller

the rollers already described in the text are used to compress the wet cloth and remove air bubbles. They can easily be made at home from a piece of TEFLON. Depending on the use, we fit a longer or shorter handle.



Summary - Sharp corners (e.g. the wing seat) are filled with a paste of 721/LG and microballoons. Then brush resin over the gelled gel-coat, lay the first cloth covering the whole impression and stipple it from above so the resin rises through it; small grooved nylon or Teflon rollers help. The cloth must be fully wetted (it turns transparent) and free of air bubbles. Add local reinforcements (nose, wing seat, carbon tape at highly stressed points), then a final full layer if needed - always resin first, then cloth.

A checklist follows: release agents everywhere including the parting faces, gel-coat with fast hardener at the correct ratio and only gelled, filled corners, slow hardener for the laminate, thorough mixing, letting bubbles rise, working from a flat tray.

THE "WET-ON-WET" PROCESS: with both halves laminated and still wet, trim the cloth flush with the parting face on the half carrying the dowel bushes, and leave about 10 mm projecting on the half with the dowels (use sharp scissors, not a knife). Place 7 mm spacers on the parting face, turn the first half over onto the second so the dowels engage, and push the projecting edge inwards against the other half with a narrow spatula, checking with a torch. Remove the spacers, let the mould close and quickly bolt it with the M6 screws - the resin's working time is running.

Then press the overlap down from inside, through the canopy, wing-seat or fin openings, using long-handled brushes and narrow rollers; wet cloth on wet cloth bonds into a single homogeneous shell, which a joint made on cured material cannot match. Use a torch rather than a hot mains lamp, and re-roll any lifted spots, adding a little resin.

Cure in a warm place (ideally 23-25°C) - cold is fatal to epoxy. After 12 hours unbolt and open the mould: you have a complete one-piece fuselage. Any air bubbles must be opened and filled with resin and microballoons. This is the whole secret of the one-piece fuselage...

Summary - Friends who tried the method built perfect fuselages in a short time, so any modeller can do it. On cloth choice: plain weave suits surfaces curved in one direction only, while twill drapes better over compound curves. The author uses 160 g/m² cloth for all his fuselages, in 1 to 3 layers as required; a single 300 g/m² layer is possible but harder to work. Two layers of 160 g/m² twill are technically better than one of 300 g/m², and carbon tape can reinforce the nose, wing seat and fin junction. Such fuselages are lighter than balsa ones, far stronger and free in shape.

Resin can also be used to make glass-epoxy sheets for skinning wings: laminate on a release-treated Formica or glass plate (optionally with unidirectional tape as a built-in spar), peel off after 12 hours and glue the rough side to the foam core - an idea for laminar-flow wings.

Final rules: treat with release agent everything that must not stick; roughen and clean anything that must, and glue it with 5-minute epoxy, resin or SUPERFORTE depending on the time needed for alignment; mix in a paper cup, then spread in a flat tray to extend working time.

