

Materials and Manufacturing (ADDA4001) – A1 Citation/Research document

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Tutor: Ian Williams/ Mathew Bellis

Course: BA Product Design

Source 1: All3DP – 3D printing speed benchmarking

<https://all3dp.com/3d-printing-speed/>

last accessed: December 2017

The screenshot shows a web browser window displaying the All3DP website. The browser's address bar shows the URL <https://all3dp.com/3d-printing-speed/>. The website's navigation bar includes links for NEWS, FEATURES, REVIEWS, PRINTABLES, BASICS, OFF-TOPIC, and 3D PRINTING SERVICE. The main content area features a large image of a 3D printer and the article title "3D Printing Speed: How Fast Can 3D Printers Go?" by Franz Grieser, dated Jan 26, 2016. Below the article title, there is a list of four items: 1. Ultimaker 2 + 3D Printer - Buy Online Now, 2. Google Chrome - Download Chrome Today, 3. Official Google Home Mini, and 4. Best Free Antivirus 2018. A cookie notice is visible at the bottom of the page, stating "Hello! This website uses cookies to ensure you get the best experience on our website More Info GOT IT." The browser's taskbar at the bottom shows the Windows logo, Cortana search bar, and various application icons. The system clock in the bottom right corner indicates the time is 12:16 on 07/01/2018.

Course: Materials and Manu 3D Printing Speed: How Download - #3DBenchy

all3dp.com/3d-printing-speed

ALL3DP NEWS FEATURES REVIEWS PRINTABLES BASICS OFF-TOPIC 3D PRINTING SERVICE

3D Printing Know-how

3D Printing Speed: How Fast Can 3D Printers Go?

by Franz Grieser
Jan 26, 2016

- 1 | **Ultimaker 2 + 3D Printer - Buy Online Now** Ultimaker 2 Plus 3D Printer. Lifetime UK Support. Buy Online Now 3dgbire.com
- 2 | **Google Chrome - Download Chrome Today** Chrome is a fast, secure and free browser for all your devices. google.co.uk
- 3 | **Official Google Home Mini** Powered by the Google Assistant. Ask it questions, tell it to do things. Buy now store.google.com
- 4 | **Best Free Antivirus 2018** Your computer could be full of hidden viruses. Run a free virus scan & remove them today.

Hello! This website uses cookies to ensure you get the best experience on our website [More Info](#) **GOT IT.**

And how long does 3D printing take in practice?

To find out how fast 3D printers actually print, we tested how long it takes to print two more or less complex objects on two popular desktop printers: the Ultimaker 2 and the Printbot Plus.

These are the two models we printed:

