Description

Image

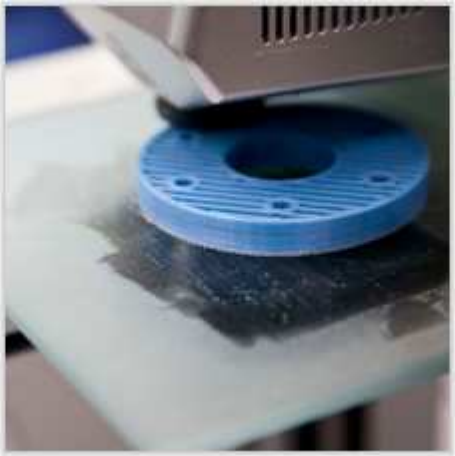
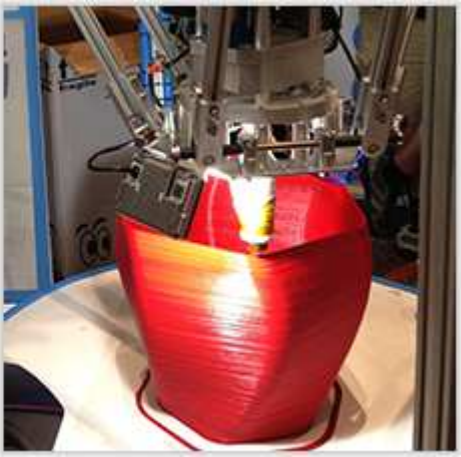




Image caption

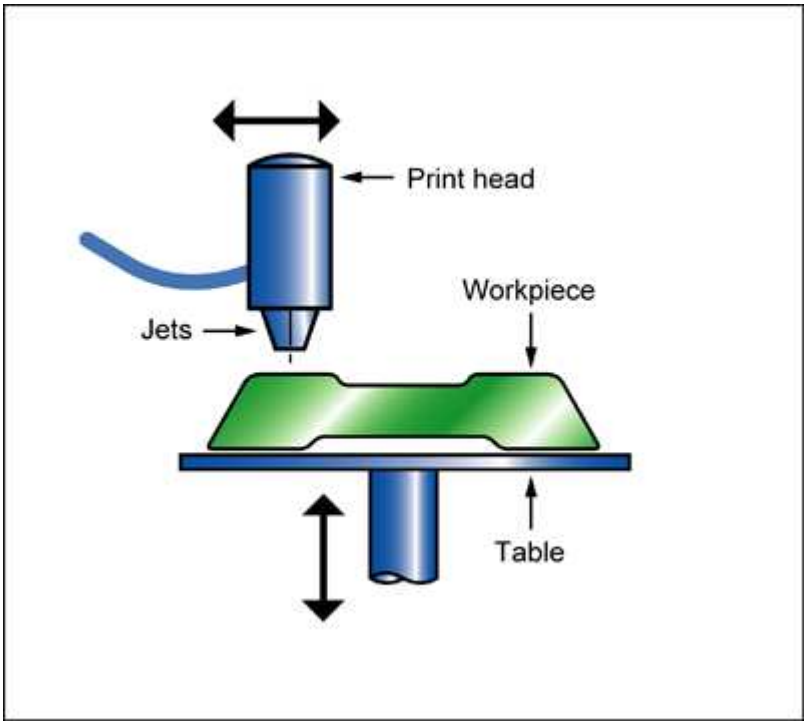
(1) Easily accessible 3D Printer manufactured by Airwolf 3D © Eva Wolf at Wikimedia Commons (CC BY-SA 3.0) (2) A 3D printer provided to high school teams participating in the FIRST Robotics Competition © Energy.gov at Wikimedia Commons [Public domain] (3) Large delta-style 3D printer © Z22 at Wikimedia Commons (CC BY-SA 4.0)

The process

3D PRINTING (three-dimensional printing) draws on the technology of ink-jet printers to build up successive layers of a prototype or model. Instead of ink, the print-head deposits thermoplastic photopolymer or wax that quickly sets. As with other additive manufacturing processes, a CAD solid model of the part is required. The attraction of 3D printing over additive manufacturing techniques is that it uses multiple jets, greatly increasing the speed at which the model can be built. Some machines can print two different materials at once.

