Steps and Resources for Composite Construction
Mark Westlake

Hopefully the following information will help you avoid some of the learning curve that comes with a project of this complexity.

Plug Construction

The most labor intensive part of this project is the construction of the full size "model" of your vehicle. Always remember that this product will be an exact replica of your finished product. Every flaw will show up later!

We have always built the frame of our vehicles first and built the plug around the mechanical systems of the car. This helps avoid part/body conflicts later on. We used sheets of polyurethane foam sheets in varying thickness and glued them together with a hot glue gun. Careful "glue planning" can really help here! Try to avoid putting glue where you intend to sand. The glue doesn't sand well. We cut belt sander strips and stapled them to long boards for most of the work. After the shape was done we used regular sheet rock mud to fill in any cracks or imperfections. Fair warning: this is the messiest part of the project. The foam gets everywhere and seems to permanently attach to all your clothes.

Polyurethane Foam (closed cell polyisocyanurate foam)
Wood
Sheet Rock Mud
Hot Glue (wood glue also works)

Fiberglass Skin

After the plug shape is done it is important that you skin it. This adds strength to your plug for the hard sanding that you will encounter as you try to polish your plug. We used two layers of 0.75 oz fiberglass matt and polyester resin. We applied the resin with regular paint rollers and paint brushes. A laminating roller is handy for breaking up any stubborn bubbles in the matt.

Fiberglass Matt 0.75 oz
Polyester Resin

Finish Layer

When the plug is skinned you may need to fix some imperfections. Bondo works great and is relatively easy to sand. When you are happy with the shape you need to spray it with a surfacing primer. We spray it with a gel coat cup gun. They are inexpensive and are the only thing that we have found that will spray the thick Duratec without thinning. You will need to spray this thick to fill in any flaws.

Duratec Surfacing Primer (Sprayed with a Gel Coat Cup Gun)

Plug Finishing

This is the back breaking part. You need to sand the plug until it is mirror smooth. We start with 220 grit wet sanding and work up to 400 grit. Rinse often and be sure to clean the plug well between grits. Left over 220 will continue to scratch the finish if it is not all removed. When the sandpaper work is done you will need to use polishing compound to finish the plug. We have had great luck with the Aqua Buff products listed below. When you are finished you can stand back and have a pretty good idea of what your finished car will look like!

Polishing Compound
Aqua Buff 1000-Fast Cut
Aqua Buff 2000-Finish Cut

Making the Mold

The first step to making the mold is making sure that it will release from the plug. I'll admit I'm pretty paranoid about this part and spend extra time making sure we do things correctly. So far we have never had a mold stick, but I have heard horror stories.

Parting Flanges

At this point you will need to decide on where you are going to split the mold. The parting flange has a twofold purpose; to stiffen the mold and to provide a place to seal the vacuum bag to. Remember that your finished part must come out of the mold and plan accordingly. Some extra planning at this point can save you a lot of work later. Make your flange wider than you think you need (6 inches is great!). We have made flanges from sheets of aluminum, masonite board, even jumbo playing cards. I have yet to find an easy way to do this. If you figure out something please let me know!

Wax

We start by waxing the plug with at least 6 layers of Partall II Paste wax. We do two layers a day for three days. This is not your typical automotive wax! This stuff takes some muscle to buff out. We wait until the wax just starts to "haze" before we begin buffing and only do 1 square meter at a time. Don't let it sit unbuffed overnight unless you really want a work out the next day.

Partall II Paste Wax (6 layers)

Parting Film

Spray the PVA in multiple thin layers until you get a uniform finish. Don't try to put too much on at once or it will run. (Remember drips will show up in your mold!) The flat spots are easy , the vertical sides take a little more patience.

Partall PVA Coverall Film (Sprayed with an automotive HVLP gun)

Assuming that you have a nice layer of parting film on the car, your team of students are assembled and fitted with respirators, you have fiberglass matt cut or torn into manageable pieces, and you still find this project stimulating, you are ready for the next step.

