# Technical write up on composite materials

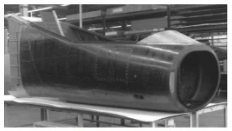
EniT Group

Germany | India | UK

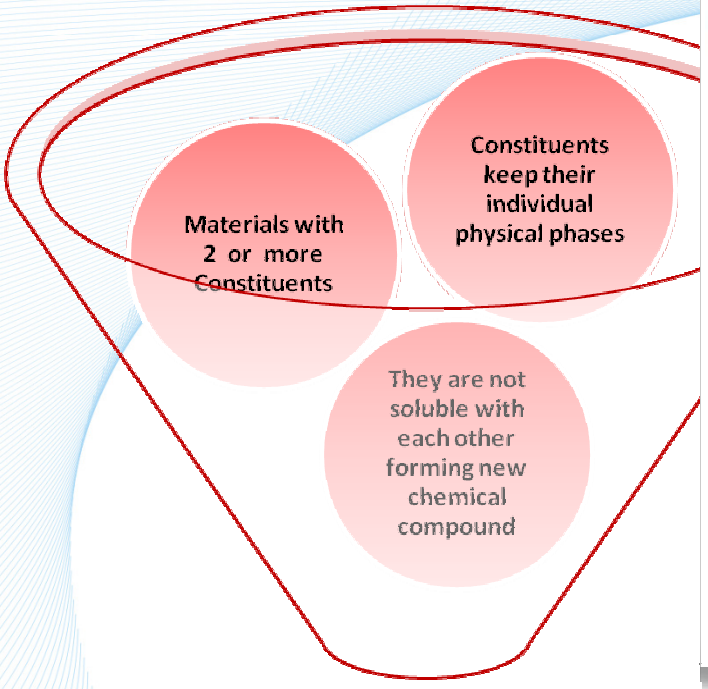
# INDEX FOR COMPOSITES

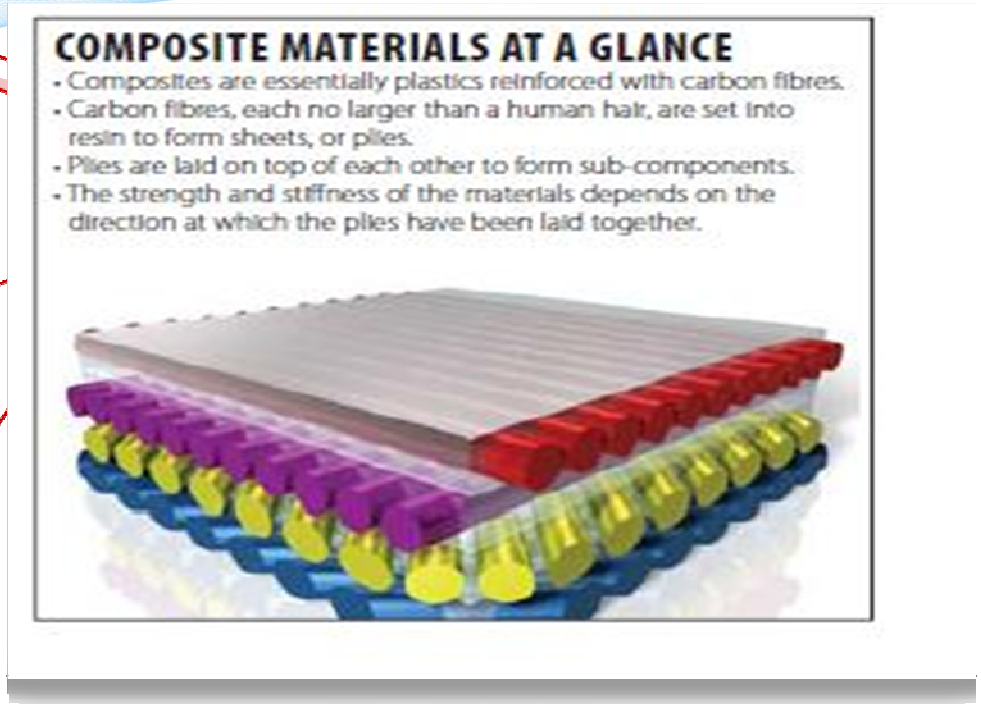
# INTRODUCTION

Evolution

| | | |
|---|---|---|
| **Plywood's by *Egyptians* Approximate 1500 BC** | Wooden Items and utensils |  |
| **Reinforced concrete by Romans Approximate 1000 BC** | Concrete buildings and sculptures |  |
| **Reinforced Clay used before Iron was invented** | Clay Pots, roof tops |  |
| **Owen's Corning Fibreglass Company in 1930 invented Fibre glass** | Lamps, Wind Sheilds |  |
| **Present Advanced developments in all kind of Industries** | Aero planes , Automobiles etc… |  |