THE DIFFERENT CLOTH WEAVES

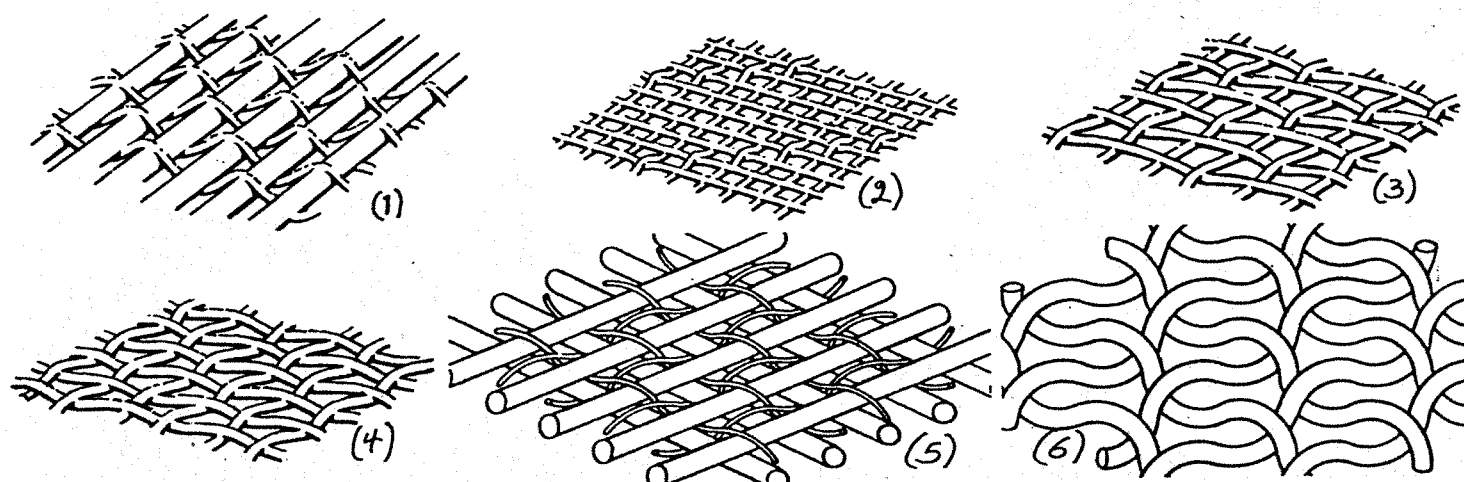


Fig. 1 - Unidirectional cloth: almost all fibres run lengthwise, with only a few cross threads; useful for wing reinforcement. Fig. 2 - Satin weave: rarely used, very hard to work. Fig. 3 - Twill weave: each thread passes over two threads of the other direction. Fig. 4 - Plain weave: threads cross alternately. Fig. 5 - High-grade cloth in which the main threads are not crossed over (a French patent). Fig. 6 - A very simple cloth, less strong than the others.

A LITTLE ENCYCLOPEDIA OF PAINTING

Summary - Colour matters: a well-painted model stands out and is the one that gets photographed. Basic rules: use contrast (contrasting colours, or light against dark tones), and remember that the primary colours red, yellow and blue combine into the secondary colours violet, green and orange. After long research the firm has had a two-part paint formulated specifically for modellers.

Planning comes before the first brush stroke: poor results usually come from impatience and bad filling and sanding rather than from the painting itself. Decide whether you are repainting or painting from scratch.

BRUSHES: round brushes are for primers and large areas; flat or oval ones are more practical and give the best final coats. Softer hair gives a better finish but makes filling coats harder to apply. Rub new brushes on a board and wash them in thinner before use; clean used brushes thoroughly and store them hanging in thinner (e.g. in a jam jar) without the bristles touching the bottom. For long storage wash them in thinner, then methylene chloride, rinse in warm water and wrap the bristles in clean paper.

SPATULAS: use very thin, flexible Japanese steel or plastic spatulas, two at a time, scraping one against the other to keep them clean; clean and lightly oil them afterwards.

ABRASIVE PAPER: dry and wet-and-dry papers come in many grits; bare balsa is sanded only dry, while paint is sanded more easily wet...

Summary - Sanding wet stops the paper clogging and scratching, cuts better and lasts longer; soak the paper for a few minutes first. Wet sanding leaves a slightly polished surface, so on epoxy fuselages finish with dry paper of the same grit to give the paint a key. Use a sanding block rather than bare fingertips to spread the pressure and avoid scratches. Avoid power sanders unless you are an expert.

RECOMMENDED GRITS: dry 80-220 for bare wood; wet 220-320 for filler, cloth/epoxy coverings and primer; 320-340 for two-part paint more than two days old; 400 for epoxy fuselages before primer or between coats; 600-1200 for removing tiny flaws, followed by car polish.

CLEANLINESS: model, tools, clothing and room must be clean and grease-free; remove dust from corners, the canopy area and the inside of the fuselage with a brush and vacuum cleaner, since most dust in the finish was already on the model.