Mold

The mold is a full size negative of your car. It will end up being the heaviest part of the project as it needs to be stiff enough to withstand the force of vacuum bagging later on. We start by spraying a thick layer of Duratec over the PVA (this takes some faith!) and then waiting about 1.5 hours to start with the first layer of matt. It is important to not wait too long before applying the first layer. We wait until the Duratec no longer fingerprints when we touch it. This allows the first layer to chemically bond to the Duratec and provides for a much nicer (and more durable) finish. After the first layer of glass matt is applied we wait over night to continue work. To avoid overheating the mold we do two layers of matt a day until the mold is thick enough. (usually 7 layers is enough for an electrathon size car). The longer you can wait before taking the mold off the plug, the better. We try to wait at least 5 days. (This helps the mold to cure and prevents a warped mold.)

Chances are if you only have one parting flange you will get to repeat this whole process again on the second half of the mold.

Layer 1 Duratec Surfacing Primer (Sprayed with a Gel Coat Cup Gun)

Layer 2 1.5 oz Fiberglass Matt and Polyester Resin

Layers 3-10 1.5 oz or 2.0 oz Fiberglass Matt and Polyester Resin

Body

After 6 months worth of work you are probably ready to start on the final (and most important) part of your project. Laying up the carbon body requires a certain amount of planning and practice to be successful.

Before we wax the mold or spray PVA we cut all the fabric, core material, and vacuum supplies to size. When everything is set, we do a complete dry run. We even pretend we are mixing resin and pouring. It is important that everyone knows exactly what their job is for this part. It is very easy to make a $500 mistake if things go wrong here! After we are confident with our dry run we wax the molds with six layers of Partall and then spray with PVA, following the same plan as we did when we were preparing the mold.

With the fabric all set and the molds prepared we take a deep breath and dive into the most hectic/stressful 1.5 hours of the project.

We put layers in the the mold in this order:
Carbon
Carbon
Core Material (with micro sphere paste)
Carbon
Peel ply
Breather
Vacuum bag

Some hints:
·A pair of electric scissors is one of the best purchases we have made. It makes cutting materials so much easier and prevents the fabric from fraying as much. They also save the day when it is crunch time.
·Have resin pre measured and ready to mix. Have more ready than you think you need.
·Have "disposable" scissors handy. (Hide your good scissors.)
·Have lots of latex gloves, change often.
·Remember resin starts to "kick" much sooner when it is in the cup. Spreading out the resin increases your work time.
·We use cheap plastic spatulas to spread the resin, but always keep a small paint roller handy for moving the resin up the sides or into hard to reach corners.
·Use a mix of micro spheres and resin to make a paste to go around any core material and smooth transitions. This helps prevent voids in the carbon. We apply the frosting-like paste with a ziplock bag and a cake decorating tip.
·Be sure to wet out all the fabric well. Try to remove "puddles" of resin before you vacuum bag.
·Assign a "time keeper". Have him report often.
·Cover the tacky tape with masking tape. Resin makes it hard to stick the bag to the tacky tape.
·Make the vacuum bag much bigger than you think you need. The bag tends to shift when you are sealing it to the flange.
·Leave the vacuum on overnight, wait 48 hours before pulling the part. Be patient!
·Be prepared for some awful noises as the part finally releases from the mold.

Body
3-4 Layers of 5.7 oz Carbon Cloth

AdTech Marine ProBuild Epoxy Resin

Hardener: Slow cure for Vacuum Bagging, Medium cure for wet lay up.

Core Material: 1 layer of 1/8 inch AirLite PVC Foam Mat

(Kevlar cloth can be substituted in area of high wear or for the addition of impact resistance)

Vacuum Bagging
Stretch Bag Film 120" wide (A little more expensive but worth it!)

Peel Ply 60" wide, Treated

Breather 4 oz. x 60" wide

Tacky Tape

Resources

Elliot Company (foam)
9200 Zionsville Road • Indianapolis, IN 46268-1081
1-800-545-1213 • Phone: (317) 291-1213 • Fax: (317) 291-1219
http://www.elliottfoam.com

Express Composites, Inc.
451 Taft St. NE Minneapolis, MN 55413, Suite 15
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A note about Express Composites: Jim Swanson and his daughter LeAnn run this small business and have saved the day for me on countless occasions. They are very knowledgeable, have everything in stock, and ship super quick. They do big and little orders. We have used them on every project we have attempted and won't use anyone else.