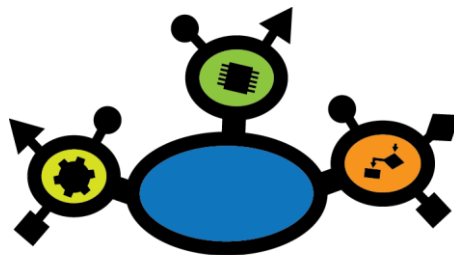


3D Printimine

Kaupo Raid

www.robolabor.ee



ROBOLABOR
www.robolabor.ee

3D Printing (additive manufacturing)

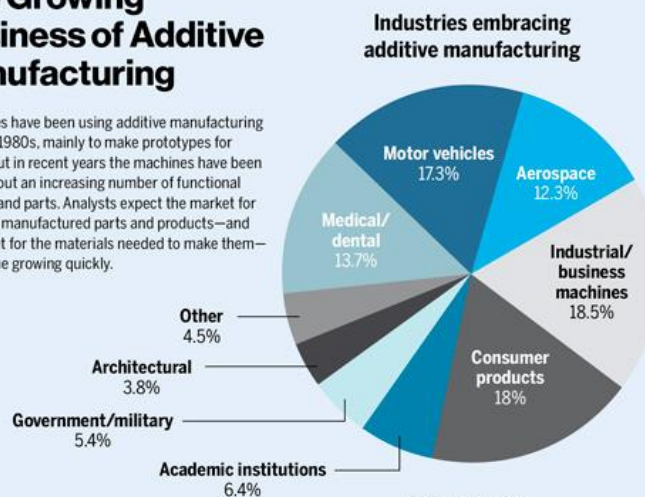


- CAD failist reaalne objekt
 - Odav, puhas ja vaikne
 - Kiire prototüüpimine
 - Struktuurselt võib nõrk jääda
 - Piiratud materjalide valik
 - Piiratud suurus



The Growing Business of Additive Manufacturing

Companies have been using additive manufacturing since the 1980s, mainly to make prototypes for testing. But in recent years the machines have been churning out an increasing number of functional products and parts. Analysts expect the market for additively manufactured parts and products—and the market for the materials needed to make them—to continue growing quickly.



