Description

Image



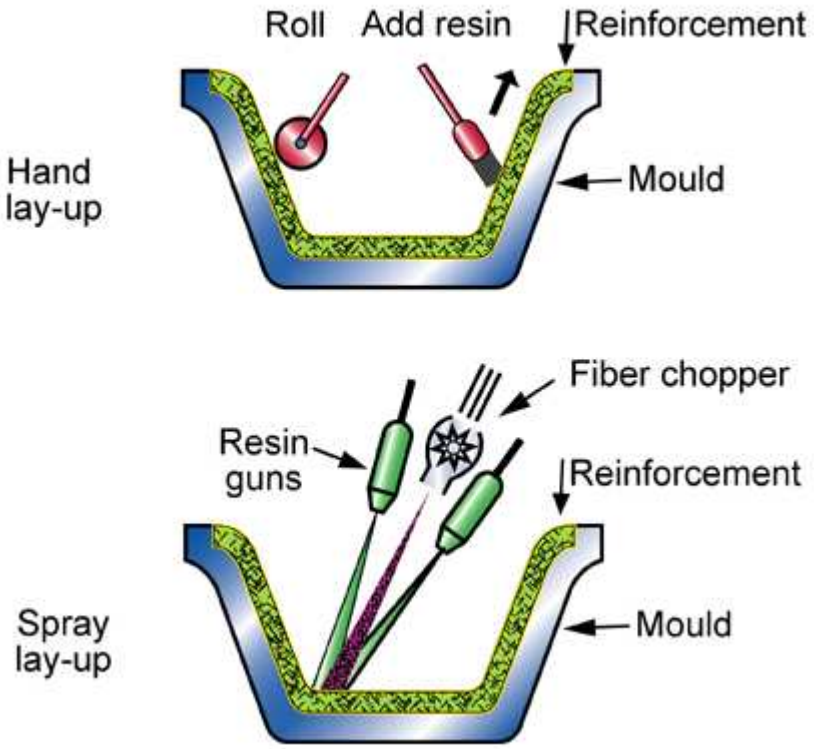
Image caption

(1) Resin Spray Gun © Granta Design (2) PrePeg composite © Granta Design at TU Delft University (3) Lotus Type 108 - LotusSport bicycle, 1992. Science Museum Object Number: 1993-76; This is the 2nd of the replicas made by Lotus Engineering of the bicycle on which Chris Boardman won the Gold Medal in the 4km pursuit event at the 1992 Barcelona Olympics. © Science Museum / Science & Society Picture Library at Wikimedia Commons (CC BY 3.0)

The process

In HAND LAY-UP, an open mold (made of glass-reinforced polymers, wood, plaster, cement or light metal alloys) is coated with a resin to give a smooth surface skin. When this has cured, a layer of reinforcement (woven or knitted glass or carbon fiber) is laid on by hand, resin is applied by a brush or spray gun, and the layer is rolled to distribute the resin fully through the fibers. The process is repeated, layer by layer until the desired thickness is reached. The type of weave influences its ability to take up double curvature ("drapability"): random mat ('glass wool') and knitted fibers have good drapability; weaves with straight wefts do not. Flame retardants and inert fillers are added to reduce cost and improve properties. In SPRAY-UP a resin mixed with chopped fibers is sprayed into the mold; it is used for large components where the reinforcement fraction need not be large.

