Post Cure and Reducing Print Through and Imaging

It is well known that all fiberglass-reinforced plastics are subject to the phenomena of print through (reinforcing fibers showing cloth or knot pattern at the surface). There have been many theories as to the reasons causing these visual anomalies. The reasons for print and imaging in epoxy composite structures are probably as diverse as the various construction techniques employed. Epoxy construction has always lead to innovative building techniques so we will try to limit the scope of this technical update to those techniques utilizing a wood stressed skin (cold molding, strip sheath and stitch and glue) in conjunction with a sheathing of fiberglass cloth or knit.

Besides the theories below, one should always be watchful for proper Industrial Hygiene - keeping dust, moisture and other contaminants off the cloth by keeping it wrapped in plastic or paper while waiting for measuring and cutting and lay-up.

Theory One: Air entrapment causes fabric print.

It is a fact that air entrapment (either micro or macro) is almost never an advantage. Air bubbles (macro air inclusions, you can see) in a composite are a source of stress concentrations and potentially the origin of catastrophic failure. Micro air entrapment in and amongst the fiber bundles will have a similar structural effect along with the addition of increased fabric print. In order to remedy this situation fabricator should utillze our Low Viscosity Laminating Resin (fortified with an air release package) and good laminating techniques. Helpful tools include bristly rollers and fin rollers. If laminating temperatures (substrate and resin) are kept above 65F air release is more complete as the viscosity allows for better air migration and release.

Note: (It is recommended all laminating be done above 75F)

Theory Two: Partial cure leads to print through and imaging.

We can tackle this in two parts. Room temperature curing epoxies are subject to incomplete cure if the cure environment is (below 60F). The greater the temperature the greater the degree of cure, less residual uncured material in the structure allows for less movement. If a structure is cured at 60F is later exposed to temperatures in the 90's additional curing of the structure and skin will take place. In order to thermally stabilize a structure it is best to expose the entire structure to temperatures above the maximum expected operational temperature during the construction process. Additional curing at later stages is usually only a cosmetic threat, so we need to keep our efforts realistic. Once a structure has been exposed to repeat elevated temperatures (one season of use) print through issues are usually stabilized and light fairing and painting are almost a sure cure.

Imaging of the stressed skin (substrate) like that of a cold molded hull is a different story all together. Glass sheathing has a Young's modulus of 10,500,000 significantly different than that of the wood skin is approximately 1,560,000. Essentially we often find ourselves looking at the image of the wood structure under the glass sheathing. This is a very difficult phenomenon to eliminate. Essentially greater cure temperatures will help stabilize the wood substrate, but there is very little we can do to force the modulus of wood to match that of the glass sheathing. After all we are still building a wooden boat even if the structure is a stressed skin/cold-molded wooden boat.

We have put our faith in the epoxy resin as an adhesive matrix to keep these two dissimilar materials intimately together. Some builders have started spiling the final layer of planking so when (note I say, when, not if) it images through the imaging is aesthetically less abrasive than that of diagonal planking. Other techniques would include utilizing a core material known to be more thermally stable than wood and engineering the structure so the glass sheathing carries the intended loads (but now we have a glass boat).

On the bright side as a stressed skin boat ages and settles down even the imaging of diagonal planking will mellow to a beautifully paintable surface. Aluminum structures suffer from similar imaging issues where plates and frames image through fairing applied at one temperature and operated at different temperature.

The best construction practices should employ a way of thermally "aging" a boat (post-cure) prior to final fairing and painting. We have seen many techniques for accomplishing this. Some of the more cost effective measures include tents of aluminum frames and layers of bubble wrap and plastic skins. Simply put if the days work can come to an end in winter shop conditions and the hull can be warmed over night to 120F and these steps are repeated through out the hull construction and fairing process the builder will have done all he can to provide the most thermally stable hull possible.