# INTRODUCTION




**COMPOSITE**

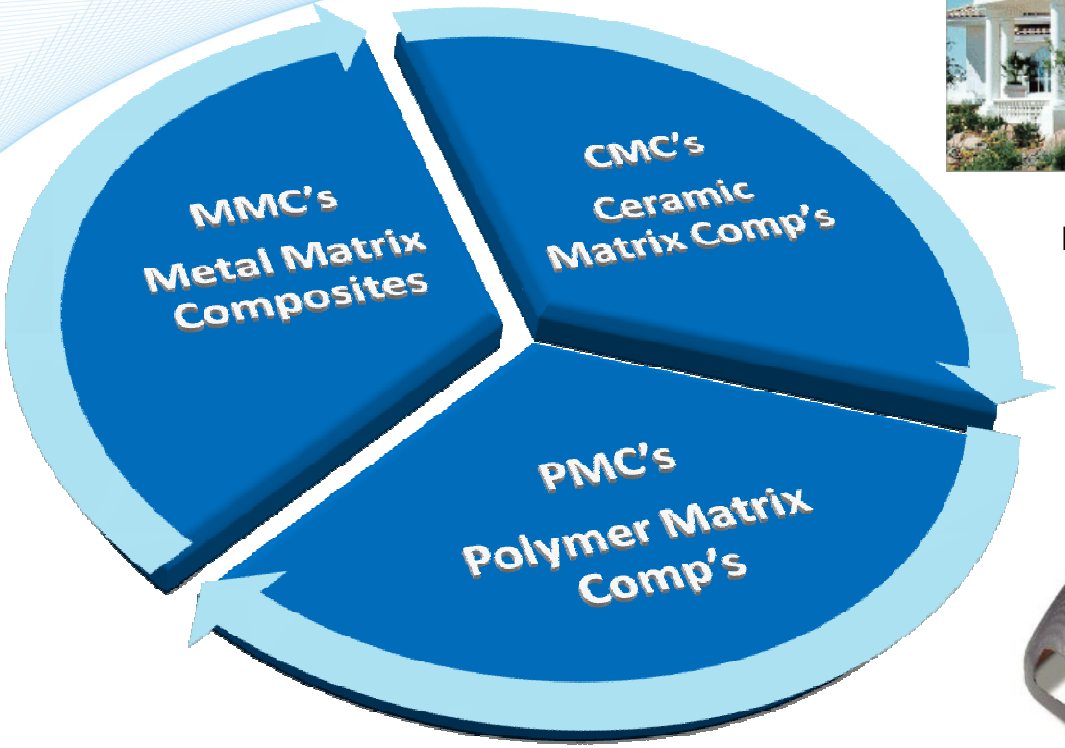
# INTRODUCTION

## Difference in Properties with Other Materials

| General Properties | Mechanical & Thermal | Chemical Properties | Processing Characteristics |
|---|---|---|---|
| • Low cost<br>• Low Density<br>• Low Dielectric constant | • High strength,High elastic elongation,High shear strength,High modulus High heat distortion temp.<br>• Low creep at use temp.<br>• High toughness/impact strength Thermal expansion near fiber<br>• Resistance to thermal degradation<br>• Low thermal conductivity | • High resistance to wear<br>• Good bond to fiber (directly or with coupling agent)<br>• Resistance to solvents & chemicals<br>• Low moisture absorption | • Low enough melt or solution viscosity<br>• and surface tension to permit thorough<br>• fiber wet-out<br>• Good flow characteristics<br>• Rapid cure or solidification<br>• Suitable for precoated reinforcement<br>• Cure temp. not greatly above use temp.<br>• Low shrinkage during and after nolding<br>• Long shelf life and pot life |