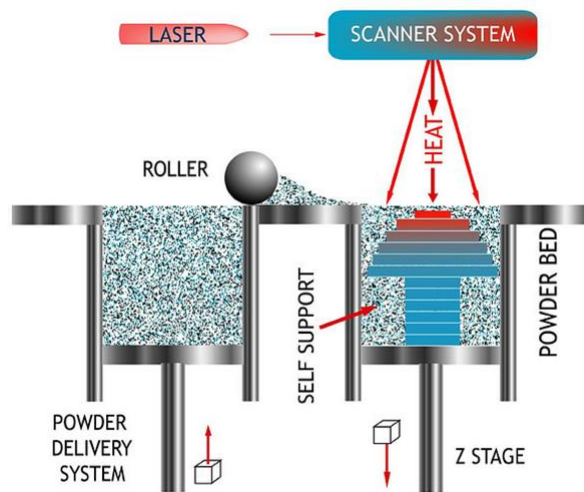
MIT Technology Review

3D Printimise tehnoloogiad

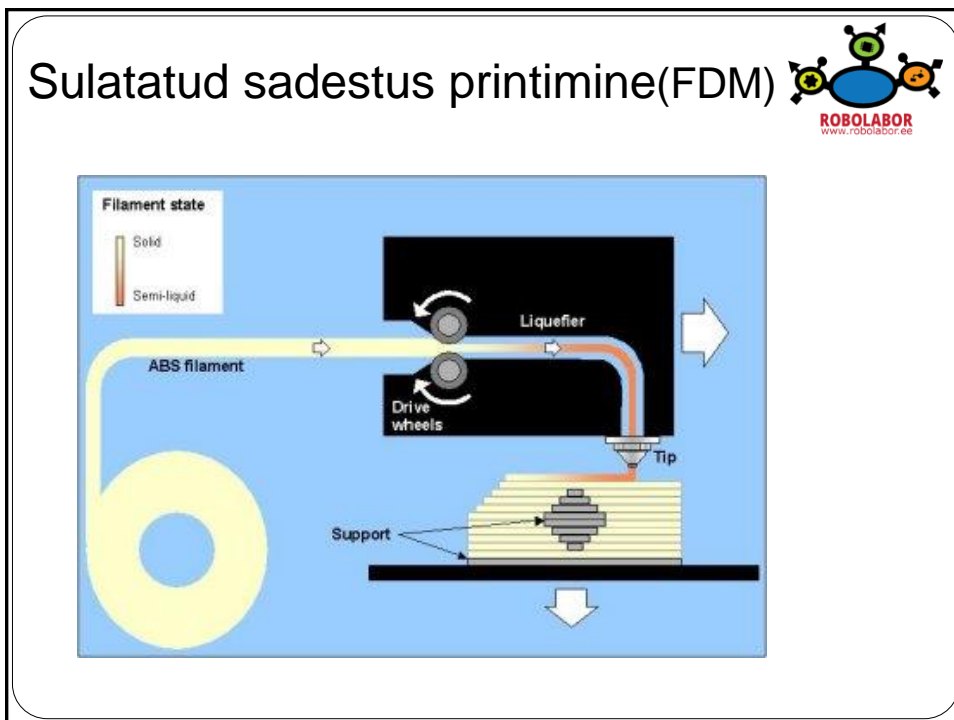
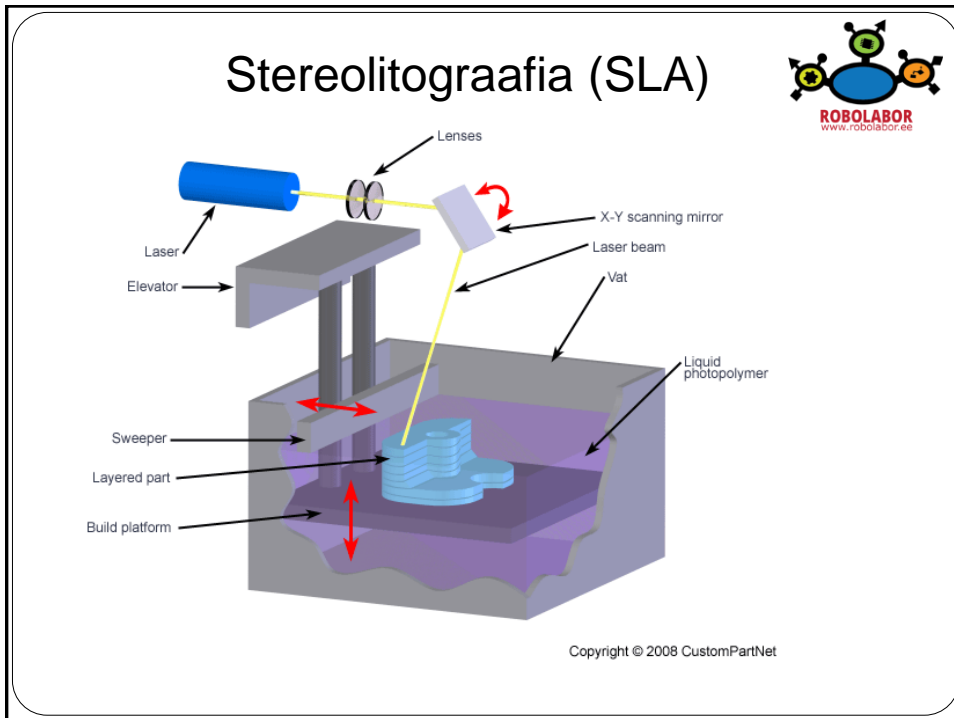


- Selektiivne laserpaagutus (SLS)
- Stereolitograafia (SLA)
- Sulatatud sadestus vormimine (FDM)
- Lamineeritud esemete printimine (LOM)
- Elektronkiirega sulatamine (EBM)
- Multi-jet-vormimine (MJM)

Selektiivne laserpaagutus(SLS)



