

CARBON MOULDINGS USING VACUUM BAGGING TECHNIQUES

INTRODUCTION

Carbon fibre mouldings look great, are light, strong, generally unaffected by fuels and oils - I could go on and on. They can cost a fair bit, especially so if you buy 'one-off' mouldings from a commercial manufacturer.

Because I like the look of carbon fibre, have a little experience in laminating / moulding, my mind was made up - I would try making covers / panels out of carbon fibre.

There are probably people reading this who are true experts in this kind of stuff and they will most certainly be capable of picking holes in the fairly crude methods I have used and described below; it is however, a pretty accurate description of how I actually went about successfully producing the mouldings and it worked for me.

I originally wrote this article for a motorbike magazine showing how to make a replacement relay cover (see below) for a motorbike but I have found that the process is directly transferrable for manufacturing various items for cars, workshop and model aircraft etc. You are only limited by your own imagination.



Plate 1

THE SKINNING PROCESS

The following describes how to make a carbon fibre moulding by 'skinning'. You could, I suppose, describe skinning as a reverse of moulding; in moulding, carbon fibre is applied into a mould and the finish that will eventually be seen is the surface that was next to the mould. In skinning, it is the opposite way round; you apply a carbon fibre skin over a pattern and the finish is achieved by building up successive coats of resin and rubbing down till you end up with a smooth surface.

By using the skinning technique, you can save a bit of work of making a mould however with a bit of care and practice using the skinning process, you can end up with a finish that is almost as good as a commercially moulded item, you can (hopefully) re-use the part that you used for the pattern and it's fairly simple, quick and cheap.

MAKING PATTERNS

If you don't have a pattern, one can be produced in a soft, easy to shape material such as white, blue or pink foam. Rough out the shape by carving the foam using a breadsaw, (this works better than it sounds), coping saw or the like and then sand it to shape. If you have a

vacuum cleaner in your workshop it will save you, the workshop, the cat, et al from becoming covered in small blobs of foam. Smooth things off by sanding it with a 'Perma-grit' sanding bar and when satisfied with the general shape, finish off by filling any dents, dings, seams etc. with something like Polyfilla and sand it smooth. When satisfied, paint on a coat of thinned PVA glue (thin it with water about 50/50) over the whole thing which will act as a sealer. Apply mould release agent and the carbon fibre can be applied over that. When you have completed the moulding, you can either release it from the pattern or if it's stuck, remove the foam by either cutting it away or dissolving it with a suitable solvent.

Commercial moulders generally produce carbon fibre mouldings using a vacuum box and an autoclave which produces a moulding that tends to be lighter, but not really all that much stronger, than the ones we are going to make. You can now buy carbon cloth which is pre-impregnated with resin and produces really good results. Although not everyone has an autoclave, it is possible however, to replicate part of the commercial process by using vacuum bagging techniques, and it allows us to reproduce fairly complex shapes.

VACUUM BAGGING

The technique works as follows: you place the carbon fibre over your pattern, wet out the weave with epoxy resin and then shove the whole lot in a polythene bag and remove the air inside the bag using a vacuum cleaner. Give it a good suck to remove all the air, tie-wrap the end of the bag to maintain the vacuum and allow it to cure.



Plate 2

By creating a vacuum inside the bag, you are applying approx. 14.5 lbs. atmospheric pressure to each sq. inch of the moulding which forces the carbon fibre to take up the shape of the pattern and without much effort on your part either. The pattern may be a fairly complex shape but with a bit of practice, you can achieve an excellent result. Once the first coat of resin has cured, you have the shape 'set' and can apply subsequent coats of resin without any problems. Carbon fibre doesn't really enjoy being forced into complex shapes or around compound curves, and if you try and do it manually, the weave can become distorted and spoil the look of the thing. Try it with a spare bit and you'll see what I mean. Using the vacuum bagging technique is an excellent way to teach it some manners.

MATERIALS - PROPERTIES AND HANDLING

Resin:

- In principle, the warmer the ambient temperature, the faster the mixed resin will cure (harden). More later.