# CLASSIFICATION OF COMPOSITES

Metal Composite Air Inlet duct for Aeroplane




Buildings

Holders and coverings In Electrical components

# TYPES OF COMPOSITES

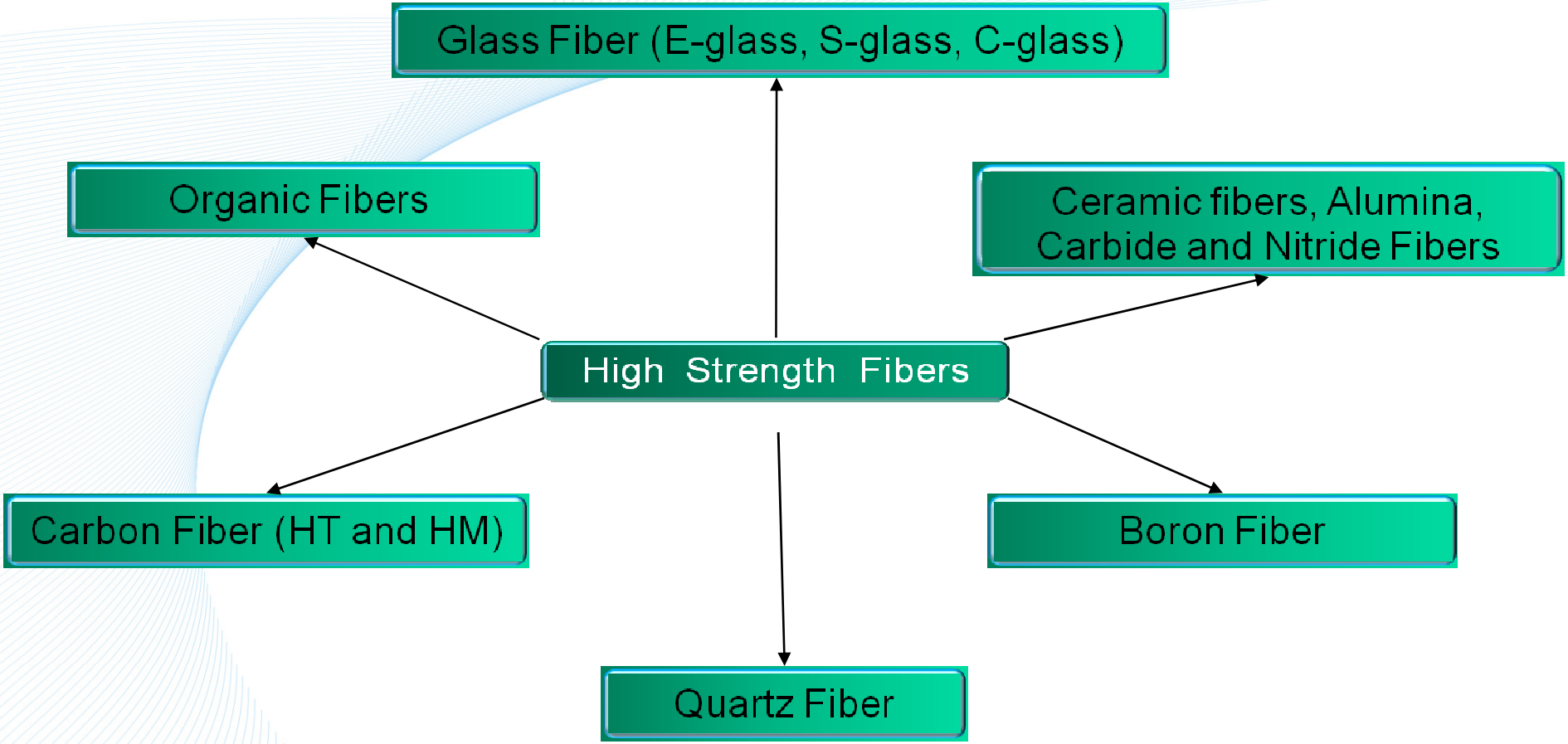
| Matrix phase/Reinforcement Phase | Metal | Ceramic | Polymer |
|---|---|---|---|
| **Metal** | Powder metallurgy parts – combining immiscible metals | Cermets (ceramic-metal composite) | Brake pads |
| **Ceramic** | Cermets, TiC, TiCN<br>Cemented carbides – used in tools<br>Fiber-reinforced metals | SiC reinforced Al2O3<br>Tool materials | Fiberglass |
| **Polymer** | | | Kevlar fibers in an epoxy matrix |
| **Elemental (Carbon, Boron, etc.)** | Fiber reinforced metals<br>Auto parts aerospace | | Rubber with carbon (tires)<br>Boron, Carbon reinforced plastics |

