

## Description

### Image



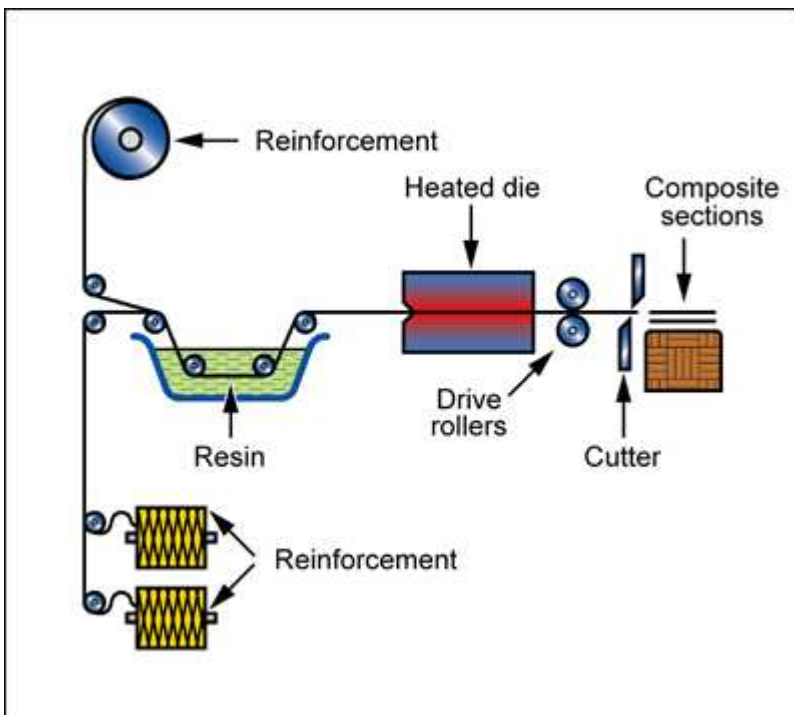
### Image caption

(1) Pultrusion Machines © Liberty Pultrusions (2) UltraGrate Fiberglass Grating is a hand lay-up composite of resin and continuous glass fiber strand that is thoroughly wetted out and woven through an open mold © Liberty Pultrusions (3) continuous lengths of fiber-reinforced polymer (FRP) profiled shapes © Liberty Pultrusions

### The process

In PULTRUSION, resin-impregnated fibers or fabrics are pulled through a series of hardened steel forming dies. The last die is heated to cure the resin, producing a rigid composite section. The profile is determined by the die cross-section; solid or hollow circular, rectangular, square sections, and channel and I-sections, are all possible. The speed of travel through the die is determined by the viscosity, thickness and curing of the resin. The section produced is either cut into discrete lengths after the puller system or wound onto a drum.

### Process schematic



### Figure caption

Pultrusion. The pultruded section is drawn through the heated die by the drive rollers.

### Material compatibility

Composites	✓
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### Shape

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

### Economic compatibility

Relative tooling cost	medium
Relative equipment cost	high
Labor intensity	low

### Physical and quality attributes

Mass range	0.22	-	441	lb
Range of section thickness	118	-	591	mil
Tolerance	9.84	-	39.4	mil
Roughness	0.0118	-	0.063	mil
Surface roughness (A=v. smooth)	A			

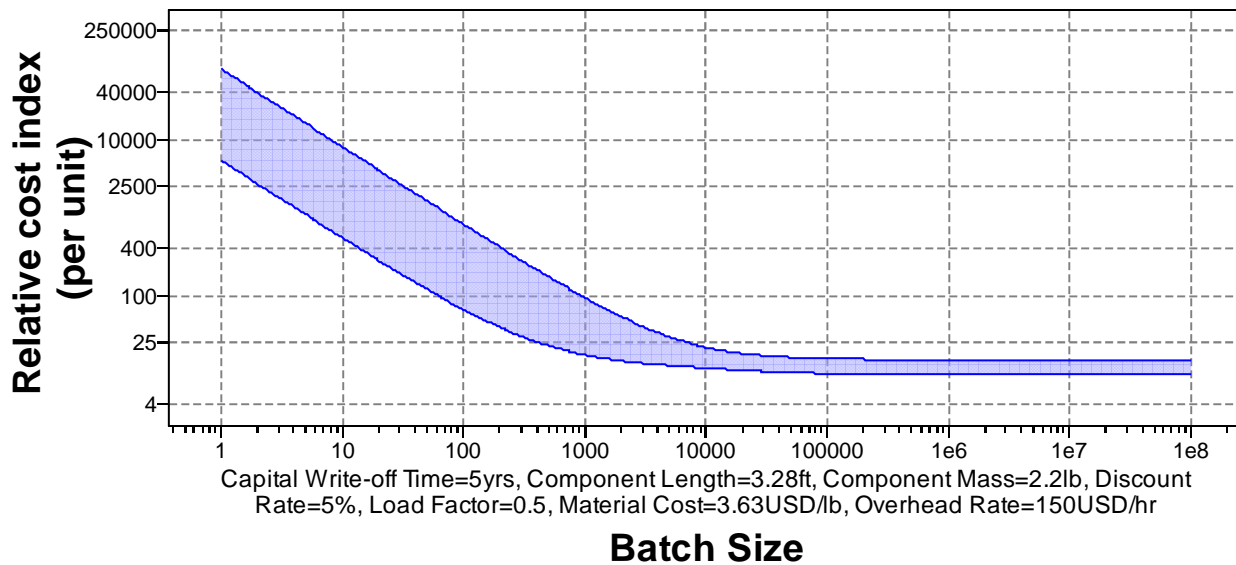
### Process characteristics

Primary shaping processes	✓
Continuous	✓

### Cost model and defaults

Relative cost index (per unit)	17.2	-	93.4
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[Parameters:](#) Material Cost = 3.63USD/lb, Component Mass = 2.2lb, Batch Size = 1e3, Component Length = 3.28ft, Overhead Rate = 150USD/hr, Discount Rate = 5%, Capital Write-off Time = 5yrs, Load Factor = 0.5



Capital cost	1.34e5	-	5.37e5	USD
Material utilization fraction	0.6	-	0.97	
Production rate (length)	0.0787	-	1.18	in/s
Tooling cost	5.37e3	-	8.06e4	USD
Tool life (length)	1.64e5	-	3.28e6	ft

## Supporting information

### Design guidelines

Pultrusion makes continuous prismatic shapes of constant cross section and thin walls. Pultruded sections of glass or carbon reinforced polyester and epoxy are available as standard products.

### Technical notes

Liquid polyester and epoxy are the most usual resin systems, but prepreg - epoxy can be pultruded. Reinforcement is typically glass (60-75%), carbon or aramid in the form of continuous roving. The production rate depends on thickness, shape complexity and the curing time of the resin.

### Typical uses

A range of cross-sections such as rods, tubes, channels, boxes, I-beams and angles are available as standard. They are used for applications such as corrosion resistant walkways, handrails, cable support systems, bridges, ladders and waste management systems.

### The economics

The costs are greater than for hand lay-up or spray-up but with the compensation of higher quality.

### The environment

Glass dust causes irritation, resin fumes are a hazard and therefore a good extraction system is required.

## Links

MaterialUniverse

Reference