REPAINTING: old paint is best sanded off; strippers may dissolve glue joints and even epoxy. The firm's two-part paint can generally go over other paints once they are roughened - test on a sample if in doubt.

APPLYING PAINT: stir thoroughly, working any sediment back in (a model-boat propeller in a slow drill makes a good mixer). Dip only half the bristle length, hold the brush at 90° for good coverage and at 45° for the final coat, and brush vertically to avoid runs. Thin coats are better than thick ones - patience pays.

THINNER: use only the specified SP thinner; others can ruin the paint, stop it curing or dull it. Keep containers closed and away from flames.

DRYING AND RECOATING TIMES depend on temperature and air circulation...

Summary - Paints dry by solvent evaporation and oxidation or cure chemically, so they need warmth and fresh air; in a small closed room the air soon saturates with solvent and drying slows down. As a rule allow a day between coats for good adhesion, though warm, sunny, breezy days allow several coats in one day, and damp, still days need longer.

TWO-PART POLYURETHANE PAINT: it cures chemically into a tough, even, high-quality film, can be brushed or sprayed, and resists fuel, sunlight and weather. Mix paint and hardener in glass or metal (never paper or plastic cups) in the stated ratio, measured by scale or spoon. Do not apply it on damp surfaces or outdoors in high humidity, keep the hardener tightly closed (moisture spoils it), work above 15°C and clean tools immediately.

USE: seal bare wood with Zapon or the filling primer, sand lightly and apply one or two colour coats. For epoxy fuselages, clean with trichloroethylene, dry-sand with 320-400 paper, apply primer, sand lightly and add one or two coats of colour; fill flaws with the firm's epoxy filler (100:50).

TECHNICAL DATA (in brief): mix 2 parts colour, 1 part hardener, 1 part SP thinner by volume; touch-dry in about 1 hour; recoatable without sanding within a limited time window; SP thinner also for cleaning tools.

Two-part epoxy paints have been dropped from the range because no fast, non-yellowing hardener exists yet and their 4-7 day cure is impractical for modellers.

SPECIAL TREATMENT OF EPOXY FUSELAGES: even a fuselage with a coloured gel-coat should be painted...

Summary - Mould release residue on fuselages prevents any paint from adhering. Remove it completely with trichloroethylene using a soaking-wet cloth (a damp cloth only spreads it), then dry-sand with 320-400 paper; a coat of primer fills small pinholes.

WOODEN MODELS: wood absorbs moisture, so seal it first with Zapon, thinned clear two-part paint or the filling primer, then sand off the raised fibres before painting.

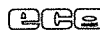
WOOD COVERED WITH GLASS CLOTH: seal with Zapon, let it dry for 2-4 hours, apply resin 799, lay light cloth (about 27 g/m² for wings and tails) and press it on with a soft brush until fully wetted. Covering the wet cloth with polyethylene film (or wrapping a fuselage with a 5 cm strip) gives a very smooth surface ready for filler, primer and paint.

Why go to this trouble on an epoxy fuselage instead of relying on a coloured gel-coat? After many experiments, customer complaints and consultations with industrial chemists, the answer is that coloured gel-coats do not hold up and turn yellow; painting is the reliable solution.

Finally, the numbers after the colour names are RAL numbers, the international colour standard, so you can match them against the colour cards in your paint shop - though the paint itself is available only from the firm.

Urs Schaller

Team up with atmospheric pressure!

(From I  n.no. 4, April 1981)

How to build an efficient vacuum rig for skinning wings at minimal cost

Summary of the article - The author describes a home-made vacuum system for jobs needing even pressure over a large area, such as sheeting foam wings with balsa or obeche, or applying glass cloth with epoxy (polyester is unsuitable). The principle: air is removed from a plastic bag, and atmospheric pressure (about 1 kg/cm^2) presses the skin onto the core. The heart of the system is a refrigerator compressor, cheap from a scrap dealer and usually still working. (A tap-water venturi pump also works, but is noisy for a 12-hour cure.) When collecting the compressor, note its three tubes: one is sealed for good; the other two, crimped where the fridge was dismantled, must be sawn open, keeping them as long as possible - carefully, since some refrigerant mixed with oil escapes.