- The warmer the resin (up to a point) before mixing it, the easier it will flow during application however to balance this, each coat will be thinner as the viscosity is lower
- There are many different types of resin - don't be a tightwad and buy the cheapest, get a good quality laminating resin - it really is worth paying a little extra and it's pointless spoiling the road for a ha'p'worth of tar.
- Resin is exothermic when mixed with hardener i.e.: it can give off a surprising amount of heat as the chemical reaction of curing takes place (NB: see the bit on "volume mixed" in the 'End Stuff' section below - the degree of exothermic reaction can be dependant on the amount of hardener added and the volume mixed.). I tend to mix it up in containers such as those plastic pots you get coleslaw / whatever in from the supermarkets. When finished applying the stuff, sit the pot containing the excess either outside or on the concrete workshop floor to cure and cool.

Carbon fibre cloth:

- It needs to be handled gently, in fact the less handling the better. Be careful of the weave fraying at the edges.
- Use very sharp scissors to cut it. If you hack away with a blunt pair, you will end up with frayed and raggy edges. A sharp scalpel and a steel rule can also do the job.
- You will sometimes find that it has masking tape applied to the edges to prevent fraying. Don't even think of peeling it off or you will end up with a mess. Cut it off with sharp scissors.
- Work over a flat surface when you are cutting it and make sure you have plenty of room to move the cloth around.

Whilst I may be stating the obvious (something they tell me I am very good at) it had to be said, as does the next bit.

Health & Safety, Furry Mouldings, Stiff Trousers

I have no idea of what you know so I have had to address the basics here and include some health and safety aspects, however it really is only common sense well applied to a specific operation.

- Resin fumes are an irritant. Make sure you are working in a ventilated room / workshop. The fumes are pretty pungent so don't do it in the house unless you can afford the divorce settlement.
- Always wear latex gloves when working with resin as Dermatitis is not nice. If you want to do belt and braces, get some barrier cream and apply to your hands (and for the person that's bound to ask - yes, apply it before you don the gloves).
- Carbon fibre dust is really not good for you - wear a dust mask when carrying out cutting, filing or any other operations that will cause dust. Better to wear latex gloves when handling the raw material.
- Know this: Before you do any laminating, lock up, give away or sell the cat (the bagging technique may be found useful at this point). The cat that owns us generally comes down to the workshop when I am in there to keep me company and have a bit of a purr. She rubbed himself against a lamination before the resin had fully cured - ergo: furry mouldings. She then rubbed herself against my legs - ergo: stiff trousers. NB: Animal lovers please note: don't write in whinging at this point or the cat gets it.

Consumables

- Carbon fibre cloth – there are different types of weave / weight / thickness & colour. A thinner cloth is generally easier to mould, and lighter and more flexible. I try and buy offcuts from a local manufacturer of Motorbike fairings so that it doesn't cost too much per sq. metre and I can modify the methods I use to suit what I get (cut the coat to suit the cloth).
- 2 pack laminating resin. Within reason, get the best you can afford.
- Mould release agent.
- Hard carnuba wax (don't use the liquid stuff)
- Wet & Dry paper – around 380 and 600 grit size should do the trick.
- Chopped strand glassfibre mat - (optional)
- Spray tin of automotive clear lacquer
- Plastic mixing pots / lollipop sticks for mixing

Tools & other Equipment and other Consumables

- Rubbing down block (the rubber ones are best – flat one side and curved on the other, they have pins to hold the wet & dry paper in position)
- Thin washers for reinforcing any bolt holes or offcuts of Aluminium sheet for load spreading plates for fixing holes (optional)
- Dust masks - paper disposable type are OK (not optional).
NB: these are for protection against dust particles and NOT fumes
- Tac Rags - wipe down the moulding after rubbing down in between coats to get rid of dust. 'Tac rags' (used in the automotive painting industry) are good as they pick up all the surface dust – get them from car accessory dealers.
- Latex / Rubber gloves - disposable type (not optional)
- Paintbrushes for applying the resin to the moulding. You will get through a few.
- Acetone - used as a brush cleaner however Meths is preferable..
Acetone fumes are toxic – it should be used only in a well-ventilated place and should **Not** be used to remove resin from your hands as it is a skin irritant. Read the warning labels on the container or get the COSHH (Control Of Substances Hazardous to Health) data sheets at the web address shown at the end.
- Methylated spirits - a safer brush cleaner. Also use it to get any resin off your hands. Has a very low flashpoint and consequent fire hazard. Try not to smoke when using it unless you are keen on self-immolation.

