Description

Image

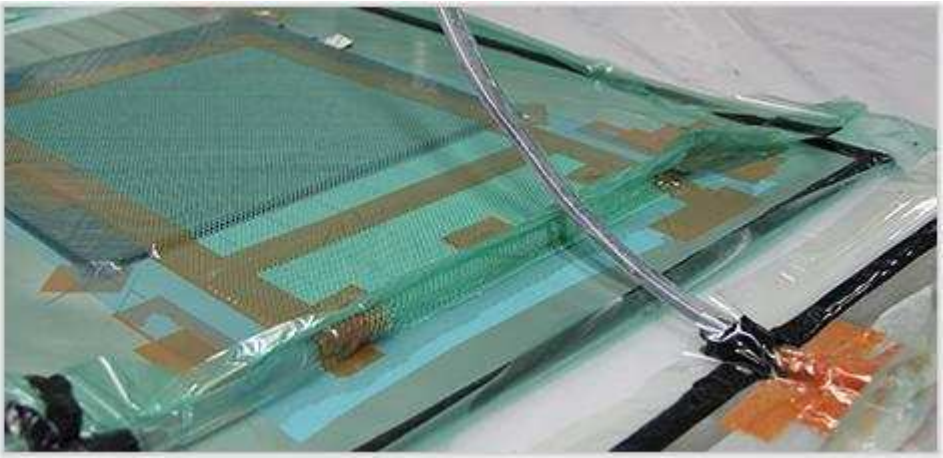


Image caption

(1) Water slide part produced by Resin Transfer Molding (RTM) © Brittany Hagen at Wikimedia Commons (CC BY 3.0) (2) Vacuum assisted composite © Granta Design at TU Delft University

The process

VACUUM ASSISTED RESIN TRANSFER MOLDING (VARTM) is a low-cost tooling way of manufacturing large complex shapes of composite materials. Reinforcement is placed in the mold in the form of layers of dry, woven fabric. This is covered by a peel ply and the whole lot is vacuum bagged. Resin is released and sucked into the bag by the vacuum, flowing through and impregnating the fabric, which is then cured.

Process schematic

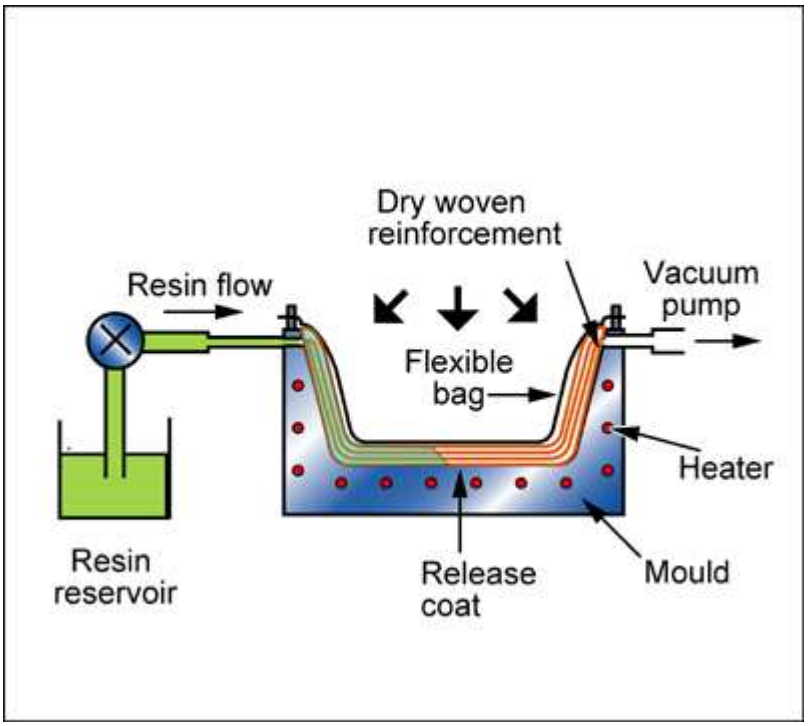


Figure caption

VARTM: the resin is pulled into the dry layup by vacuum.