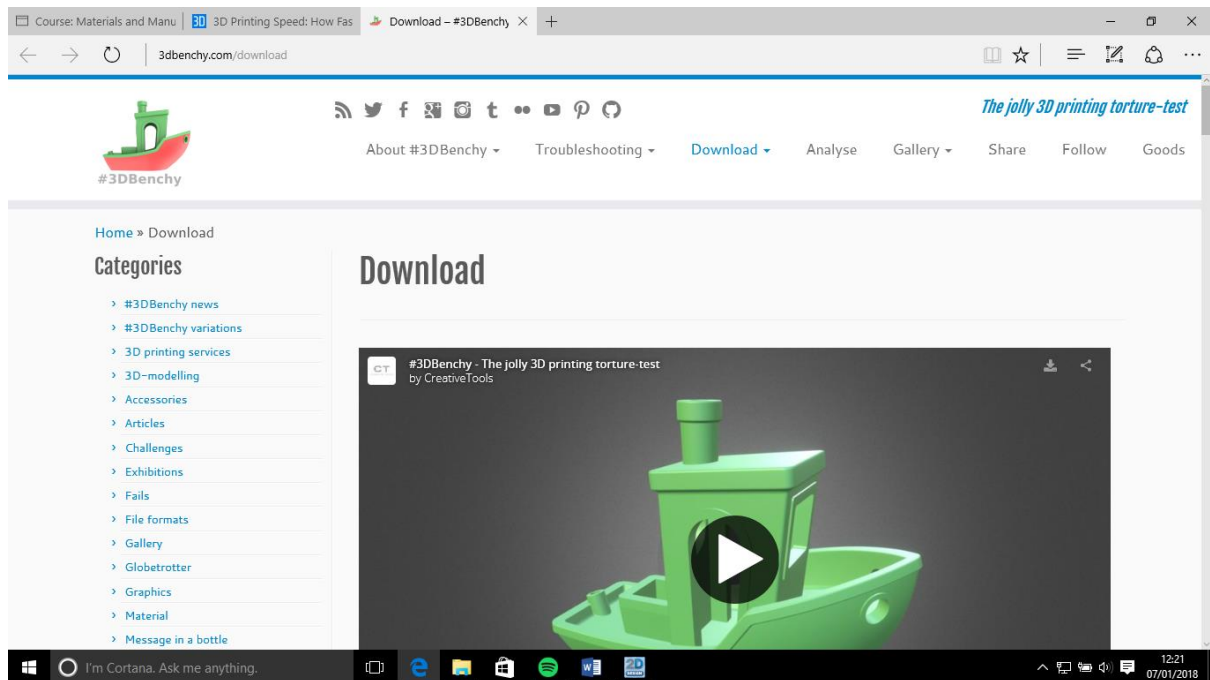
- 3DBenchy: This is a 3D model that had been designed for testing and benchmarking 3D printer; it is a pretty complex and challenging model. The boat is 6cm long, 4.8cm high and 3.1cm wide. [You can get the STL file for 3DBenchy for free to do your own tests.](#)

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Source 2: 3Dbenchy – 3D printer benchmarking

<http://www.3dbenchy.com/download/>

last accessed: December 2017



Source 3: Image, 3D printer

<https://gepl.org/2017/10/3d-printing/>

last accessed: January 2018

Course: Materials and Mar 3D 3D Printing Speed: How F Tests - #3DBenchy 3d printing - Bing images Did You Know: 3D Printers 3D Printing - Glen Elly

gepl.org/2017/10/3d-printing

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Youth Middle School High School Adult

3D Printing

Category: Where The Child Things Are

Posted: October 12, 2017

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By: Megan Stepniewski, Youth Associate

3D Printing is slowly becoming mainstream due to the machines becoming more and more affordable and consumer friendly. It's a beautiful fusion between science, engineering, technology, and art. So here are some things to know if you want to get into 3D printing.

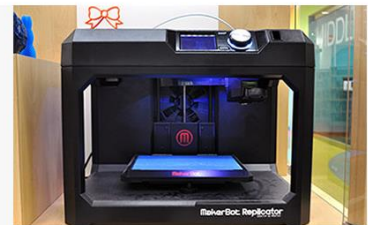


Robo 3D
Ultimaker

*The Glen Ellyn Public Library owns two MakerBots with nick names. You can stop by anytime and see them at work in the Youth Department.



Greetings! My name is Eugene. I am a MakerBot Replicator 2. Did you know that I can heat up plastic filament to 419°F?



Hi!!! My name is Gertrude or Gerty for short. I am a 5th Generation MakerBot. Did you know that the plastic filament is made from corn?!

The Filament

Filament is the term used for the material that the 3D Printers print with. The most common is plastic filament. You can choose from many different kinds of plastic and which one depends on the strength you need for your print. Common plastics are ABS, PVA, and PLA. The Glen Ellyn Public Library uses PLA, which is a corn-based plastic. It is super safe and produces a minimal amount of fumes. It is slightly flexible and shouldn't be used for part that will be put under a great amount of stress.

3D printers are not just restricted to plastic. Other filaments include **metal** and **glass**. Stranger filaments include **concrete**, which can print out large buildings and structures, and **biological material**, which is used to print skin, organs, and other body parts. Currently there are even 3D printers for food!

