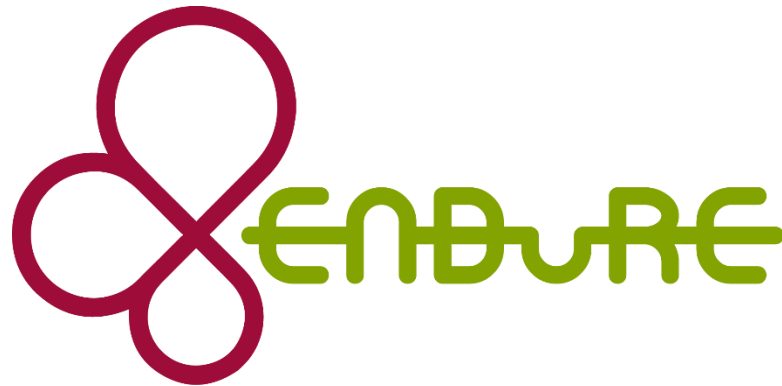




Rapid Prototyping

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COMPARATIVE ANALYSIS

Rapid Prototyping

- Features of AM Systems:
 - Process type - Stereo lithography, Laminating, Fused deposition modelling, Sintering of powder, Solid ground curing, etc.
 - Work space(mm) - depends on the models
 - Material - photopolymer resin, coated paper, ABS, wax, metal alloy, etc.

Which Process Should You Pick?

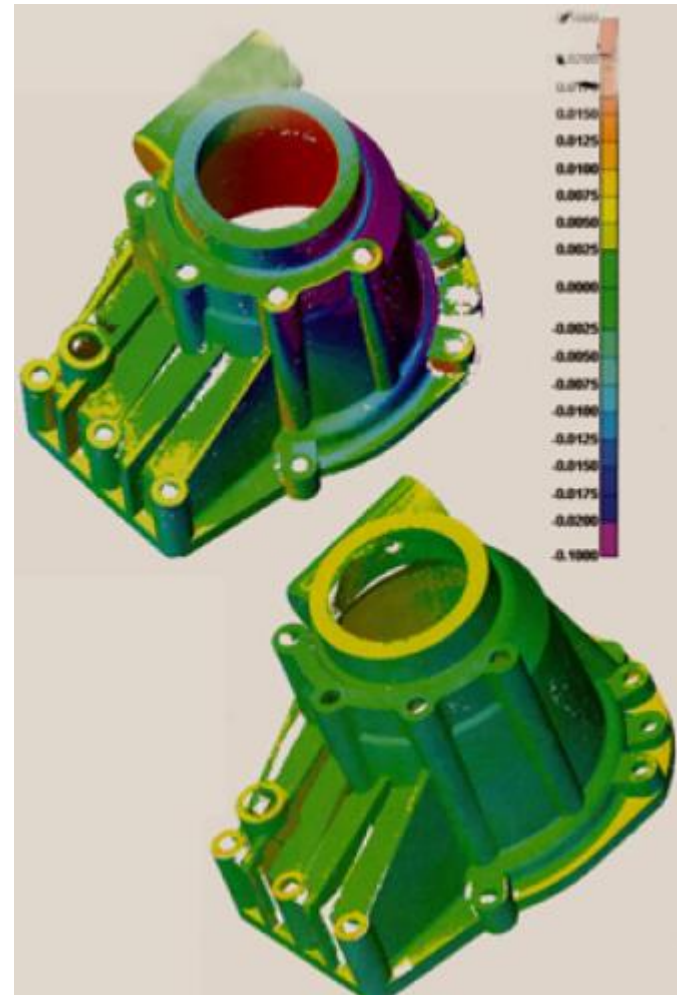
- Do you need a prototype (not just a model)?
 - SLS, FDM (for robustness, strength).
- Do you need a mold for a small batch?
 - SLA (for smooth, hard surface).
- Does part need multiple colors?
 - 3D Color-Printing.
- Does part have convoluted internal spaces?
 - 3D-Print, SLS, SLA (easy support removal).

