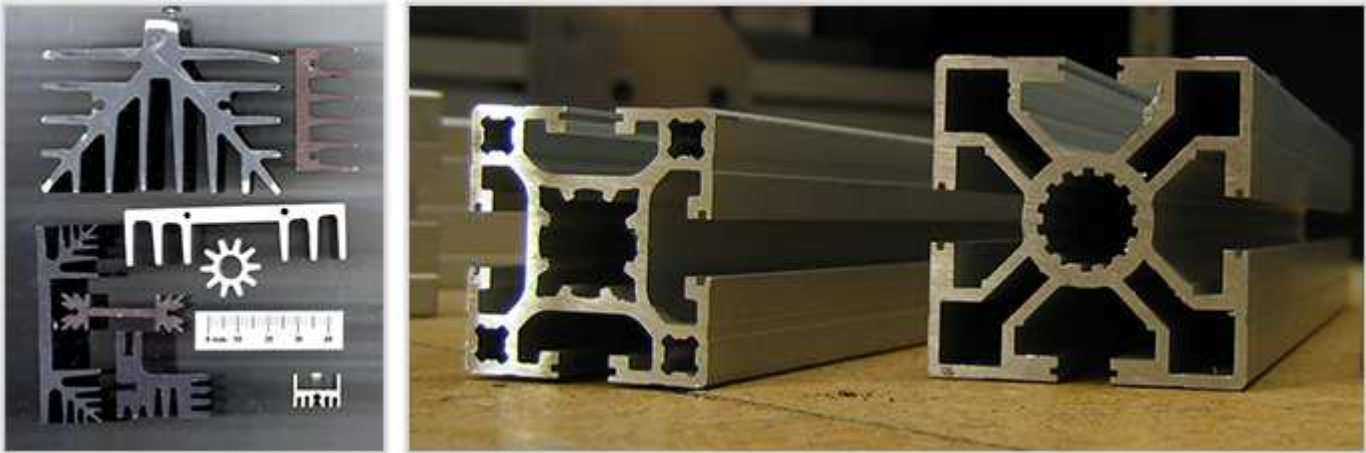


## Description

### Image



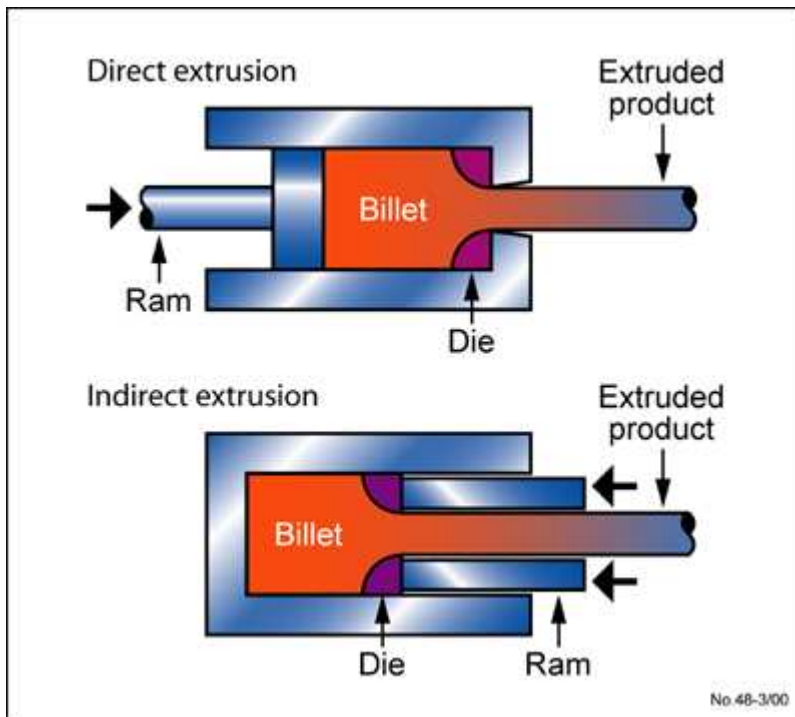
### Image caption

(1) Pieces of extruded aluminium © Adwarf at Wikimedia Commons [Public domain] (2) Pieces of extruded aluminum © Mike1024 at Wikimedia Commons [Public domain]

## The process

The process of squeezing toothpaste from its tube is one of extrusion. The gooey toothpaste - or the gooey polymer or metal in the industrial process - is forced by pressure to flow through a shaped die, taking up the profile of the die orifice. In co-extrusion two materials are extruded at the same time and bond together - a trick used in toothpaste to create colored stripes in it.