Source 4: 3DXTech – material pricing

<https://www.3dxtech.com/>

last accessed: December 2017

Course: Materials and 3D Printing Speed: H Tests: #3DBench 3d printing - Bing im Did You Know: 3D P 3D Printing - Glen El 3DXTech

3dxtech.com/search.php?search_query=ABS§ion=product

Sort By: Relevance

Purple Passion ABS Filament
\$29.95 **\$19.95**
★★★★★ 3 reviews
OPTIONS

Bright White ABS Filament
\$29.95
★★★★★ 3 reviews
OPTIONS

Evergreen ABS Filament
\$29.95 **\$19.95**
OPTIONS

Dark Blue ABS Filament
\$29.95 **\$19.95**
OPTIONS

Polycarbonate (PC) Pellets
\$25.00
OPTIONS

3DMMAX® Polycarbonate (PC) 3D Printing Filament
\$42.00
OPTIONS

CarbonX™ Carbon Fiber PC 3D Printing Filament
\$80.00
★★★★★ 1 review
OPTIONS

PC Refill for Fortus® 360/400/900mc Printers (92in3)
\$395.00 **\$250.00**
OPTIONS

Black & White Available

Ultim™ 1010 3D Printing Filament
\$70.00
★★★★★ 2 reviews
OPTIONS

Ultim™ 9085 3D Printing Filament
\$80.00
★★★★★ 4 reviews
OPTIONS

Ultim® 9085 Support Refill for Fortus® 360/400/900mc Printers (92in3)
\$685.00 **\$475.00**
OPTIONS

Ultim® 9085 Refill for Fortus® 360/400/900mc Printers (92in3)
\$685.00 **\$475.00**
OPTIONS

13:21 07/01/2018

Course: Materials 3D Printing Speed: H Tests: #3DBench 3d printing - Bing Did You Know: 3D 3D Printing - Glen 3DXTech pound3d to dollar

3dxtech.com/search.php?search_query=polycarbonate§ion=product

Sort By: Relevance

Polycarbonate (PC) Pellets
\$25.00
OPTIONS

3DMMAX® Polycarbonate (PC) 3D Printing Filament
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OPTIONS

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Course: Materials 3D Printing Speed: H Tests: #3DBench 3d printing - Bing Did You Know: 3D 3D Printing - Glen 3DXTech pound3d to dollar

3dxtech.com/search.php?search_query=Ultim§ion=product

Sort By: Relevance

Ultim™ 1010 3D Printing Filament
\$70.00
★★★★★ 2 reviews
OPTIONS

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★★★★★ 4 reviews
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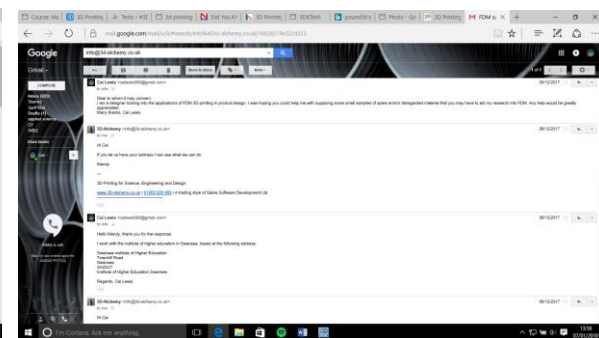
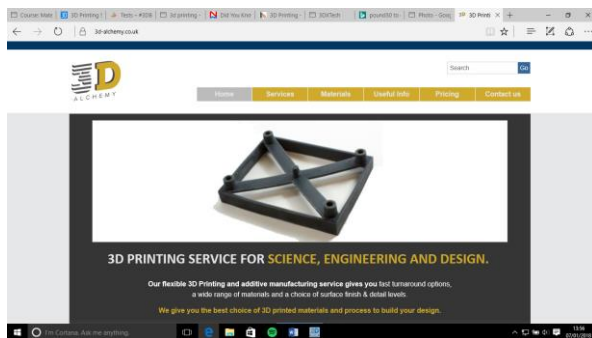
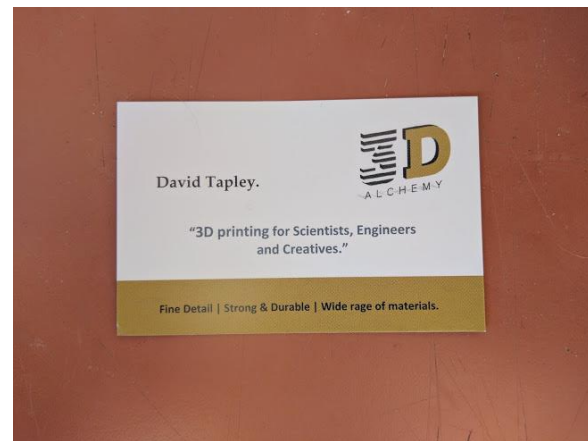
Ultim® 9085 Support Refill for Fortus® 360/400/900mc Printers (92in3)
\$685.00 **\$475.00**
OPTIONS