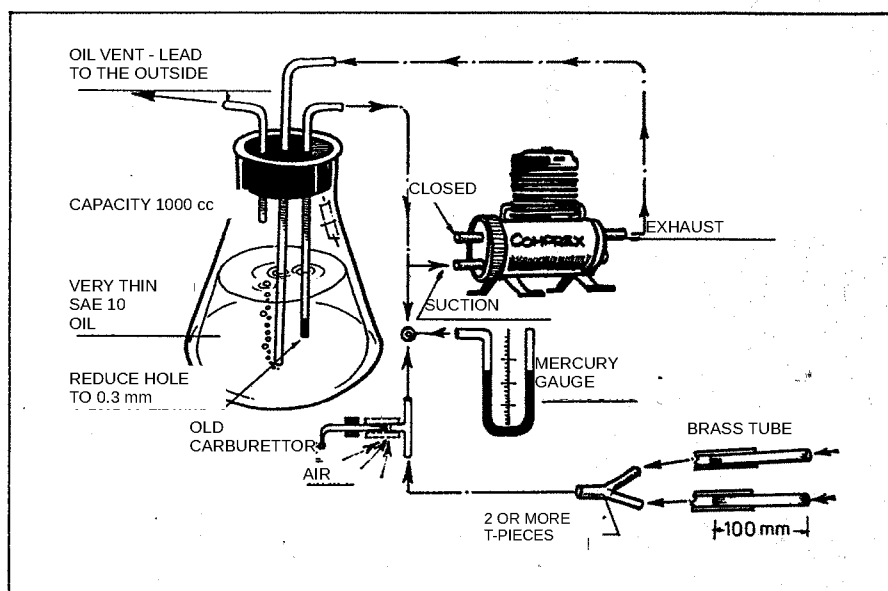


Fig. 1 - Layout of the vacuum system.

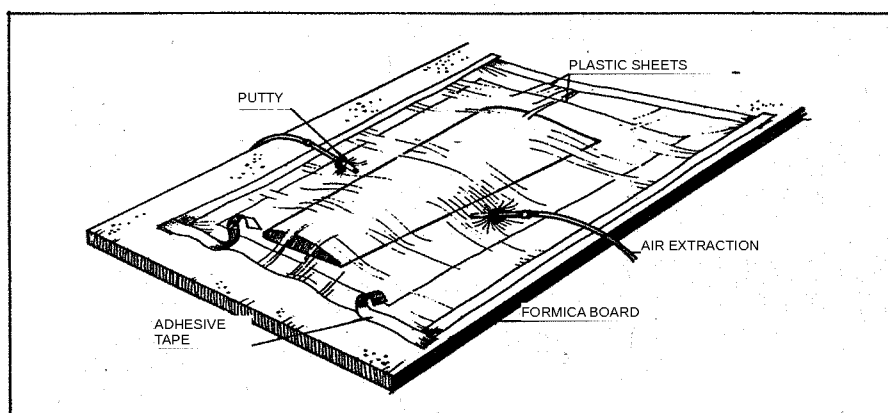


Fig. 2 - Tubes under the plastic sheet draw out the trapped air; use several suction points for large parts.

(Summary continues on the next page.)

