











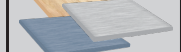





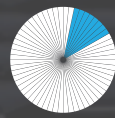
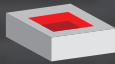





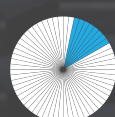






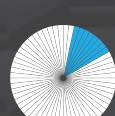
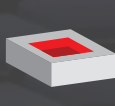




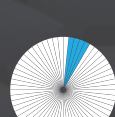






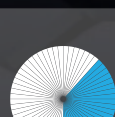






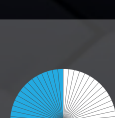






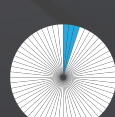






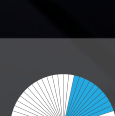





COMPOSITE

MATERIAL / PROCESS

SELECTION GUIDE

	Composition			Process Capabilities			Material Capabilities				Tooling		Notes	
	Resin Category	Resin Types	Fiber Material	Part Size Range	Annual Volume	Cycle Time	Paint	Inserts	Molded In Features	Specific Gravity	Mold Cost	Mold Materials	Benefits	Drawbacks
	 Thermoplastic	 Thermoset		  			 In-Mold or Post Applied		 Ribs & Bosses	$SG = \frac{P}{\rho H_2O}$				
Long Fiber Injection ( <b>LFI</b> )	 Thermoset	Polyurethane	Glass, Natural	 	1K - 50K		 In-Mold	 Limited		1.04 - 1.33 Low - Med	\$\$ \$25k - \$200K	Steel Epoxy Aluminum Nickel	- Large Part Sizes - In Mold Painting - Lightweight - High Stiffness - Material Optimization for Weight & Mechanical Properties	- Less Fiber Loading In Deep Draws
Reaction Injection Molding ( <b>DCPD</b> )	 Thermoset	Dicyclopentadiene	N/A	 	1K - 50K		 Post Applied			1.04 Low	\$\$ \$25k - \$200K	Epoxy Aluminum Nickel	- Large Part Sizes - Lightweight - High Matl Toughness - Low Mold Cost - High Impact Resistance	- Engineered Resin Cost
Reaction Injection Molding ( <b>PUR</b> )	 Thermoset	Polyurethane	Glass, Mineral, Carbon, Aramid	 	1K - 50K		 In-Mold			0.65 - 1.12 Low - Med	\$\$ \$25k - \$200K	Steel Epoxy Aluminum Nickel	- Large Part Sizes - In Mold Painting - Can mold solids, foams, elastomers, and composites	- Resin Cost is Greater Than Thermoplastic
Sheet Molding Compound ( <b>SMC</b> )	 Thermoset	Epoxy Polyester Vinylester	Glass, Mineral, Carbon, Aramid		10K - 50K		 Post Applied	 Limited		1.3 - 1.9 Med - High	\$\$\$ \$75k - \$300K	Steel	- Variety of Specialty Resins - High Heat Resistance - High Production Volume	- Expensive Tooling - Less Fiber Loading in Deep Draws - Secondary Processes Required for Good Surface Appearance
Resin Transfer Molding ( <b>RTM</b> )	 Thermoset	Epoxy Polyester Vinylester	Glass, Mineral, Carbon, Aramid	 	< 3K		 Post Applied			1.4 - 1.9 Med - High	\$ \$5k - \$30k	Epoxy Aluminum	- Large Part Sizes - Can Vary Material Properties Greatly - Low Tooling Costs	- Annual tooling costs for multi-year programs - Slow cycle times
Fiberglass Reinforced Plastic ( <b>FRP</b> )	 Thermoset	Epoxy Polyester Vinylester	Glass, Mineral, Carbon, Aramid	 	< 1K		 Post Applied			1.5 - 1.9 Med - High	\$ \$5k - \$25k	Wood Epoxy Ren Board	- Low Cost Tooling - Very Large Parts Can be Produced - Wide Range of Part Properties	- No B-side geometry such as bosses or ribs - Large part tolerances
Thermoplastic Injection Molding ( <b>IM</b> )	 Thermoplastic	PP, PE PS, ABS Nylon	Glass	 	25K - 100K+		 In-Mold or Post			0.9 - 1.2 Low - Med	\$\$\$ \$75k - \$300K	Steel Aluminum	- Very Fast Cycle Times - Lightweight resin - Very Good Part Detail - In Mold Color, No Painting Required	- Expensive tooling costs - Can't mold large parts
Vacuum Forming ( <b>VF</b> )	 Thermoplastic	PC, PE PS, ABS Acrylic	Glass	 	500 - 5K		 In-Mold or Post			0.9 - 1.2 Low - Med	\$ \$5k - \$30k	Wood Epoxy Aluminum	- Low Cost Tooling - Very Large Parts Can be Produced - In Mold Color, No Painting Required	- No B-side geometry such as bosses or ribs - Large part tolerances