Ultim® 9085 Refill for Fortus® 360/400/900mc Printers (92in3)
\$685.00 **\$475.00**
OPTIONS

13:23 07/01/2018

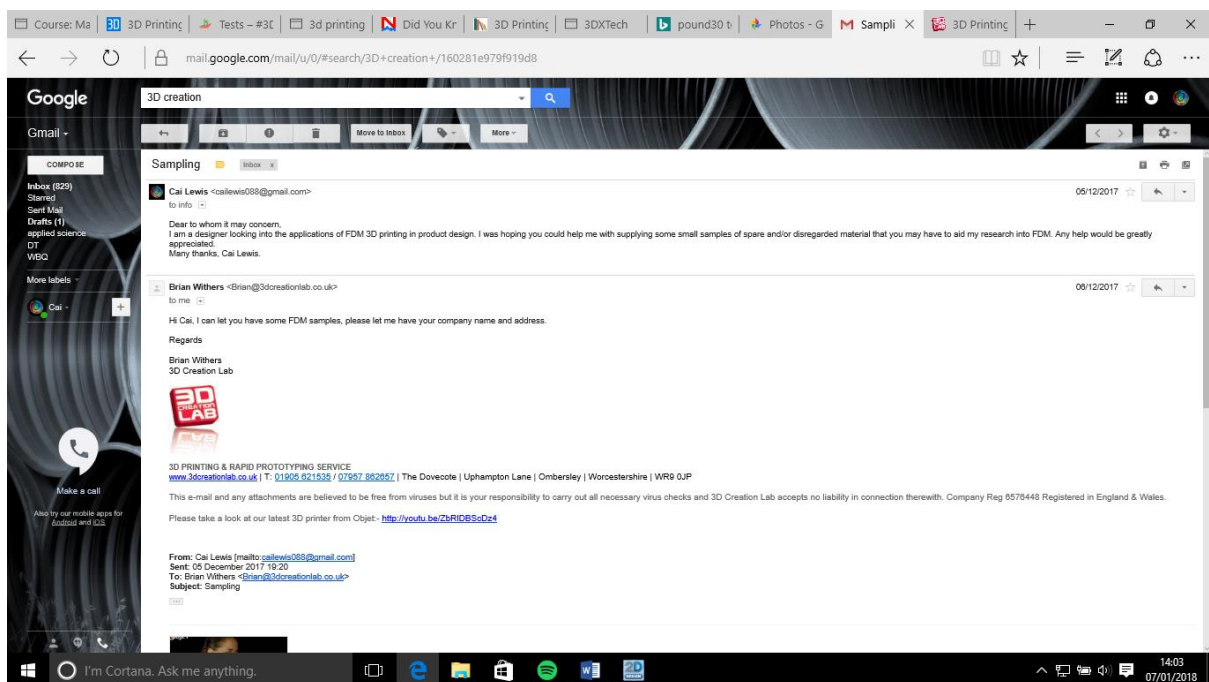
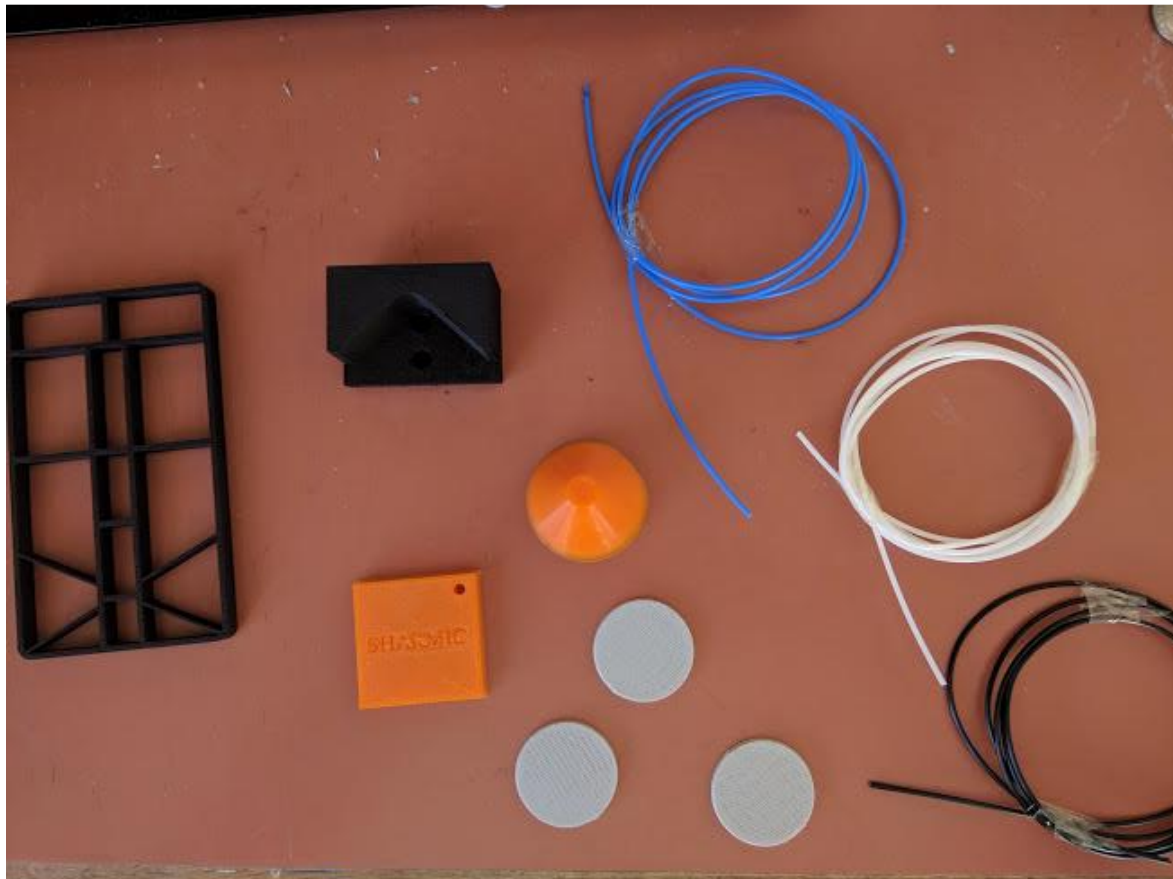
Source 5: 3D Alchemy – sample supply

<https://www.3d-alchemy.co.uk/>



Source 6: 3D creation lab – sample supply

<https://www.3dcreationlab.co.uk/>



Source7: 3dprinting.com- general information

<https://3dprinting.com/what-is-3d-printing/>

last accessed: November 2017

The screenshot shows the 3dprinting.com website. The main heading is "What is 3D printing?". Below it are social media sharing buttons for Facebook (3K), YouTube (16), Twitter (260), Google+ (164), LinkedIn (313), and Dribbble (60), along with a "4K SHARES" button. The text explains that 3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file. It further states that the creation of a 3D printed object is achieved using additive processes, where an object is created by laying down successive layers of material until the object is created. Each of these layers can be seen as a thinly sliced horizontal cross-section of the eventual object. It also mentions that 3D printing is the opposite of subtractive manufacturing, which is cutting out / hollowing out a piece of metal or plastic with for instance a milling machine. Finally, it states that 3D printing enables you to produce complex (functional) shapes using less material than traditional manufacturing methods.