Accuracy, resolution and surface finishing

	Layer thickness(mm)	Accuracy (mm)
SLA	0.05 - 0.3	0.01 - 0.2
LOM	0.1 - 1	0.1 - 0.2
FDM	≈0.05	0.130 - 0.260
SLS	≈0.08	0.03 - 0.4
SGC	0.01 - 0.15	0.05 - 0.5

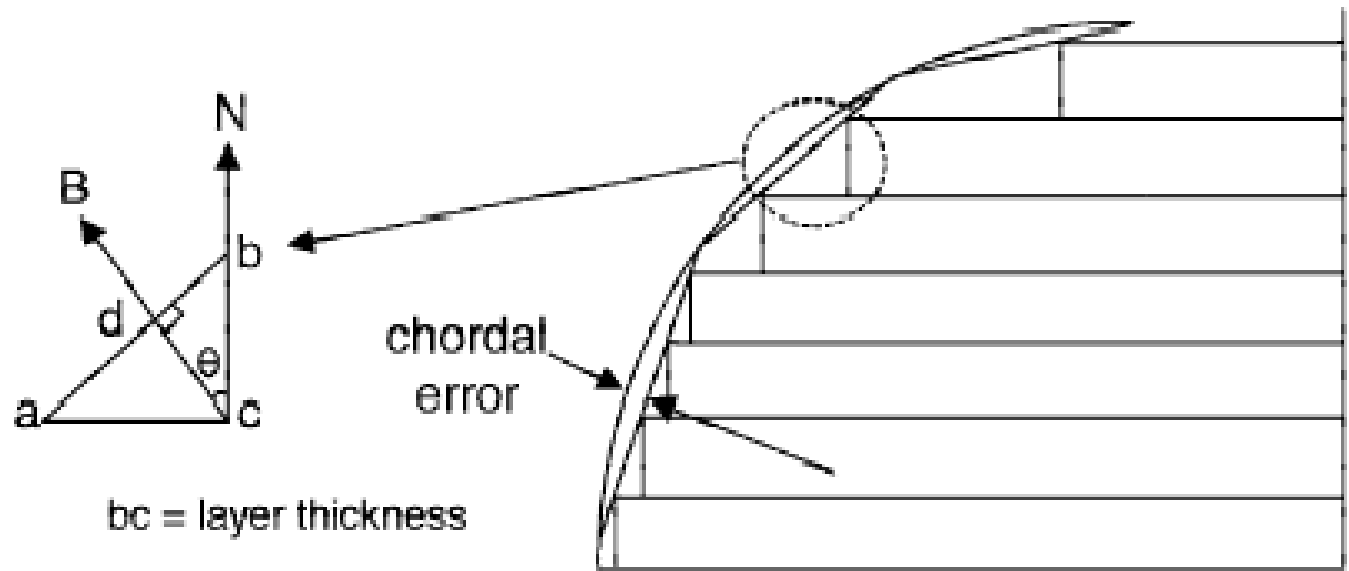
Accuracy, resolution and surface finishing

- Accuracy and resolution
 - tolerances are still not quite at the level of CNC,
 - Because of intervening energy exchanges and/or complex chemistry one cannot say with any certainty that one method of RP is always more accurate than another, or that a particular method always produces a certain tolerance.



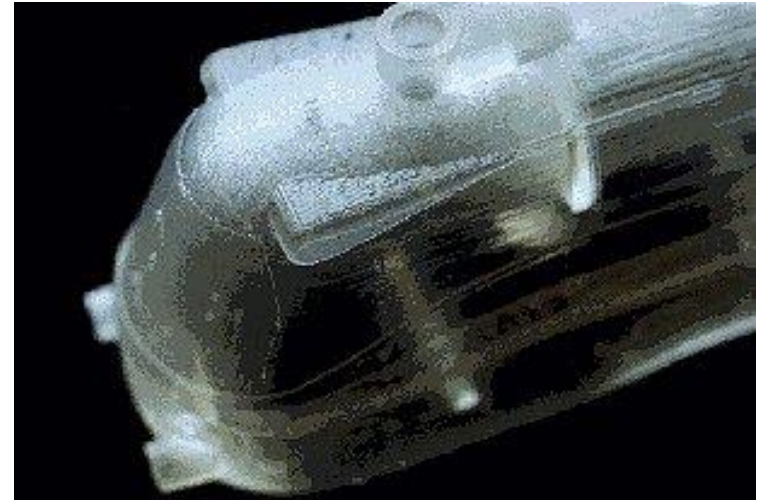
Accuracy, resolution and surface finishing

- Stair Stepping:
 - Since rapid prototyping builds object in layers, there is inevitably a "stairstepping" effect produced because the layers have a finite thickness.



