Description

Image

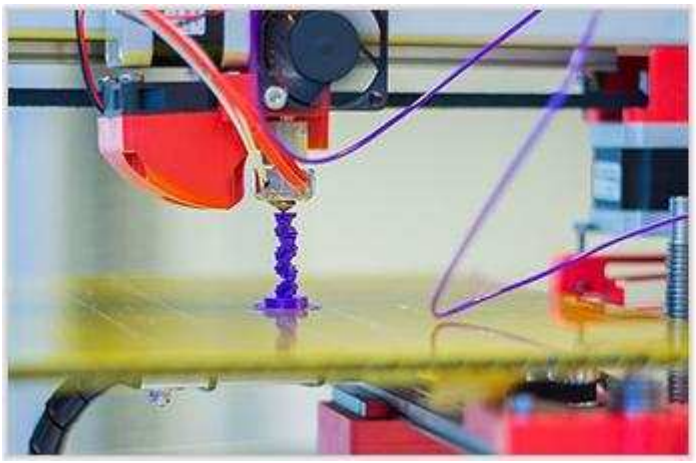


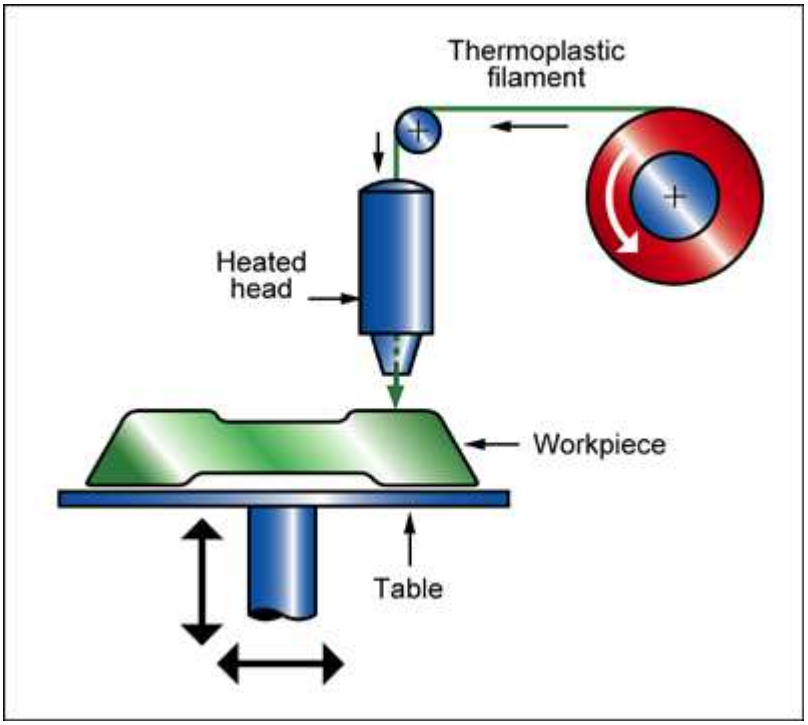
Image caption

(1) The printing head of a FELIX 3D Printer in action © Jonathan Juursema at Wikimedia Commons (CC BY 3.0) (2) 3D printing result © Mr. Zabej at Wikimedia Commons (CC BY 4.0)

The process

FUSED DEPOSITION MODELLING (FDM) is an additive manufacturing technique suitable for use in an office environment. A fine stream of molten material (usually thermoplastic) is deposited by a two-axis heated extrusion head. Semi-liquid thermoplastic material is extruded and then deposited one layer at a time starting at the base. This builds the model vertically on a fixtureless base. Successive layers adhere together through thermal fusion. The FDM process requires no post-production UV curing, enabling multiple versions of a part to be created within a short time frame. This is the most widely used additive manufacturing method for home and office use due to the low machine and operating costs. As with other additive manufacturing processes, a CAD solid model of the part is required.

