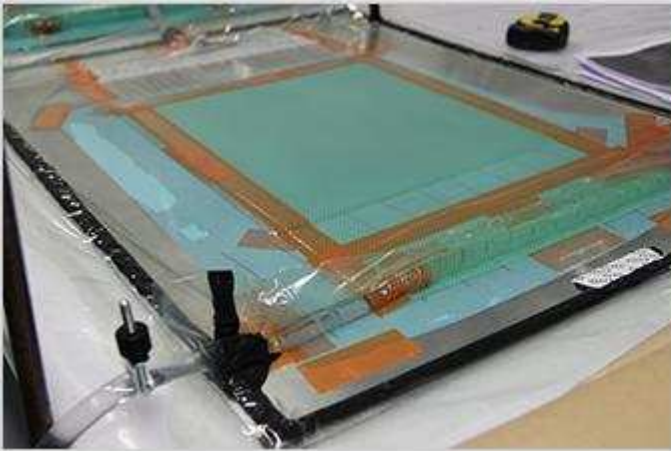


## Description

### Image



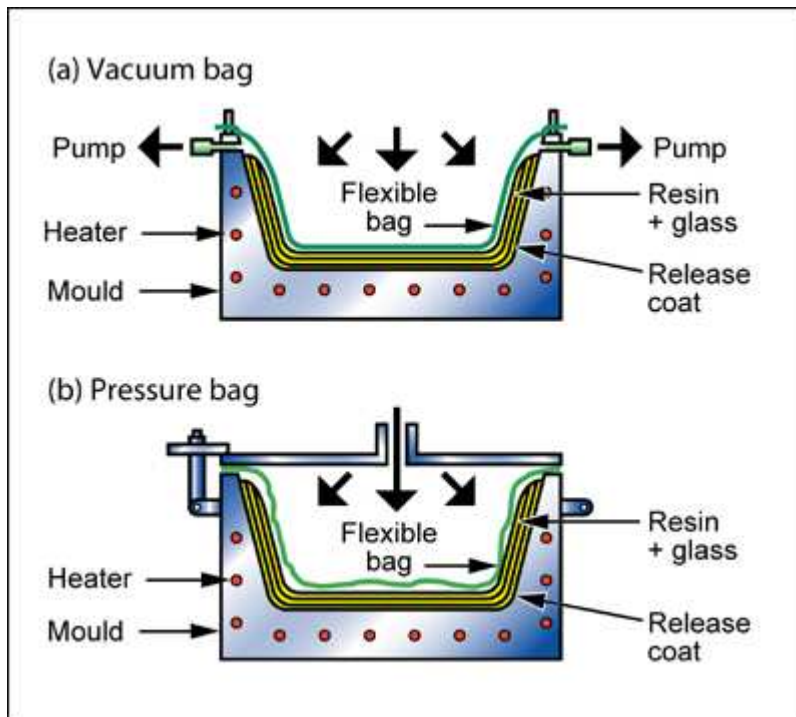
### Image caption

(1) Composite creation © Granta Design (2) Wind turbine blade © Steppinstars at Pixabay [Public domain]

### The process

In VACUUM/PRESSURE BAG MOLDING reinforcement is layed-up on the mold and resin is applied by conventional hand or spray lay-up techniques. The laminate is then sealed beneath a rubber membrane and the air pumped. Atmospheric pressure or a pumped pressure applies a uniform compression across its surface. The single-part mold, made of epoxy, GRFP or metal, is relatively cheap. The use of vacuum or pressure bags gives high quality, dense products.