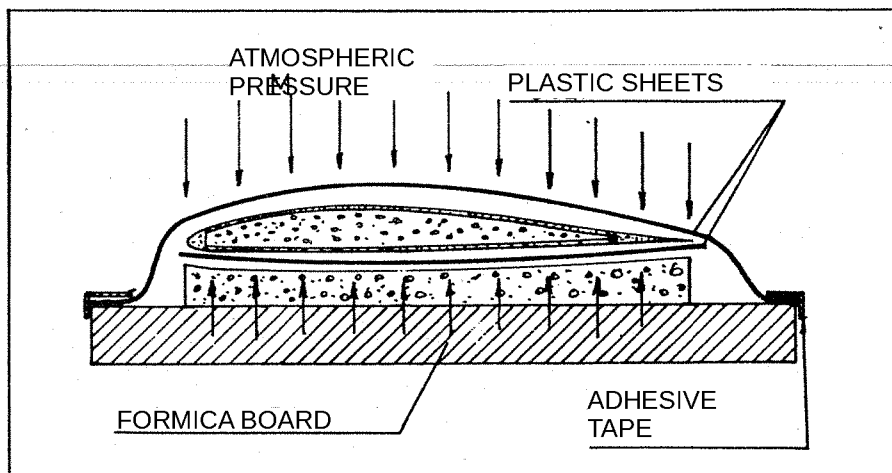


Fig. 3 - The foam cradle can be omitted if the airfoil has a flat underside.

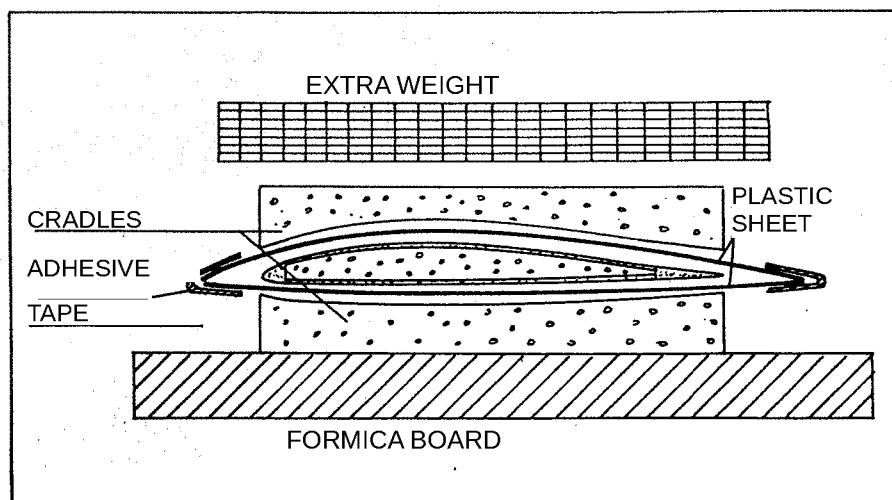


Fig. 4 - The wing lies between two plastic sheets; a weight on top (e.g. a marble slab) helps the cradles seat properly.

Summary (continued) - Remove the compressor's thermal cut-out: the pump runs at 50-60°C during long cures, which does not harm it, but the cut-out would keep switching it off. Add a glass or plastic bottle as an oil trap, PVC tubing (about 10 mm outside diameter), plastic T-pieces and brass suction tubes. A mercury or water gauge is optional; an old carburettor in the line lets you bleed in air to regulate the vacuum. To start, put about 800 cc of thin SAE 10 oil in the bottle and let the compressor draw in about half, then fit the 0.3 mm restrictor (or pinch the oil-return line, opening it only now and then).

In use, the part is sealed in a bag of 0.10 mm polyethylene tubing, with suction tubes sealed in with Plasticine or putty; as the air is drawn out, outside pressure squeezes the bag flat. Fig. 3 shows one set-up for skinning one surface: the top sheet is taped airtight to a Formica board, which both bonds the skin and presses the part flat; with a matching cradle underneath, any airfoil works.

Leaks announce themselves with a hiss; use at least two suction points on long parts. In Fig. 4 only the wing is bagged, giving more even pressure top and bottom but needing weights to keep it straight - and both halves can be done at once, stacked.

After sheeting, the wing can be finished with glass cloth: seal with Zapon, sand, lay 18-27 g/m² cloth with thinned Epoxy 799 and cure again under vacuum. After 24 hours the wing has gained only about 0.4-0.5 g/dm², and is mirror-smooth, fuel-proof and much stronger. The author invites calls for further advice - but not for fridge repairs!

Urs Schaller