**MMC's**
Metal Matrix Composites

**CMC's**
Ceramic Matrix Comp's.

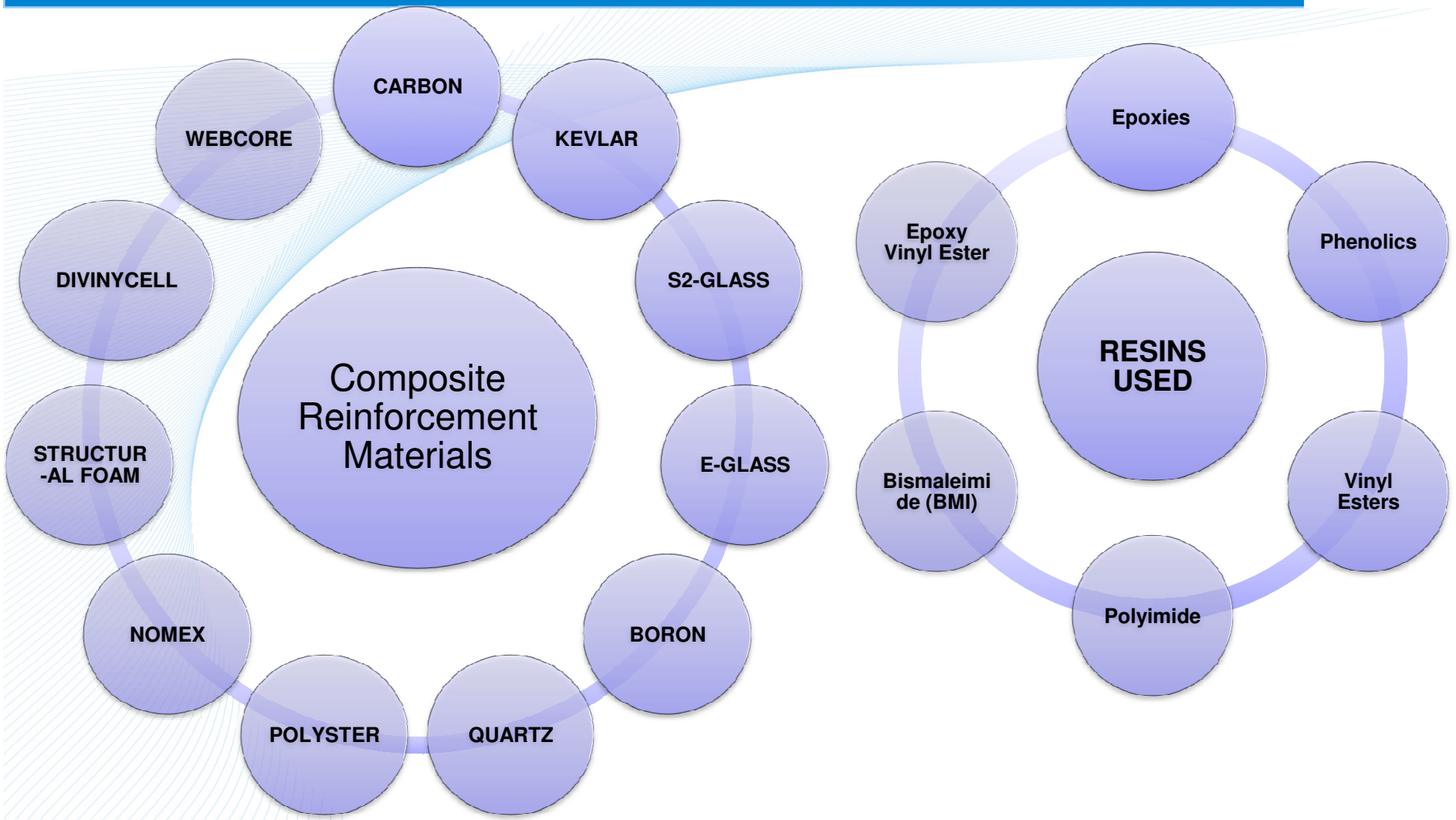
**PMC's**
Polymer Matrix Comp's

# TYPES OF FIBERS AVAILABLE IN MARKET




The Above Fiber combination results in High Strength Fibers

# GENERAL COMPOSITE MATERIALS AND RESINS



# WHY COMPOSITES ?

- High Strength with weight Ratio
- Great Freedom of Shape
- Material can be Tailored
- Excellent Fatigue Endurance.
- Excellent Chemical Resistance
- Excellent Weather/Water Resistance
- Excellent RAM(Radar Absorbing materials)
- Can manufacture Structures avoiding joints.

