Composites Processing

- Fabrication Methods
  - Wet Layup
  - Prepreg Layup
  - Filament Winding
  - Fiber placement/fiber steering
  - RTM/VaRTM
  - Press Molding
  - Pultrusion
Wet Layup

- Fabric plies are wetted out and then placed to fabricate the part.
- CD-ROM
Prepreg Layup

- Preimpregnated plies of tape are cut and hand placed to make the part.
Filament Winding

- Uses relatively low tech. hardware and control systems to place fiber tows to make a wide variety of composite structures (aircraft fuel tanks, radomes, NGV fuel tanks.)
  - Wet winding
  - Dry winding
- Show video
Filament Winding
Filament Winding
Fiber Placement

- Automated tape laying used to produce non-circular parts with simple contours and sophisticated layups
- For even more complex curvature high DOF fiber placement equipment used
- Video tells the story better than I can
  - SME video
  - Northrop Grumman F/A 18 E/F inlet duct video
Resin Transfer Molding

- Dry fiber preform is preplaced in a mold, can be closed or even one-sided (use bag.)
- Inject with low viscosity resin and cure.
Resin Transfer Molding

- F18 E/F Outer Wing Flap Fairing
- F22 Bypass Louver Seal
- Mountain Bike Tubes
SCRIMP

- Seeman Resin Injection Molding Process
- Reinforcing material is placed in an open mold and held in place using a vacuum bag (same as vacuum bag molding.)
- The layup is comprised only of dry fiber (preform)
- Resin is then introduced using only vacuum and sophisticated resin distribution network to promote flow
  - Uses reasonably light molds
  - Closed molding process popular with boatbuilders
Press Molding

- Layup is placed in a hydraulic press with heated platens instead of an autoclave.
Pultrusion

- Dry fibers are drawn through a wet resin bath and pulled through a die to make constant cross-section composite parts.
Pultrusion
Other Fabrication Slides

- Marion Composites
- Spray Up
- Rapid Fiber Preforming (P4 Process)
Vacuum Bagging

Vacuum bagging is the removal of air in an enclosed environment. This removal of air creates atmospheric pressure (14 psi) on the laminate, works out to over 2000 psf.
Benefits of Vacuum Bagging

- Vacuum bag evenly applies pressure, conforming to both simple and complex shapes.
- Application of vacuum pressure provides control of part thickness by compressing the laminate during cure.
- Application of vacuum removes air and volatiles from the laminate, resulting in low void content and a stronger laminate.
- Vacuum pressure provides assistance in core placement and bonding.
Basic Requirements of Vacuum Bagging

- Tooling Considerations
  - Minimize sharp corners
  - Incorporate flange for vacuum bag application
  - Tool should have vacuum integrity
  - Tool must have a non-stick surface
  - Use a “gel coat” on plastic tooling
    - keeps resin from attacking tool surface,
    - provides aesthetic finish,
    - UV protection

© 2003, P. Joyce
Basic Requirements of Vacuum Bagging

- Additional Considerations
  - Heat up/Cool down rate
  - Tool size at temperature
  - CTE mismatch between the tool and the part.
Typical Application Sequence

- Application of Mold Release
- Lay up of Laminate
- Release Fabric (Peel Ply)
- Release Film
- Bleeder Ply
- Breather Materials
- Sealant Tape
- Bagging Film
- Installation of Vacuum Valves
Mold Release Application

- A release or parting agent is applied on the face of the tool to ensure the laminate does not adhere during cure.
- Release agents are usually silicone, wax, Teflon, or vegetable oil.
- Follow manufacturer’s recommended application procedure
  - To achieve optimum release of part,
  - To reduce transfer possibilities of release agent to part,
  - To reduce volatile migration into part during high T cures
- Important to properly clean and polish the mold surface
- Release film is sometimes used in lieu of release agent.
  - Perforated and non-perforated

© 2003, P. Joyce
Release Fabric or Peel Ply
Application

- Peel ply typically used between the layup and the bleeder ply, so that resin soaked bleeder plies can be removed after the cure.
- The peel ply layer is generally a nylon or polyester material that is applied directly against the laminate.
- After the laminate has completed cure, the peel ply is removed.
- Peel ply material has minimal elongation characteristics.
- Peel ply material will absorb resin.
- Peel ply materials may be treated with release agent to enhance removal.
Release Film Application

- The release film layer is used to control resin flow and protect the part from breather and bagging film.
- The most common types are fluoropolymers.
- Release film has high elongation characteristics which allow it to conform to part shape.
- It will release when applied directly to laminates or over peel ply.
- When non-perforated, volatiles may permeate through release film into breather pack.
- A layer of non-perforated release film may be used directly on the tool surface in lieu of a release agent.
- May also be used to cover up minor imperfections in the tool.
Breather/Bleeder Application

- The breather material layer is one of the most essential steps in the vacuum bagging process.
- Use enough of it so that air can freely pass along the surface of the entire part inside the bag.
- If resin bleed is anticipated use even more to soak up excess resin.
- It is normally a polyester or nylon nonwoven material with some stretch, designed to promote air flow (be careful of temperature requirements.)
- When used with release film, it will absorb resin and assist in controlling fiber ratio within the laminate.
- Breather material is used to evacuate air, moisture, and volatiles during the cure cycle.
Sealant Tape

- Sealant tape is used to secure the vacuum bagging material to the tool (or itself.)
- Typically a rubber based extruded material with high tack (can be any double-faced self-stick tape so long as it maintains tackiness at temperature.)
- Take care to avoid wrinkles where the tape touches the bagging film.
- Often designed to cure with the part to allow for easy removal after completion of part cure.

© 2003, P. Joyce
Vacuum Bagging Film
Application

- Vacuum bagging film is the final layer of material applied and secured to the tool using sealant tape.
- As the vacuum is drawn, the bag is pulled down and conforms appropriately to the tool and part.
- Allow plenty of excess bag material. . .
- Bagging film has high elongation properties and when properly applied easily conforms to any shape.
- Bagging film is available in several formulations for various heat ranges and resin systems.
- Some resins completely destroy vacuum bagging films when direct contact is made.