Accuracy, resolution and surface finishing

- **FINISH**
 - The finish and appearance of a part are related to accuracy, but also depend on the method of RP employed.
 - Technologies based on powders have a sandy or diffuse appearance, sheet-based methods might be considered poorer in finish because the stairstepping is more pronounced.



Accuracy, resolution and surface finishing

Technology	SLA	SLS	FDM	Wax Inkjet	3D printer	LOM
Max Part Size (cm)	30x30x50	34x34x60	30x30x50	30x15x21	30x30x40	65x55x40
Speed	Average	Average to fair	Poor	Poor	Excellent	Good
Accuracy	Very good	Good	Fair	Excellent	Fair	Fair
Surface finish	Very good	Fair	Fair	Excellent	Fair	Fair to poor
Strenghts	Market leader, large part size, accuragy, wide product	Market leader, accuracy, materials, large part size	Lab on desktop, price, materials	Accuracy, finish, lab on desktop	Speed, lab on desktop, price, color	Large part size, good for large castings, material cost
Weaknesses	Post processin g messy liquids	Size and weight, system price, surface finish	Speed	Speed limited, materials, part size	Limited materials, fragile parts, finsh	Part stability, smoke, finish and accuracy

Cost

Machine	Cost	Material	Application
Fused Deposition Modeler 1600 (FDM)	\$10/hr	ABS or Casting Wax	Strong Parts Casting Patterns
Laminated Object Manufacturing (LOM)	\$18/hr	Paper (wood-like)	Larger Parts Concept Models
Sanders Model Maker 2 (Jet)	\$3.30/hr	Wax	Casting Pattern
Selective Laser Sintering 2000 (SLS)	\$44/hr	Polycarbonate TrueForm SandForm	light: 100%; margin: 0">Casting Patterns Concept Models
Stereolithography 250 (SLA)	\$33/hr	Epoxy Resin (Translucent)	Thin walls Durable Models
Z402 3-D Modeller (Jet)	\$27.50/hr	Starch/Wax	Concept Models

Cost

- System costs
 - from \$30,000 to \$800,000
 - training, housing and maintenance (a laser for a stereolithography system costs more than \$20,000)
- Material
 - High cost
 - Available choices are limited.

Cost - Vendors

Photopolymer

3D System (formerly DTM)	US	http://www.3dsystems.com
EOS	Germany	http://www.eos.info/en
CMET	Japan	http://www.cmet.co.jp/eng/
Envisiontec Perfactory	Germany	http://www.envisiontec.de

Deposition

Stratasys	FDM	US	http://www.stratasys.com
Solidshape (now it is a Stratasys company)	Inkjet	US and the Netherlands	http://www.solidshape.com
3D Systems (formerly DTM)	Thermojet™	US	http://www.3dsystems.com
Soligen	casting cores/patterns	US	http://www.soligen.com