# APPLICATION OF COMPOSITES

## Aerospace

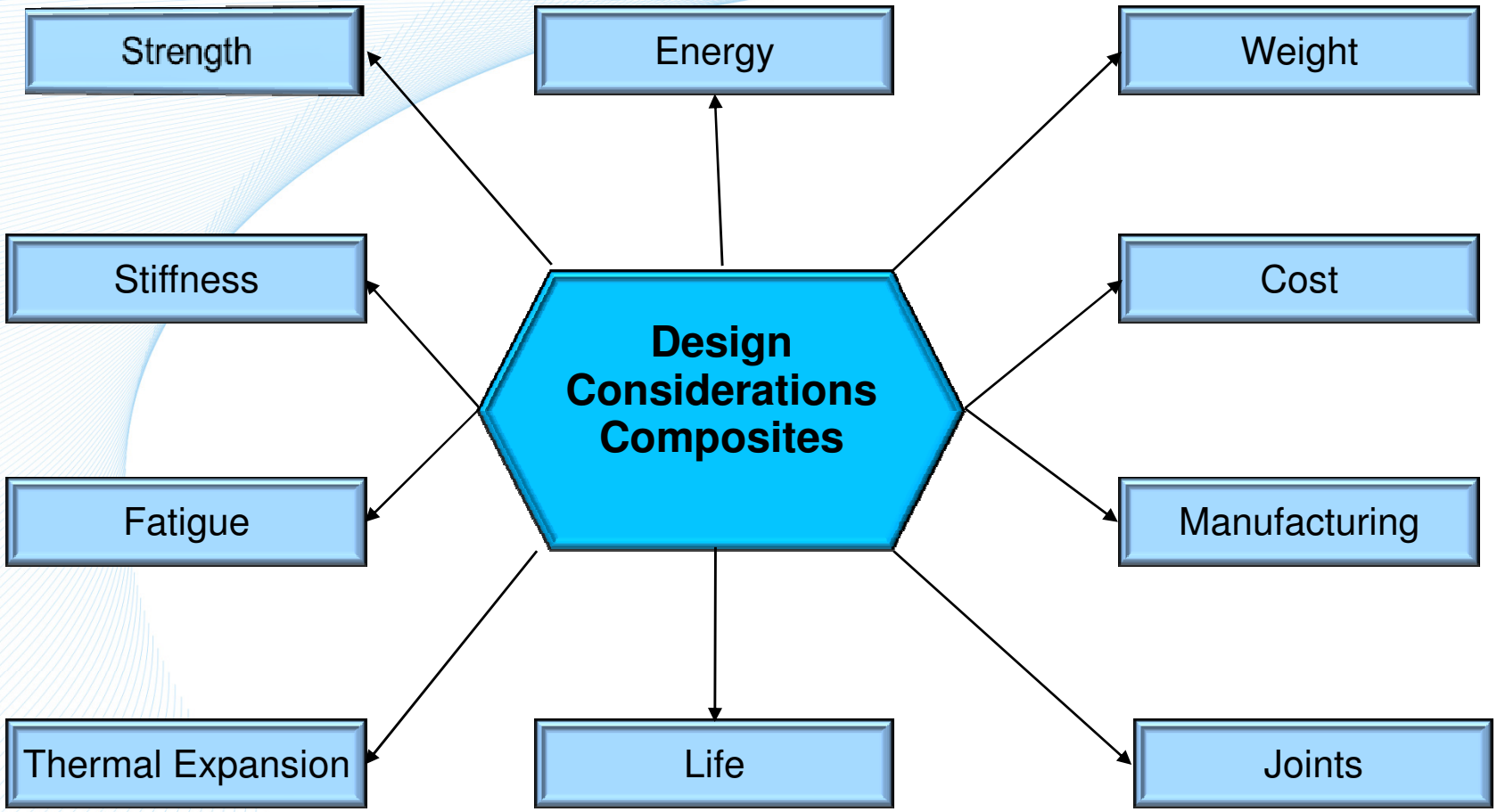

## Automobile

## Medical Application

## Ship Building

## Wind Turbine

# DESIGN CONSIDERATION



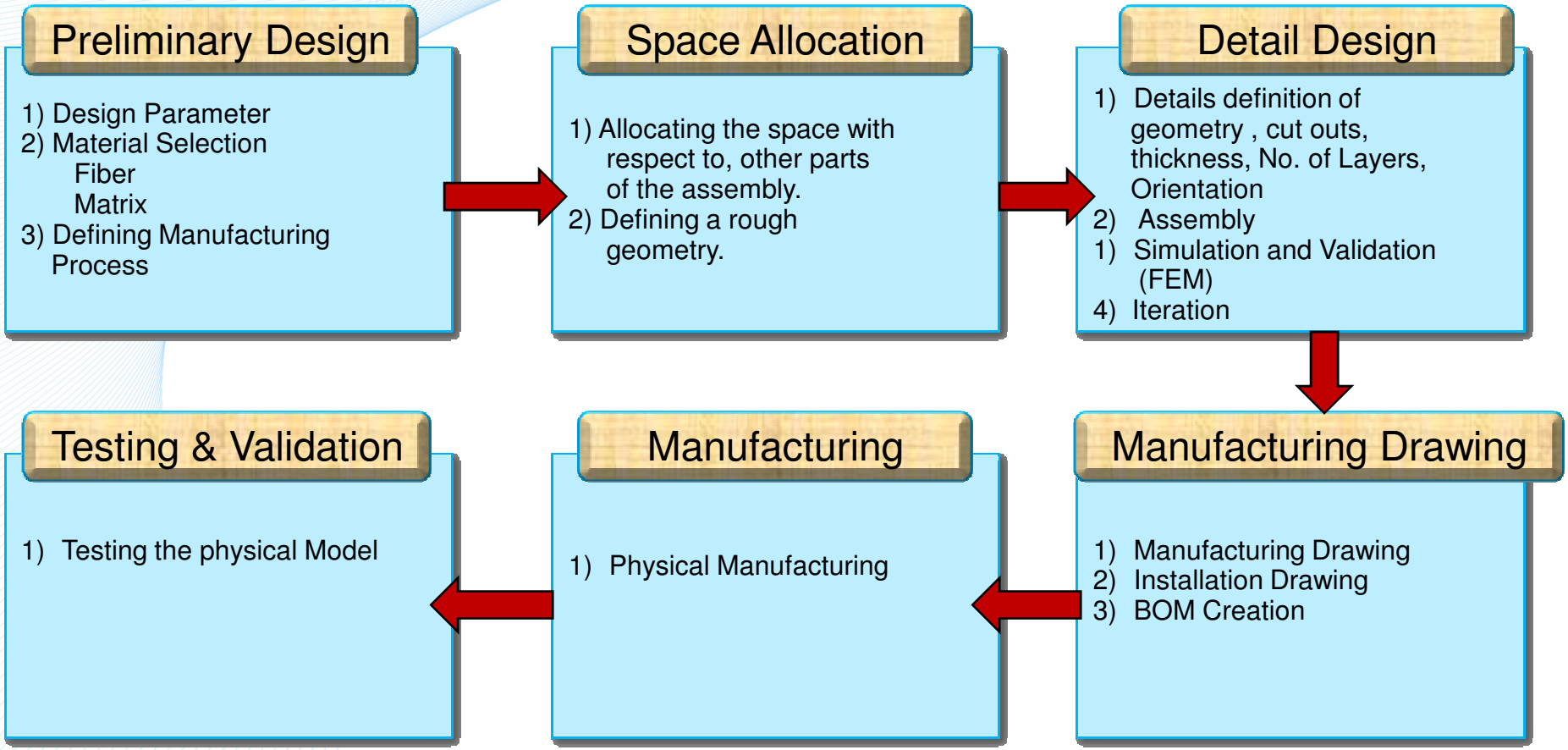
# DESIGN CONSIDERATION

## Design Consideration for Carbon and Glass Fibre.

- **Strength** :- The Material will have limits of stress and strain that cannot be exceeded without fracture
- **Stiffness**:-The structure will be designed to deform a specific amount or perhaps be limited to a specific deformation without vibrating excessively or buckling .
- **Fatigue Life**:-The Material or internal damping in composite material is high , fatigue characteristics are quite good.
- **Thermal Expansion** :- Should have low thermal expansion.
- **Life**:- The Structure might have specified life span.
- **Energy**:-The structure might have to absorb specified amount of energy and still remain functional
- **Weight**:- The structure might have to weigh less then a specified amount for the configuration to be a feasible design.
- **Cost**:- Structure might have to cost less then a specified amount .
- **Manufacturing**:- Should be easy to fabricate .Its not feasible to modify after manufacture
- **Adhesive** and **Bolted** joints need careful consideration

# DESIGN CONSIDERATION

## Life Cycle for the Composite Component.



# General Composite Processing Summary

## Temperature is used to

- Initiate and sustain chemical reaction in thermo set resins
- Melt thermoplastics
- Reduce viscosity

## Pressure is used to

- Force the viscous resin-fiber material into a mold.
- Compact a laminate.
- Squeeze out voids

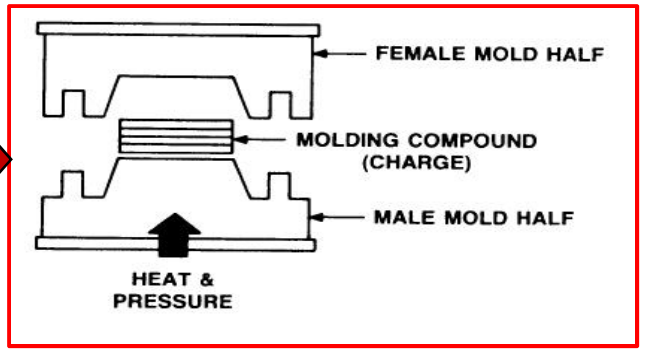
## Vacuum is used to

- To help pull out trapped air or other gasses that may be produced during the chemical reaction.