Process schematic



Material compatibility

Composites	✓

Shape

Circular prismatic	✓
Non-circular prismatic	✓
Flat sheet	✓
Dished sheet	✓
Hollow 3-D	✓

Economic compatibility

Relative tooling cost	low			
Relative equipment cost	low			
Labor intensity	high			
Economic batch size (units)	1	-	500	

Physical and quality attributes

Mass range	1	-	6e3	kg
Range of section thickness	2	-	10	mm
Tolerance	0.8	-	2	mm
Roughness	* 0.5	-	3.2	µm

Surface roughness (A=v. smooth)	A

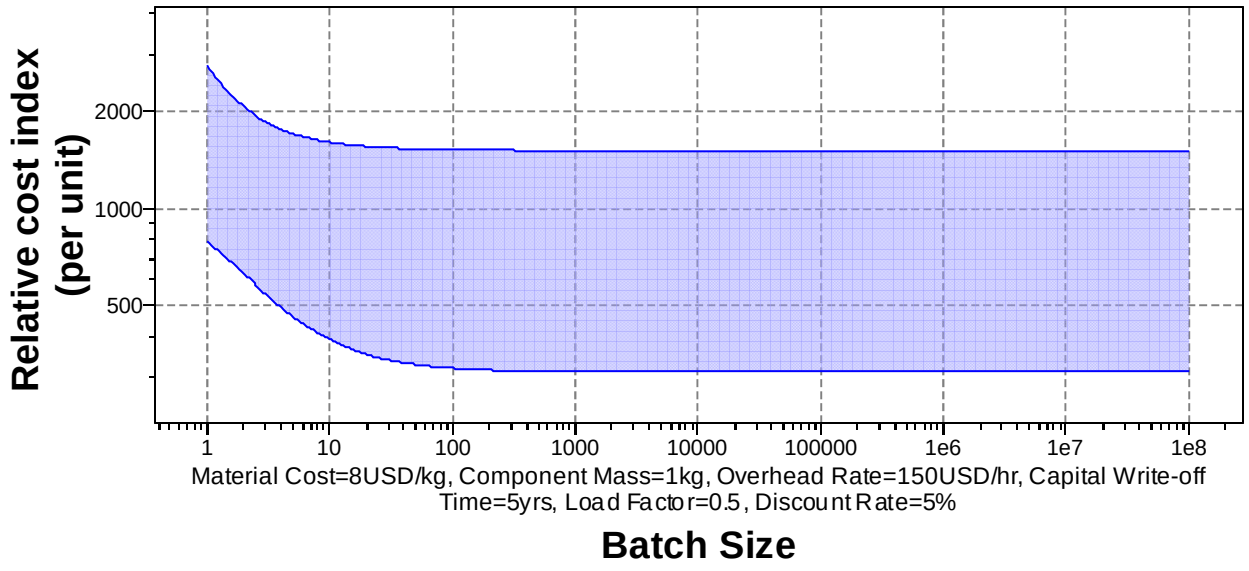
Process characteristics

Primary shaping processes	✓
Discrete	✓
Prototyping	✓

Cost model and defaults

Relative cost index (per unit)	* 312	-	1.51e3	

Parameters: Material Cost = 8USD/kg, Component Mass = 1kg, Batch Size = 1e3, Overhead Rate = 150USD/hr, Discount Rate = 5%, Capital Write-off Time = 5yrs, Load Factor = 0.5



Capital cost	* 82	-	820	USD
Material utilization fraction	* 0.8	-	0.95	
Production rate (units)	* 0.1	-	0.5	/hr
Tooling cost	* 82	-	1.64e3	USD
Tool life (units)	* 200	-	1e3	

Supporting information

Design guidelines

Lay-up methods give the greatest freedom to exploit the potential of fiber-reinforced polymers. They are generally limited to shapes with high surface area to thickness ratios. Ribs, bushes and foam panels inserts are all possible.

Technical notes

The resin systems are all thermosetting, based on polyesters, epoxies, vinyl esters or phenolics. The reinforcement is commonly glass fiber but carbon and natural fibers, such as jute, can also be used.

Typical uses

Both processes are used to make boat hulls, building panels, vehicle bodies and monocoque bicycle frames, ducts, tanks, sleighs, tubs, shower units, casings and shells.

The economics

The process is continuous, allowing automation and minimizing labor costs.

The environment

Open molds lead to evaporation of resin, creating a health hazard: adequate ventilation is

Links

MaterialUniverse

Reference