### Process schematic



### Figure caption

Vacuum-bag and pressure-bag molding (figure following T.H. Meister)

### Material compatibility

Composites	✓
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### Shape

Flat sheet	✓
Dished sheet	✓

### Economic compatibility

Relative tooling cost	low
Relative equipment cost	medium
Labor intensity	medium
Economic batch size (units)	1 - 1e3

### Physical and quality attributes

Mass range	0.8 - 2e3	kg
Range of section thickness	2 - 6	mm
Tolerance	0.8 - 1.2	mm
Roughness	* 0.5 - 3.2	µm
Surface roughness (A=v. smooth)	A	

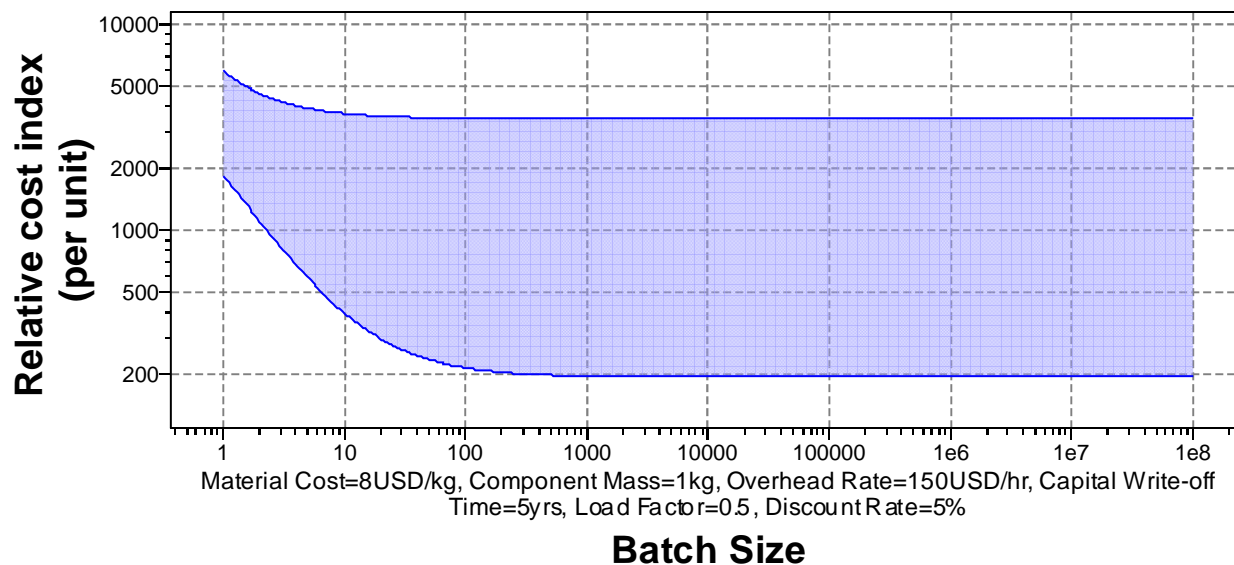
### Process characteristics

Primary shaping processes	✓
Discrete	✓
Prototyping	✓

### Cost model and defaults

Relative cost index (per unit)	194 - 3.49e3
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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	3.28e4	-	8.2e5	USD
Material utilization fraction	0.85	-	0.95	
Production rate (units)	0.05	-	1	/hr
Tooling cost	820	-	3.28e3	USD
Tool life (units)	100	-	1e3	

## Supporting information

### Design guidelines

Both processes are limited to simple shapes with high surface area-to-thickness ratio. Ribs and bosses possible but undercuts, inserts and foam panels should be avoided.

### Technical notes

Liquid resins based on polyesters or epoxies are commonly used. Prepreg epoxy and polyester SMC can also be molded by these processes. Reinforcement is typically glass (25-60%), carbon or aramid.

### Typical uses

Aircraft sections, and interior panels, radomes and structural sections of high-performance

### The economics

The cost of sheet forming operations depends largely on tooling costs. Dedicated tools and dies are usually expensive, and require large batch sizes to make them economic. Processes with low cost tooling, such as spinning, are best suited to small batch sizes, because they are labor intensive.

### The environment

Although the vacuum bag does reduce the number of volatiles emitted during cure, they can still be hazardous. Disposal of bagging can be environmentally harmful.

## Links

MaterialUniverse

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Reference

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