# MANUFACTURING PROCESS

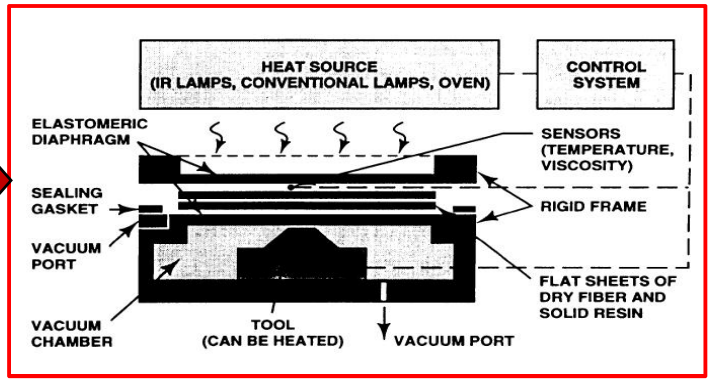
## Compression Molding

A "preform" or "charge", of SMC ,BMC or sometimes prepreg fabric, is placed into mold cavity. The mold is closed and the material is compacted & cured inside by pressure and heat. Compression molding offers excellent detailing for geometric shapes ranging from pattern and relief detailing to complex curves and creative forms, to precision engineering all within a maximum curing time of 20 minutes




## Resin Transfer Molding

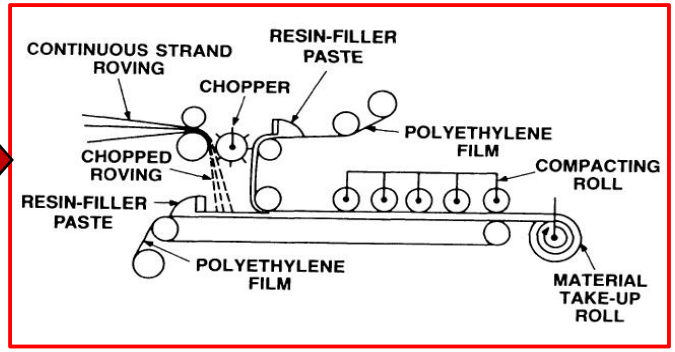
A closed-mold pressure injection system which allows for faster gel and cure times as compared to contact molded parts. The process uses polyester matrix materials systems association with cold-molding and most reinforcement material types such as continuous strand, cloth, woven roving, long fiber and chopped strand. Also known as RESIN-INJECTION PROCESS



# MANUFACTURING PROCESS

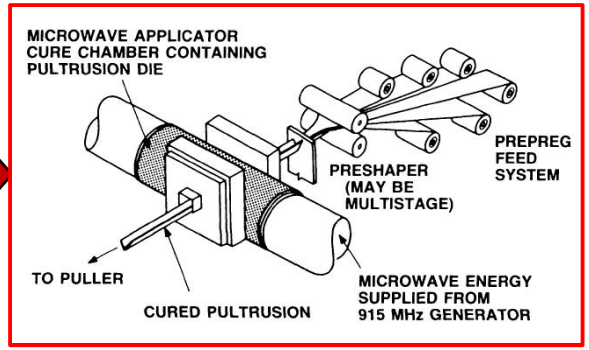
## Sheet Molding Compound Machine

A fiber glass reinforced thermosetting compound in sheet form, usually rolled into coils interleaved with plastic film to prevent auto adhesion. Made by dispensing mixed resin, fillers, maturation agent, catalyst and mold release agent onto two moving sheets of polyethylene film. The lower one also contains chopped glass roving or glass mat




## Pultrusion

Fiber bundles and slit fabrics are pulled through a wet bath of resin and formed into the rough part shape. Saturated material is extruded from a heated closed die curing while being continuously pulled through die. Process is for any extruded material and geometric shape such as roadside reflector poles and ladder rails.

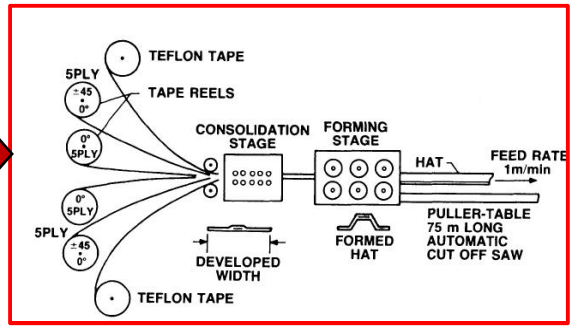


# MANUFACTURING PROCESS

Contd...