MOULDING

Pattern Preparation

Relax. If you screw anything up in the following stages, don't worry about it. Have a good swear at the cat (it's probably stuck to the moulding anyway) and start again. Generally, our mouldings are so small that you can easily start again from scratch which won't waste too much time, certainly won't break the bank and as a further bonus, you are adding to your experience and skills all the time. Worst case scenario is if you screw up the moulding and get it stuck to the pattern however to do that, you *really* have to try hard. Ensure that the pattern surface finish is as good as you can get it.

Apply a good quality hard wax. Any make that contains a high proportion of 'Carnuba' wax is the business but tends to be more expensive, however for the amount you will be using, hang the expense - chuck the cat another canary.

Apply a coat of mould release agent. Allow it to dry, polish with a soft cloth and apply another coat. Repeat in accordance with the manufacturers instructions. You can reckon on between 3-5 coats of release agent. The release agent should be applied to the pattern both inside and out for reasons that will become apparent later.

Applying the Resin and Moulding the Carbon Fibre Cloth

Don't do moulding if the temperature where you are working is less than about 15°C; the ideal range is about 15-25°C. If it gets cold when I finish, I usually shove the moulding in a cardboard box with a small hole cut in one corner and poke a hairdryer set to low into the hole and go and have a cuppa. This gives you a very crude, but very effective curing 'oven'. The technique also helps maintain matrimonial (or should that be matriarchal) harmony - the Memsahib read me the riot act when I tried to lightly bake a moulding in the oven. The riot act was also invoked some years back when during a wet October, I tried to dry our Walnut harvest in the tumble drier. That as they say is another story, but the noise really was pretty awesome.

Shape the carbon fibre cloth gently over the pattern making sure you leave about 15mm (or ½" in old money) or so overlap hanging over the edges of the pattern which will be trimmed later. Don't pull it as you will stretch it out of shape and it will spoil the uniform look of the weave. Trim the edges of the cloth to size, using a set of very sharp scissors taking care not to fray the edges too much.

Have the Hoover, the poly bag and a couple of poly bag ties on standby (V. large sandwich bags work well). When satisfied that the carbon fibre cloth fully covers the pattern, mix up some resin.

Ideally, you are looking to get an even coverage of resin over the carbon cloth - you can always rub down any runs later. Make sure when spreading the resin that you don't pull the weave, raise any individual strands of carbon or stretch it - we need to try and keep the weave looking even and flat. The method that works for me is to make sure the resin is warmish before I mix it (reasonable 'runny' to use a technical term). I pour it on the cloth and brush it out very gently and only as much as absolutely necessary. The objective of this stage is to wet the carbon fibre right through the weave with resin and provide a hard 'shell'. You should have no problems with air bubbles doing it this way.

Vacuum Bagging the Moulding

Apply the resin carefully and gently spread it evenly to cover all of the carbon fibre cloth including the overlap. Use enough resin to wet-out the fibre but don't put great dollops of the stuff on. Shove the whole lot into a plastic bag, taking care not to move the carbon fibre on the pattern as you do so. Gently shape the carbon fibre over the mould through the bag and shape the overlap around the edge of the pattern (this is why we applied release agent to the inside: the carbon fibre should curl round the edge & the overlap will mould itself to the inside of the pattern). I would recommend that if you have any doubts about this part of the operation, don't grasp any of it (and given my writing technique this is understandable), or even if you do - try a dummy run without the resin. It only takes a minute or so and will give you a better idea of how it is done. See Plates 2 & 3.

When satisfied that the carbon cloth is in the right position, turn the Hoover on, open the air bleed so that it isn't sucking *too* much, gather the opening of the poly bag and stick it into the Hoover nozzle. Have the bag tie ready and when the Hoover has sucked all the air out and starts to 'redline', tie the bag end. Make sure that the vacuum is holding. If it is not, give it another suck with the Hoover.



Plate 3

Anyway, sit the whole lot somewhere warm and it should cure within about 20 minutes. Hardening times vary a bit with resin types, manufacturers and temperatures so that I can only give you a guide. With an ambient temp. of around 25°C, I was working in the open air and the resin I was using was going off within 15 - 20 mins.