Tradenames

VARTM, SCRIMP (Seeman composite resin infusion molding process), RIFT (resin infusion under flexible tooling) VARI (vacuum assisted resin injection), VRTM (vacuum resin transfer molding) RIRM (resin injection re-circulation molding), VIMP (vacuum injection molding process).

Material compatibility

Composites	✓			

Shape

Flat sheet	✓			
Dished sheet	✓			

Economic compatibility

Relative tooling cost	low			
Relative equipment cost	medium			
Labor intensity	medium			
Economic batch size (units)	10	-	500	

Physical and quality attributes

Mass range	0.5	-	600	kg
Range of section thickness	1	-	20	mm
Tolerance	0.3	-	1	mm
Roughness	1	-	2.4	µm
Surface roughness (A=v. smooth)	A			

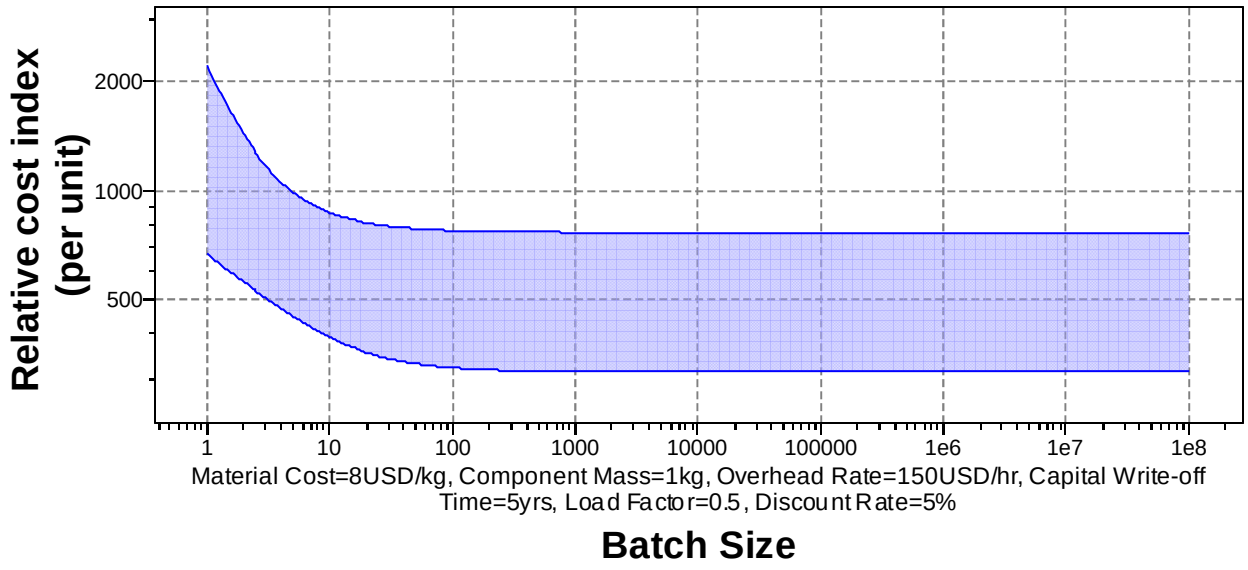
Process characteristics

Primary shaping processes	✓			
Discrete	✓			

Cost model and defaults

Relative cost index (per unit)	314	-	765	

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	820	-	1.64e4	USD
Material utilization fraction	0.85	-	0.95	
Production rate (units)	0.2	-	0.5	/hr
Tooling cost	164	-	1.64e3	USD
Tool life (units)	200	-	500	

Supporting information

Design guidelines

Both simple and complex shapes can be molded. Ribs, bosses and foam inserts are all practical, but undercuts present difficulties.

Technical notes

Most common resin systems can be used; the commonest are epoxies, phenolics, polyesters and vinyl-esters. Reinforcement takes the form of woven fabrics of glass, carbon or other fibers. Polymeric foam cores allow sandwich-like structures to be molded.

Typical uses

VARTM and its variants are used to mold small yacht hulls and for boat building, train and truck body panels.

The economics

Dies can be expensive. Laser or water-jet cutting can be cheaper than blanking for small batch sizes. Explosive forming competes with stretching for large components and small batch sizes.

The environment

The total enclosure of the process gives good environmental control of solvent vapor. The process is an exceptionally clean one.

Links

MaterialUniverse

Reference