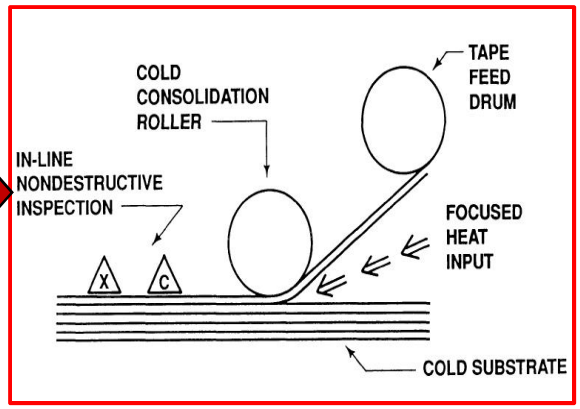
## Roll Forming

The roll forming process can be used to directly produce long structural shapes in large quantities. The entering material form is rolls of variously orientated fiber-reinforced tape.The layers are consolidated and then formed into, e.g a hat-shaped stiffener. Note the presence of a stiffer layer such as boron-epoxy in surrounding layers of glass-epoxy. Such an optimally placed stiff layer dramatically increases the bending stiffness, yet is easily made, unlike any metal stiffener.




## Thermo-plastic Lay-Up

Thermoplastics, like metals, soften with heating and eventually melt, hardening again with cooling. This process of crossing the softening or melting point on the temperature scale can be repeated as often as desired without any appreciable effect on the material properties in either state. Typical thermoplastics include nylon, polypropylene and ABS, and these can be reinforced, although usually only with short, chopped fibers such as glass.



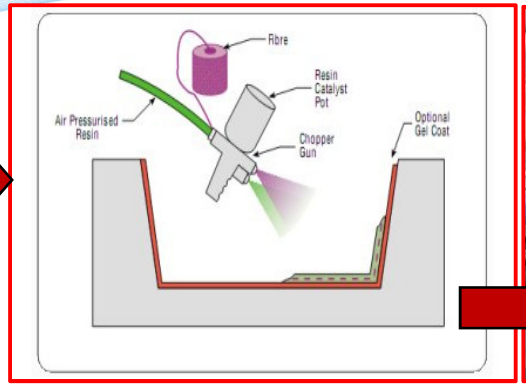
# MANUFACTURING PROCESS

Contd...

## Spray Lay-Up

Spray lay-up uses a hand-held spray gun which chops the fibers and than feeds it into a spray of resin aimed at the mould. The materials are left to cure under standard atmospheric conditions.

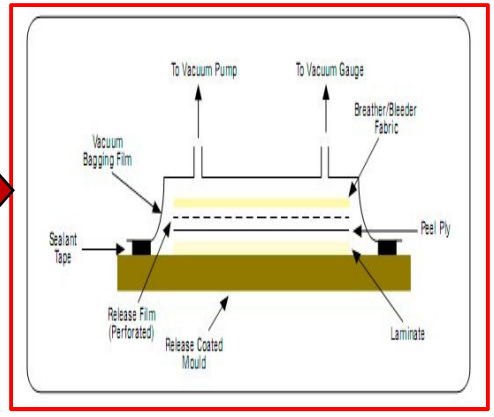
Spray lay-up can only make use of glass fibers. Polyester is primarily used as matrix.