Images created by Chris Chen and Matthew Wettergreen

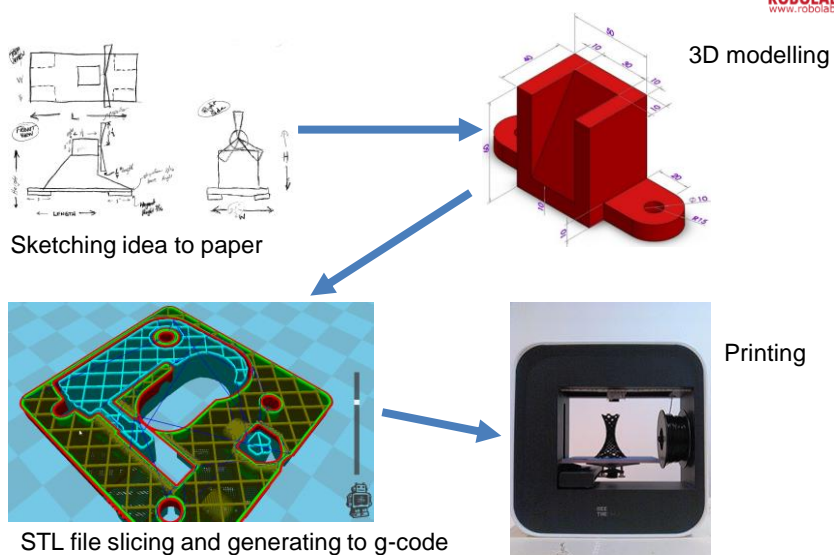


Sulatatud sadestus vormimine (FDM)




- Kõige levinum 3D printimise tehnoloogia
- Odav
- Printide kvaliteet on hea
- Lihtne kasutada
- Erinevad materjalid
- Lihtsalt skaleeritav

Ideest reaalse mudelini



3D models libraries



printable
3D Models
Search Engine

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3D PRINTERID

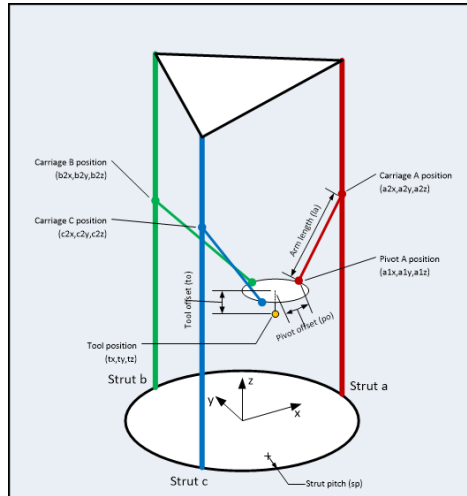
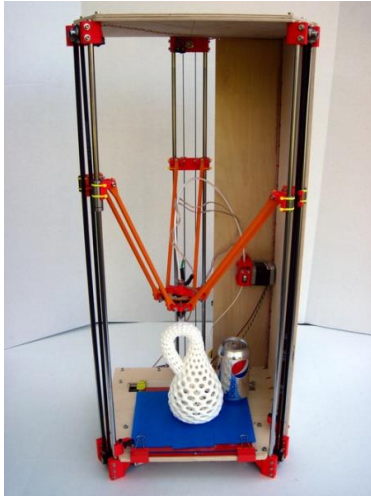
Kaupo Raid

FDM/FFF printerid



- Kossel K800
 - Delta konfiguratsioonis printer
 - Ringikujuline ehitusplaat (diameeter 120mm)
- Bee The First
 - Lineaarsed x, y ja z teljed
 - Ristkülikukujuline ehitusplaat (190x135x125)
 - Lihtsalt kaasaskantav

Delta printer



Makerbor Replicator Desktop



**3D-PRINTER
50 EESTI
KOOLILE**

Printerite omadused



- Printeri töö ala suurus
- Prinditava kihi paksus
- Printeri resolutsioon
- Prinditavad materjalid
- Prinditava toormaterjali valik (diameeter, rull)
- Printimise kiirus
- Printimise meetod
- Printeri võime töötada arvutist sõltumatusena
- Soojendusega printimise alus