Below the text is a section titled "The Best 3D printers for Beginners". To the right of this section is a "3D Printing Newsletter" sign-up form with a "Subscribe now" button. Below the newsletter sign-up is a "Recently added" section listing four 3D printers: Anet A3 (\$239.99, Found 2 prices), Reiscube R2 (\$158.99, Found 4 prices), Tronxy X35 (\$339.99, Found 2 prices), and HOONY H6 (\$238.53, Found 2 prices).

The website also features a cookie notice: "This website uses cookies to ensure you get the best experience on our website. [Learn more](#)". A "Got it!" button is present below the notice.

The Windows taskbar at the bottom shows the time as 14:50 on 07/01/2018.

<https://3dprinting.com/materials/>

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with choosing the right material. Look at our side menu for a quick overview of what materials we have listed and if there is a specific material that you would like to know more about but is missing from the list, let us know!

ABS

ABS (Acrylonitrile Butadiene Styrene) is an petroleum-based polymer. It is very resistant to high temperature which makes this material perfect for real-world components. It is a pretty cheap material allowing for cost effective prototyping. ABS is the go-to material for most 3D printers. Along with PLA, it is the most common material used for desktop 3D printing.

Features

ABS is available in a large array of colours which makes it popular among makers. Even the colorless ABS 3D printed object can be painted to any color. The material is mechanically strong, so you don't have to worry about the lifespan of your model.

If you're using ABS it is advised to print at 220° and 250°centigrade. To avoid bending and warping you will want to print with ABS on a heated bed (from 50° to 100°C) to ensure gradual cooling of the material. ABS gets a shiny, glossy look when processed with acetone vapour as this solution has the property to melt the upper layer of the printed making it smooth and shiny.

The biggest downfall of ABS is that it is a nonbiodegradable toxic material that releases toxic fumes at high

FLSUN OO Delta

\$447.36

Found 4 prices

Markforged

3D Print Strong Parts

23x stronger than parts printed on other 3D printers

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861

865 SHARES

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- Nylon sometimes shrinks during prints, and thus results can be imprecise

[Buy Nylon filament on Amazon](#)

ULTEM

ULTEM is a subclass of Polyetherimide materials, like PEEK. Natural ULTEM 1,000 has an amber hue. ULTEM gains a large amount of strength in combination with glass fiber reinforcement, making it one of the strongest materials among 3D printing thermoplastics. ULTEM has been used by various companies to replace previously metal parts. This is because the strength is high enough to have applications in aerospace and missile manufacturing (though it is not used ubiquitously in these fields).

Applicable Technologies

- FDM/FFF

Features

ULTEM has very high durability at room temperature and mechanical strength. Even though it is a thermoplastic, it requires a very high temperature to melt making it less common than PLA, ABS and Nylon. ULTEM also has interesting mechanical properties.

Glass reinforcement comes in a variety of ranges giving it very varying properties based on the proportions. ULTEM is

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Polycarbonate (PC)

Polycarbonate is a thermoplastic that is also known distributed under the trade name Lexan. It is generally lightweight and transparent. It is often used in industries as diverse as CD production, riot gear and sun glasses. Needless to say it has a diverse range of applications.

Polycarbonates are easily thermofomed and molded. This has been one of the reasons it is a staple of so many products as an engineering plastic.

Applicable Technologies

- FDM/FFF

Features

Due to its high heat deflection (heat resistant up to 116 °C) PC is incredibly useful for high temperature applications such as the inside the hood of a car. It also has a great flexibility and snaps right back into its original shape when bent or twisted. It can be as transparent as glass while possessing half its density. Yet, it has a density and tensile strength higher than both PLA and ABS. PC is ideal for anyone looking to produce a strong yet flexible transparent print.