**Auto Clave Curing Process**

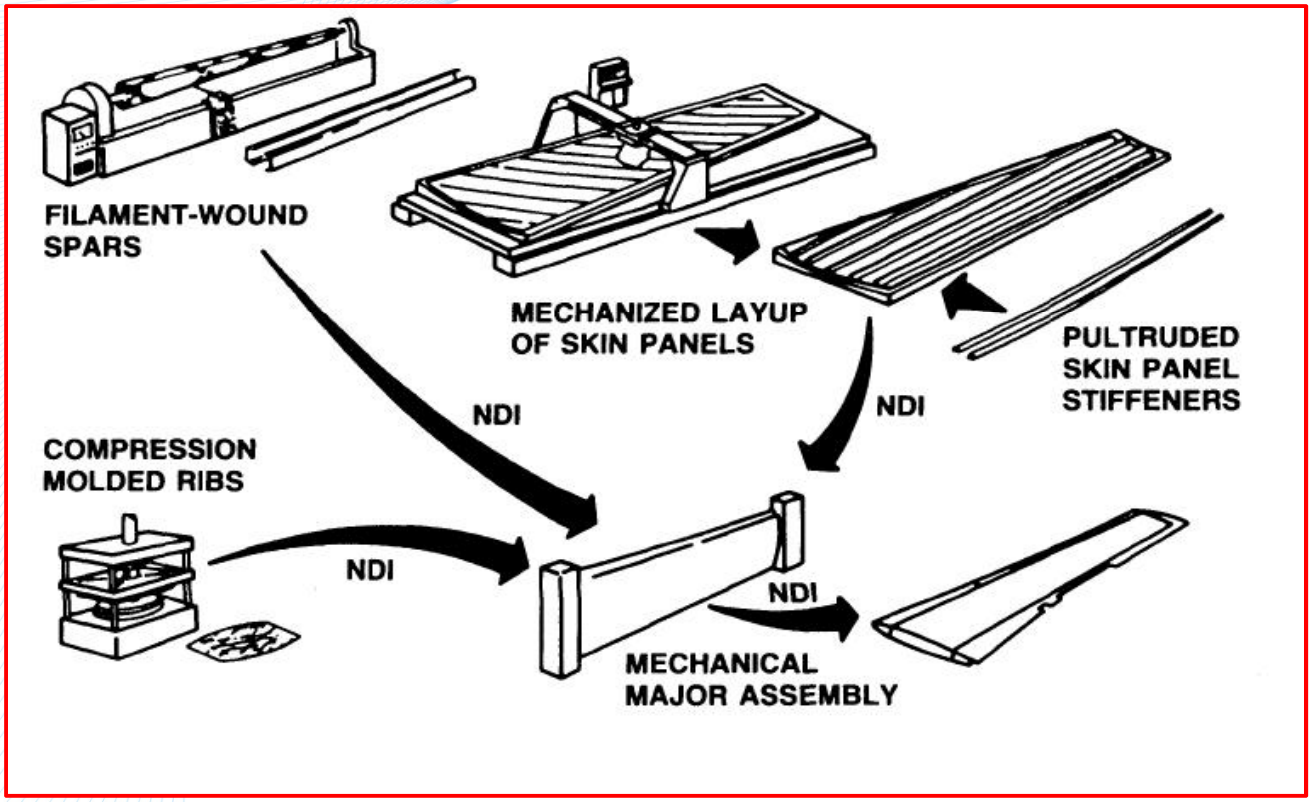
## Vacuum Baggage

Vacuum bagging is basically an extension of wet lay-up. In order to improve the consolidation of the laminate laid-up by hand or spray, pressure up to 1 atmosphere is applied. A plastic film is sealed over the laminate and onto the mould. After that the air underneath the plastic film is extracted by a vacuum pump



# MANUFACTURING PROCESS

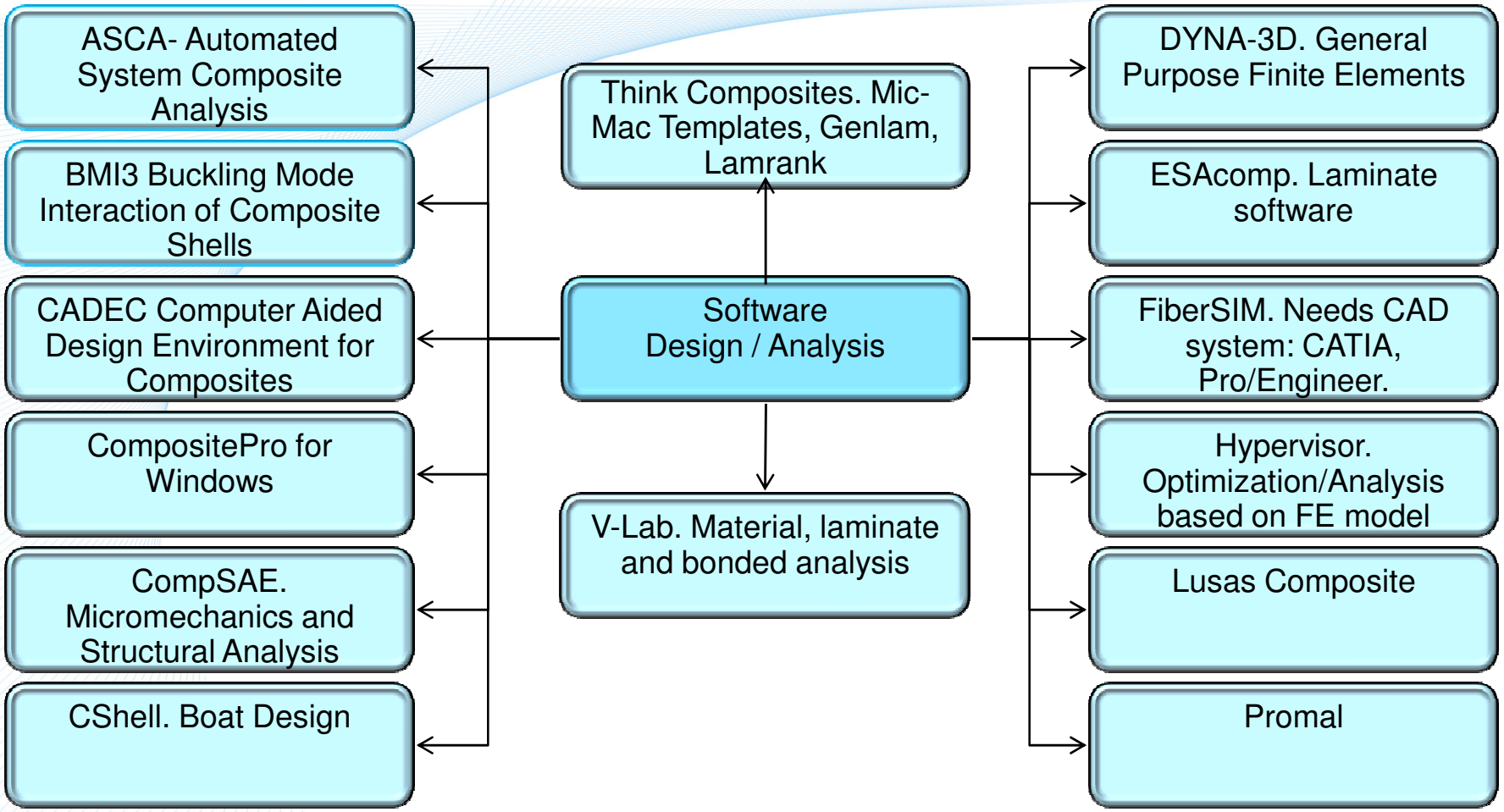
## Picture Illustrating Combined Manufacturing Operation to Produce a Wing



# COMPETITIVE THREATS

- Lengthy Product Approvals
- Life cycle performance lesser than Other materials(Steel, Concrete...)
- Recycling not Economical compared to Metals
- Disposal Cost more

# SOFTWARE USED



# THANK YOU