PRINTING	SIZE & WEIGHT	SOFTWARE
<p>PRINT TECHNOLOGY FUSED DEPOSITION MODELING</p> <p>BUILD VOLUME 25.2 L X 19.9 W X 15.0 H CM [9.9 X 7.8 X 5.9 IN]</p> <p>7,522 CUBIC CENTIMETERS [456 CUBIC INCHES]</p> <p>LAYER RESOLUTION 100 MICRONS [0.0039 IN]</p> <p>FILAMENT DIAMETER 1.75 MM [0.069 IN]</p> <p>FILAMENT COMPATIBILITY MAKERBOT PLA FILAMENT LARGE SPOOL 0.9 KG [2.0 LB]</p> <p>NOZZLE DIAMETER 0.4 MM [0.015 IN]</p> <p>PRINT FILE TYPE .MAKERBOT</p>	<p>PRODUCT DIMENSIONS 52.8 L X 44.1 W X 41.0 H [20.8 X 17.4 X 16.2 IN]</p> <p>SHIPPING BOX 57.6 L X 52.1 W X 54.6 H CM [22.7 X 20.5 X 21.5 IN]</p> <p>PRODUCT WEIGHT 16 KG [35.3 LBS]</p> <p>SHIPPING WEIGHT (INCLUDES ACCESSORY KIT) 20.8 KG [45.9 LBS]</p>	<p>SOFTWARE BUNDLE MAKERBOT DESKTOP SOFTWARE</p> <p>SUPPORTED FILE TYPES STL, OBJ, THING, MAKERBOT</p> <p>OPERATING SYSTEMS WINDOWS (7+) MAC OS X (10.7+) LINUX (UBUNTU 12.04+, FEDORA 19+)</p>
<p>TEMPERATURE</p> <p>AMBIENT OPERATING TEMPERATURE 15-32°C [60-90°F]</p> <p>STORAGE TEMPERATURE 0-38°C [32-100°F]</p>	<p>MECHANICAL</p> <p>CONSTRUCTION PC ABS WITH POWDER-COATED STEEL REINFORCEMENT</p> <p>BUILD SURFACE GLASS WITH BLUE TAPE</p> <p>STEPPER MOTORS 1.8° STEP ANGLE WITH 1/16 MICRO-STEPPING</p> <p>XY POSITIONING PRECISION 11 MICRONS [0.0004 IN]</p> <p>Z POSITIONING PRECISION 2.5 MICRONS [0.0001 IN]</p>	<p>ELECTRICAL</p> <p>POWER REQUIREMENTS 100-240V, 50-60 HZ 0.76-0.43 A, 100 W</p> <p>CONNECTIVITY USB, ETHERNET, WI-FI</p>
		<p>CAMERA</p> <p>CAMERA RESOLUTION 320 X 240</p>

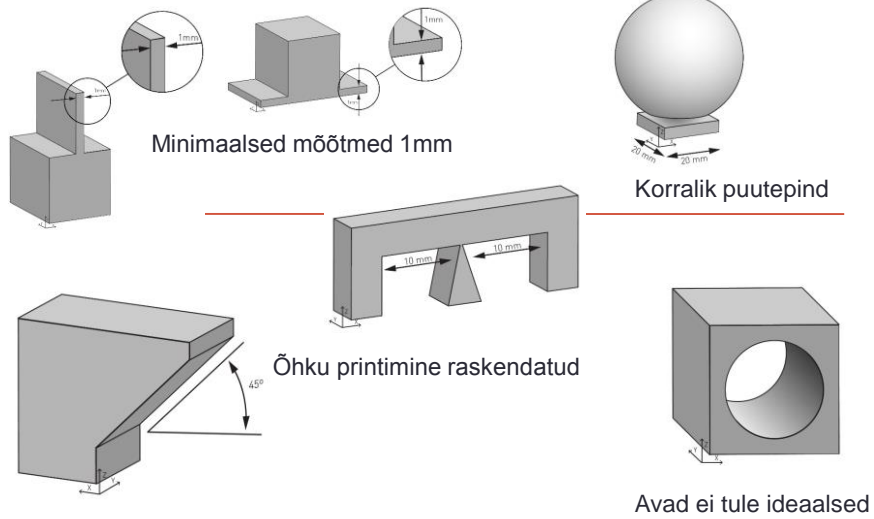
Print technology Fused Filament Fabrication (FFF)	Build volume 223 x 223 x 205 mm	Nozzle diameter 0.4 mm
Warranty 12 months (excluding the hot end)	Print surface Heated bed (50° - 100° C)	Supported filaments PLA, ABS, CPE
AC input 100 - 240 V, 14 AMPS	Layer resolution Up to 20 micron	Filament diameter 2.85 mm
Electrical 50 - 60 Hz, 221 Watt max.	Sound Average operational noise: 49 dBA	Connectivity Stand-alone SD card printing
Speed and precision Print speed: 30 mm/s - 300 mm/s Travel speed: 30 mm/s - 300 mm/s Precision: 12.5 / 12.5 / 5 micron	Physical dimensions Desktop size: 357 x 342 x 388 mm Shipping size: 400 x 400 x 550 mm Weight/Shipping weight: 11.2 / 18.0 kg	Software Supplied software: Cura File types: STL / OBJ / DAE / AMF OS: Windows / Mac / Linux
Temperatures Nozzle temperature: 180 - 260 °C Heated bed temperature: 50 - 100 °C Operational temperature: 15 - 32 °C Storage temperature: 0 - 32 °C	Layer resolution Fast: 200 micron (0.2 mm) Normal: 100 micron (0.1 mm) High: 60 micron (0.06 mm) Ultra high: 40 micron (0.04 mm)	What's included? Ultimaker 2, one free hot end pack, power supply, cable, USB cable, online manual, quick start guide, SD card, glass plate, glue stick, filament, grease and hex wrenches