This process is also known as material jetting.

Process schematic



Material compatibility

Polymers - thermoplastics	✓
Polymers - thermosets	✓

Shape

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

Economic compatibility

Labor intensity	medium			
Economic batch size (units)	1	-	10	

Physical and quality attributes

Mass range	* 0.22	-	22	lb
Range of section thickness	47.2	-	3.94e3	mil
Tolerance	11.8	-	78.7	mil
Roughness	2.95	-	3.94	mil
Surface roughness (A=v. smooth	B			

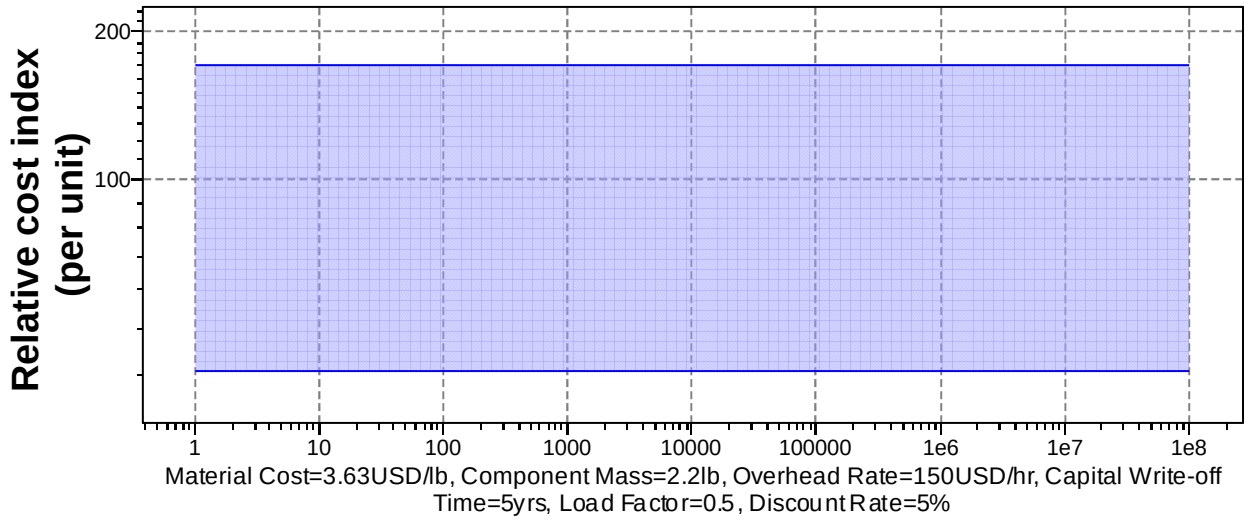
Process characteristics

Primary shaping processes	✓
Discrete	✓
Prototyping	✓

Cost model and defaults

Relative cost index (per unit)	* 40.7	-	170	

Parameters: Material Cost = 3.63USD/lb, Component Mass = 2.2lb, Batch Size = 1e3, Overhead Rate = 150USD/hr, Discount Rate = 5%, Capital Write-off Time = 5yrs, Load Factor = 0.5



Capital cost	1e3	-	4e5	USD
Material utilization fraction	* 0.9	-	0.98	
Production rate (units)	1	-	5	/hr
Tooling cost	* 0	-	0.1	USD
Tool life (units)	1e5	-	1e6	

Supporting information

Design guidelines

Complex shapes can be made. Shallow undercuts can be created without supports because the extruded polymer or wax cools and solidifies very quickly, but large overhangs require a second deposition head to build supports from a water or solvent-soluble material. The supports may be dissolved out when the model is complete if made from a different material.

Technical notes

The build envelope (L x W x H) ranges from 152 x 152 x 51 mm for jewelry and dentistry to 533 x 381 x 300 mm.
Typical layer thickness is 16 - 76 µm.

Typical uses

Making prototypes and models quickly from CAD systems. Investment castings for jewelry and dentistry industries.

The economics

The cost of 3D printing is similar to that of FDM, with desktop printers costing around $1000 to $3000 and industrial models up to $24600.

The environment

No particular environmental hazards.

Links

MaterialUniverse

Reference