When the resin hardens, remove the moulding from the bag. You might tear the bag when getting it off but that doesn't matter. When you have removed all of the bits of polythene bag left sticking to the moulding, apply another coat of resin spreading it as evenly as you can. The moulding may well separate from the pattern at this point. If it is a large part that is being moulded it will be a bit 'floppy' in which case shove the pattern back to give it some rigidity until you have applied further coats of resin. With small, rigid mouldings however, it doesn't really matter providing you handle it reasonable carefully.

Applying Further Coats of Resin

It is surprising how far the stuff goes - experience will quickly tell you how much you need to mix (Important - see also the note in 'End Stuff' below on volume mixed). What we are trying to achieve at this stage is to completely fill the weave by adding further coats of resin until we end up with sufficient thickness to rub down without cutting through to the carbon cloth- you may need up to around 3 coats to do it. When satisfied, give it a gentle rub down with 380 wet & dry paper used wet. We are trying to take the top off any lumps and bumps in the resin only. Again, be very careful not to cut through the resin and abrade the carbon cloth. Don't worry about the finish on the overlap as this will be trimmed, however, do make sure that it has been wetted out with at least one coat of resin.

After applying the resin, the overlap will need to be trimmed. There are several ways to go about this and you will have to choose the one best for you. Depending on the method you use, make sure you wear a dust mask - as stated earlier, carbon fibre dust is really not good for you.



Plate 4

Trimming the Mould Edges and removing the pattern

The goal is to leave about 2 mm of overlap to enable the edge to be sanded flat and even. If the pattern has come away from the moulding (either at this or at any previous stage), that is fine. All we do is to fit the moulding back onto the pattern and mark round the edges with a very soft thick pencil so we know where the edge is. Plate 4 shows a cover that has the edges trimmed.

You can trim the edges using:

- a 'Dremel' tool and a very thin cut-off wheel, however you have to take great care not to slip or allow the wheel to jump out of the cut and damage the moulding. Causes a fair bit of dust doing it this way.
- a very fine bladed razor saw to cut off the excess - if you use a saw with large teeth or try to rush it, you will splinter the edges for sure. This is steady-away stuff and you need to be careful so as not to tear any of the carbon fibre, break off chunks of resin or splinter the edge of the moulding. This is not a bad way to do it - less dust and pretty controllable.
- a scalpel. It can be a bit tedious as it needs a fair bit of care and patience but no dust. If you are a bit ham-fisted, make sure your local A & E has someone on standby who is good at stitching.
- If you are very careful, you can trim it using a pair of really sharp tin snips or wire cutters. This is my personal preference but may not suit everybody.

Releasing the Moulding From the Pattern and Trimming the Edge

Whatever method you use, take your time, use the Mk.1 eyeball often and cut gently. Don't try to rush it – you have lashings of time. Trim the overlap then if it is not already released, gently twist it backwards and forwards a few times and you will hear clicks and creaks as the moulding separates from the pattern. Work your way around the moulding easing the edges away from the pattern with your fingers. The moulding should release from the pattern without too much effort. (This could well be the point at which you find out whether you applied sufficient release agent)

Once the moulding is separated from the pattern, make sure the remaining overlap gets a coat of resin to seal it. I initially use a file to remove most of the lumps and bumps from the edge and then coarse wet and dry (something like 120 grit)..

Rubbing Down & Applying Logos



Plate 5

If the ambient temp. is at a reasonable level, you will not have to wait too long for each coat of resin to harden to the stage where you can rub it down. If you are working in a cold, damp and draughty shed then it will take much longer to harden. Build up the finish by brushing on more coats of resin. Rub down in between coats with 380 wet & dry paper used wet. This way you get rid of many imperfections as they happen and they are not carried over to the next coat. Just be careful you don't cut through the resin and into the carbon fibre. As you add subsequent coats the finish will improve. Use a dollop of washing-up liquid in the water (you don't need much to do the job) which will give better wetting properties and prevent any sticking. Plate 5 shows a moulding after a releasing from the bag & prior to rubbing-down.