Selective laser sintering

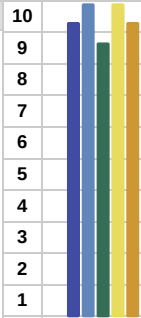
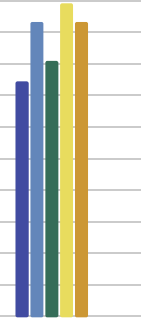
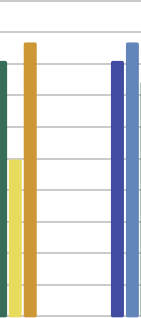
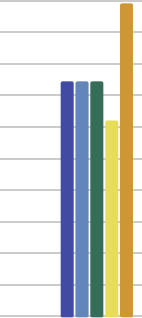
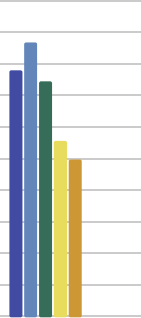
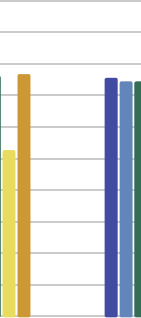
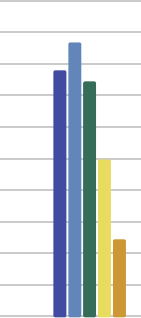
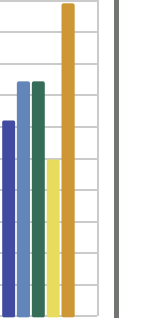
3D Systems	US	http://www.3dsystems.com
EOS	Germany	http://www.eos.info/en

Cost - Low cost 3D printer

2013 Best 3D Printer Reviews and Comparisons

Displaying 1 to 10 of 19

« Previous 10 | Next 10 »

Rank	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
10-9 Excellent	Cubify CubeX	Cubify Cube	LulzBot AO-101	Afinia H	Replicator 2	AW3D XL	AW3D V5	Replicator 2X	Mbot Cube	3DTouch
8-6 Good										
5-4 Average										
3-2 Poor										
1-0 Bad										
Print/Email										
Reviewer Comments	Read Review	Read Review	Read Review	Read Review	Read Review	Read Review	Read Review	Read Review	Read Review	Read Review
Ratings	9.53	8.60	8.08	7.85	7.63	7.58	7.38	7.35	7.25	7.08
Overall Rating Printing Features Printer Design Included Components Connectivity Help & Support										

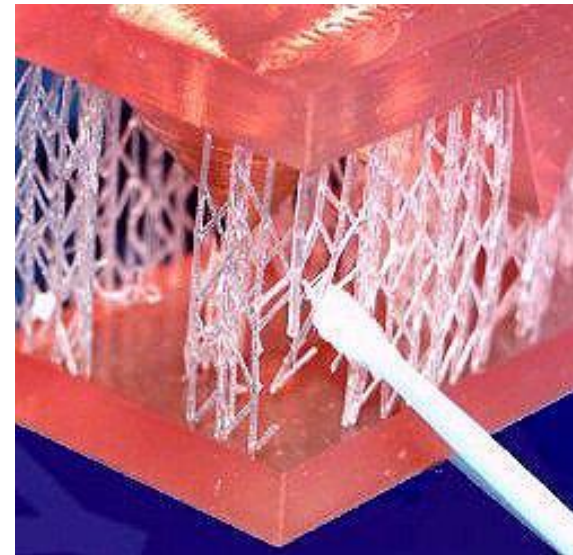
Cost - Time

- Secondary Operations
 - Post Curing (Stereolithography)
 - Infiltration, for fragile parts (3DP, MJM, SLS)
 - Final machining of metal parts
 - Removing of the support structures

Support structure (red material),
water-soluble, fused deposition
modeling



Support structure,
stereolithography.

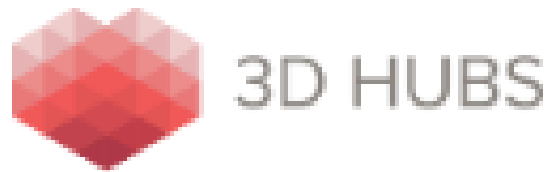


Asking for a quote

- <https://www.stratasysdirect.com/>



- <https://www.3dhubs.com/>

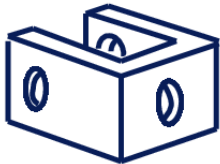
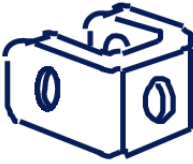
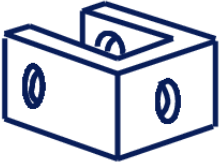
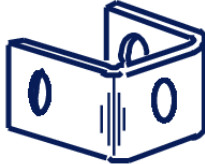
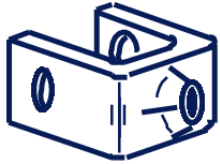




IS IT A GOOD CHOICE
TO 3DPRINT EVERYTHING?