NÄITEID PRINTERITEST

Printer	Ultimaker 2	BeeTheFirst	Replicator
Tööala	230 x 225 x 205	190 x 135 x 125	252 x 199 x 150
Kihi paksus	0,02	NA	0,1
Resolutsioon	XY/Z: 0,0125 / 0,05	Low/High	Low/Med/High
Materjalid	PLA, ABS, Nylon,...	PLA	PLA
Kiirus	30 - 300 mm/s	NA	NA
Iseseisvus	SD kaart, USB	USB	USB, WiFi, Mälupulk, Ethernet
Alusplatvorm	Soojendusega klaas	Pleksiklaas	Klaas



3D PRINTERILE SOBIV DISAIN



Tarkvarad



Universaalsed:

- Cura (Ultimaker)
- Meshmixer
- Slic3r
- 3D PrinterOS

Printeri spetsiifilised:

- BeeSoft
- MakerBot Desktop Software
- 3D Systems SLA/SLS Software

G-kood



- G-kood on defineeritud standarditega
- Keel millest koostatakse arvprogrammjuhtimisega (APJ) pinkide juhtprogramm
- Koosneb standartsetest sümbolite kogumist
- Sümboliteks on numbrid, tähed, märgid
- Program -> Block -> Word -> Character
- Programm -> Lause -> Sõna -> Adressaat ja arvsõna, sümbol
- 3D Printerite standard:
<http://reprap.org/wiki/G-code>

G-kood



- Sõna algab adressaadiga, mis defineerib sõna tähenduse (X,G,M)
- Adressaadile järgneb alati arvsõna ja need kirjutatakse alati kokku (X100.)
- Iga lause peab asuma eraldi real, sest juhtprogrammi täidetakse reakaupa

"Cura" g-koodi näide

```
1 ;FLAVOR:UltiGCode
2 ;TIME:30
3 ;MATERIAL:102
4 ;MATERIAL2:0
5
6 ;Layer count: 1
7 ;LAYER:0
8 M106 S255
9 GO F9000 X93.755 Y92.760 Z0.500
10 ;TYPE:SKIRT
11 G1 F1200 X94.949 Y91.547 E0.34041
12 G1 X96.214 Y90.406 E0.68112
13 G1 X97.543 Y89.342 E1.02161
14 G1 X98.932 Y88.357 E1.36217
15
16 ...
17
18 G1 X122.359 Y88.399 E102.06656
19 G1 X120.919 Y88.005 E102.36514
20 G1 X119.457 Y87.698 E102.66392
21 G1 X117.980 Y87.477 E102.96261
22 M107
23 G10
24 G1 Z1.000
25 GO F9000 X117.980 Y87.477 Z5.500
26 M25 ;Stop reading from this point on.
27 ;CURA_PROFILE_STRING:eNrtWk1v20YQvRJGf8QeEzRWSUqK
28
29
```