## Process schematic



## Material compatibility

Ceramics



Metals - non-ferrous



### Shape

Circular prismatic



Non-circular prismatic



### Economic compatibility

Relative tooling cost

high

Relative equipment cost

high

Labor intensity

low

### Physical and quality attributes

Mass range

1 - 1e3 kg

Range of section thickness

1 - 900 mm

Tolerance

0.5 - 1 mm

Roughness

0.8 - 3.2  $\mu\text{m}$

Surface roughness (A=v. smooth)

B

### Process characteristics

Primary shaping processes



Continuous

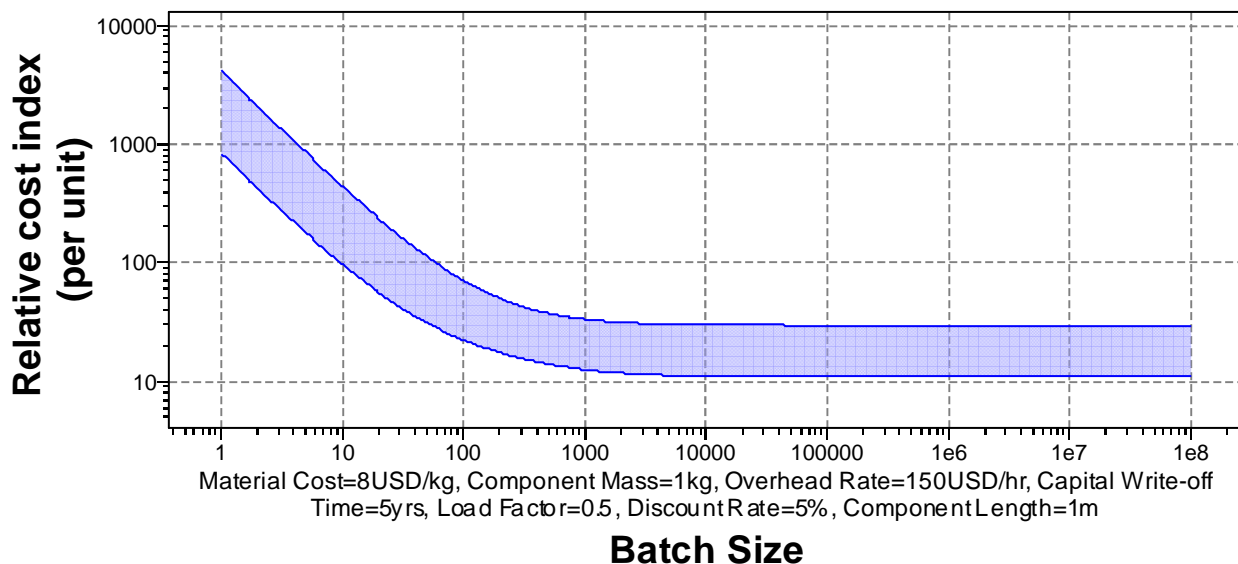


### Cost model and defaults

Relative cost index (per unit)

12.5 - 33.4

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



Capital cost

1.64e5 - 1.64e6 USD

Material utilization fraction

0.9 - 0.97

Production rate (length)

0.01 - 5 m/s

Tooling cost	820	-	4.1e3	USD
Tool life (length)	100	-	1e5	m

## Supporting information

### Design guidelines

Metals extrusion is limited to ductile materials with melting points below 1700°C, commonly aluminum, copper, magnesium, low and medium carbon steels, low alloy steels and stainless steels. The extrusion of steel usually requires the addition of a molten glass lubricant. The tolerance is often lower than expected because of creep and die wear; it can be improved by cold drawing as a secondary process. Symmetric cross-sections, constant wall thickness and generous radii are the easiest to form; the aspect ratio of the section should not exceed 14:1 for steel or 20:1 for magnesium. Impact extrusion is a cold process for metals (aluminum, copper, lead, magnesium, tin, zinc, carbon steels, low alloy steels) which combines the principles of forging and extrusion. Polymer extrusion begins powder or pellets; pressure is built up by a rotating screw, forcing the polymer through a heating chamber and through the die. The extrusion cools as it leaves the die and can then be drawn to a smaller cross-section. Most polymers can be extruded (including those with particulate and short fiber-reinforcement). In ceramic extrusion ceramic powder is mixed with a polymer binder and extruded like a polymer. The extruded section is then fired, burning off the polymer and sintering the ceramic powder.

### Technical notes

There are two variants of the extrusion process: direct - where the die is stationary and the metal is forced through it; and indirect - where the die itself compresses the metal. Indirect extrusion has less friction between the billet and die, so there are lower extrusion forces but the equipment is more complex and the product length is restricted.

### Typical uses

Tubing, window frame sections, building and automotive trim, aircraft structural parts, railings, rods, channels, plastic-coated wire, seals, filaments, film, sheet, pellets, bricks.

### The economics

Equipment and tooling costs are low - much lower than for injection molding - but cycle times are longer than any other molding process, and it is labor-intensive.

### The environment

No special problems here.

## Links

MaterialUniverse

Reference