Design for manufacture

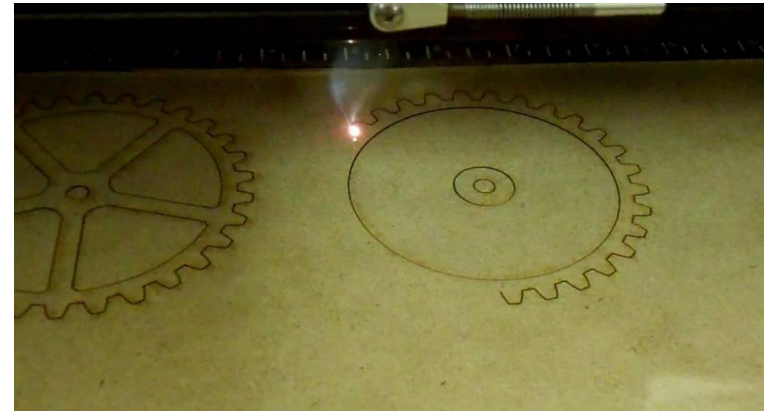
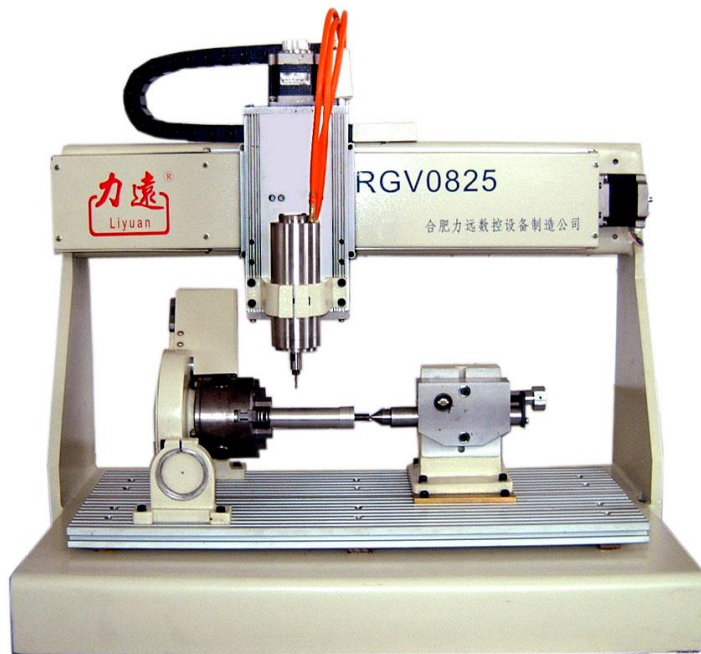
A simple fork end for Pneumatic Piston

					
Machine from Solid	Welded Assembly	Casting	Extrusion or Stock Channel	Sheet Metal	Injection Mold
	 x3				
\$95	\$75	\$55	\$25	\$1.20	\$0.30
Piece-part costs					
\$10	\$100	\$400	\$8	\$5,000	\$60,000
Tooling costs					

Production Volume: Recurring Costs versus Non-Recurring Costs

Subtractive technologies

- Laser cutter
- CNC milling machines



NC Machining & Rapid Prototyping

- Numeric control machines requires a skilled operator to set up the machining specifying:
 - tools,
 - speeds,
 - raw materials.
- NC Machining allows:
 - a wide range of materials
 - better accuracy
 - to reveal manufacturing limits in a given design.

Additive vs Subtractive Manufacturing

- AM can not become complete replacement for the SM (Milling, Turning, EDM etc.)
- AM technologies are instead complementary for:
 - complex or intricate geometric forms,
 - simultaneous fabrication of multiple parts into a single assembly,
 - multiple materials or composite materials in the same part.
- Thus, AM is the enabling technology for controlled material composition as well as for geometric control.

Environmental and health issues