Once again, and I can't stress this enough, when rubbing down, be very careful not to cut through the resin and abrade the carbon cloth (or the logo / transfer if you have applied one). You don't want to ruin the finish at this stage. You want to end up with a smooth pinhole free surface that is ready for polishing.

When you have a nice smooth surface ready to spray with Acrylic lacquer, you can get very tricky indeed. If you want to apply a decal / transfer / logo whatever you want to call it, this may be a good point to do so. Make a test piece to make sure the decal is compatible with the lacquer by applying a decal to a bit of aluminium / whatever then spray it with lacquer to make sure the it doesn't melt the decal. Wet slide decals are generally ok This can give a lovely 'depth' to the final finish. I normally finish off the rubbing down before applying the transfers then spraying the moulding with several coats of lacquer.

Finishing-off

I have in the past had a mate of mine with a car painting business spray the finished article using 2 pack clear-over-base lacquer which gives a really hard finish and it came out beautifully but you need a pukka spray bay, masks, extractors etc as I understand that this stuff has a cyano content and is a bit nasty.

If a matt finish is the one that blows your skirt up, then instead of using a final wax polish, you could try finishing off by gently rubbing the surface with a bit of metal polish. You could also

try jewellers rouge to the same end. Jewellers rouge by the way, is a very fine, red (hence 'rouge') abrasive paste used by, yes you've guessed, jewellers. You can also get it in the form of a wet & dry paper which is coloured red by the way.

Other Mouldings

If you decide to make mouldings of other parts as patterns, the main points to consider are:

- Will the shape of the part allow the moulding to release easily ?
- Will rigidity be a consideration? Depending on shape / size, you may have to use a thicker cloth
- Is it a complex shape with compound curves? Does it need vacuum bagging to mould it effectively (and do they *really* make sandwich bags *that* big)?

End Stuff

NB:

One *REALLY* important lesson I learned was that the volume of resin you mix can be very important. During the manufacture of one moulding, I decided to reduce the volume of resin I mixed up to try and avoid wastage, however to my horror, this coat of resin did not fully harden in a couple of places and remained a bit sticky. I originally thought it was traces of Meths on the brush that had caused the problem however discussing it with a mate, I discovered that apparently some resins need a certain volume before the chemical reaction of hardening is fully effective – the 'critical mass' I suppose, and I failed to make the connection at the time. However, I rubbed down the sticky bits and after upping the volume of resin to that used originally, I slapped another coat on and all was back to normal.

Suppliers & Data Sources

Engineering suppliers as described earlier for the various bits of kit. Car accessory shops for wet & dry, rubbing blocks, chopped strand mat, possibly resin. Carbon fibre cloth suppliers via the web or offcuts if you know a local outfit that does commercial mouldings. Model aircraft suppliers / shops are a good source of further info on carbon fibre cloth and resins.

Some websites I find very useful:

- <http://www.permagrit.com/system/index.html>
(permagrit sanding blocks. Some good info and links. Know this: once you have used a perma-grit tool, you will never be without one in your workshop)
- <http://www.resin-supplies.co.uk/resins.htm>
(Materials - range of resin types with application data)
- <http://www.spsystems.com>
(this one also has some vacuum bagging stuff)
- http://www.fibre-lyte.co.uk/cf/cf_materials.html
(carbon fibre - mail order)

There are lots more out there - I did various searches using only Google and here are just some of the results:

- "carbon fibre cloth uk" gave me 13,100 hits
- "laminating resins" gave me a mere 2,370.
- "carbon fibre laminating epoxy resins UK" narrowed it down (!) to 247

Knowledge is power

Have a look at the University of Bristol site for COSHH data sheets. You can then be fully confident about any of the materials you are using.

End Quote

Of some relevance when trawling the net: Arthur C. Clarke (he of science fiction writing fame) is quoted as saying “getting information from the internet is like taking a glass of water from Niagara Falls”. I reckon he hit that one right on the head.

INDEX OF PLATES

- Plate 1 - Finished article - Rubbed down, Lacquered, 'T' cut and waxed
- Plate 2 - Vacuum set-up
- Plate 3 - Vacuum set-up: close-up
- Plate 4 - After removal from vacuum bag – internal view
- Plate 5 - After removal from vacuum bag – external view