Process schematic



Material compatibility

Polymers - thermoplastics	✓			

Shape

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

Economic compatibility

Relative tooling cost	low			
Relative equipment cost	high			
Labor intensity	medium			
Economic batch size (units)	1	-	10	

Physical and quality attributes

Mass range	*	0.1	-	15	kg
Range of section thickness		0.5	-	100	mm
Tolerance		0.127	-	2	mm
Roughness	*	100	-	125	µm
Surface roughness (A=v. smooth)		C			

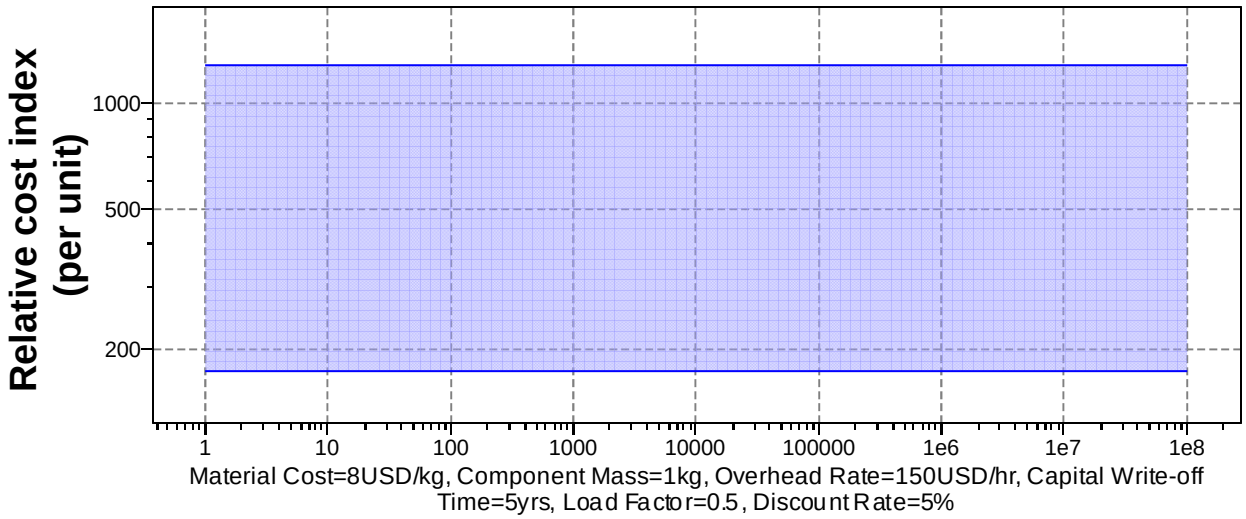
Process characteristics

Primary shaping processes	✓			
Discrete	✓			
Prototyping	✓			

Cost model and defaults

Relative cost index (per unit)	*	173	-	1.27e3	

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	9.43e4	-	4e5	USD
Material utilization fraction	* 0.9	-	0.98	
Production rate (units)	0.13	-	1	/hr
Tooling cost	* 0	-	0.1	USD
Tool life (units)	1e5	-	1e6	

Supporting information

Design guidelines

Support structures (which can be removed later) are required in addition to the main body of the object for overhangs. Due to the rounded bead, sharp angles are not possible and small voids occur where the deposition direction changes so there is porosity in some areas. This porosity may be reduced at the expense of surface finish.

Technical notes

The build envelope (L x W x H) ranges from 127 x 127 x 127 mm to 914 x 610 x 914 mm.
Typical layer thickness is 78 - 330 µm.
A variety of materials and colors can be used for model building including ABS, wax-filled plastic adhesive material, proprietary nylon, investment casting wax and possibly metals with a low melting point.

Typical uses

Making prototypes and models quickly from CAD systems.

The economics

Prices range from around $200 for DIY assembly machines, to $1500 for ready-assembled, to $15000 for industrial models. Objects cost around $0.40 per cubic cm.

The environment

The materials are non-toxic. There is minimum material wastage in the

Links

MaterialUniverse

Reference