It is also soluble in dichloromethane, it melts at temperatures of 260 – 300 °C and it will also require a heated bed (190 °C) to produce the best results. In general the closer to 300 °C, the better the print quality you can get (although, its transition temperature is quite good, so reaching 300 °C is not an absolute necessity).

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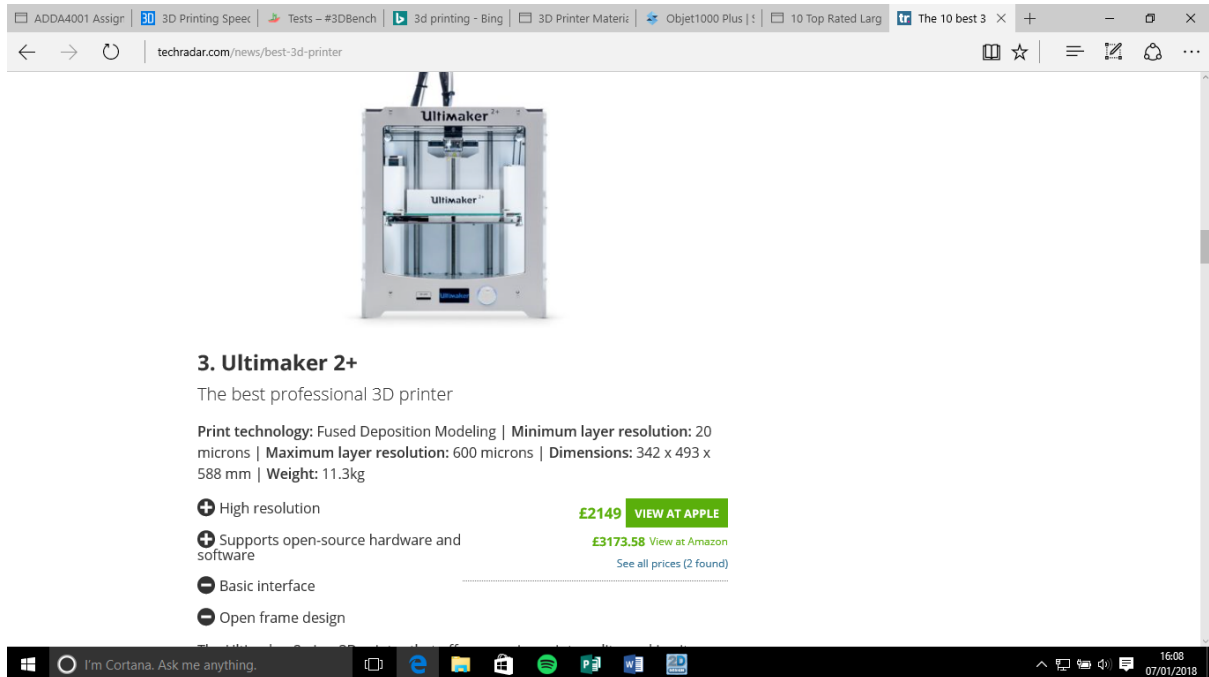
865 SHARES

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14:53 07/01/2018

Source 8: TechRadar – Ultimaker specifications

<http://www.techradar.com/news/best-3d-printer>



3. Ultimaker 2+
The best professional 3D printer

Print technology: Fused Deposition Modeling | **Minimum layer resolution:** 20 microns | **Maximum layer resolution:** 600 microns | **Dimensions:** 342 x 493 x 588 mm | **Weight:** 11.3kg

- ⊕ High resolution
- ⊕ Supports open-source hardware and software
- ⊖ Basic interface
- ⊖ Open frame design

£2149 [VIEW AT APPLE](#)
£3173.58 [View at Amazon](#)
[See all prices \(2 found\)](#)

Source 9: stratasys.com – Objet1000 Plus specifications

Browser tabs: ADDA4001 Assignment 1 - I | 3d printing - Bing | **Objet1000 Plus | Stratasys** | The 10 best 3D printers of 2

Address bar: stratasys.com/3d-printers/objet1000-plus

Navigation: ON DEMO | **INTRODUCES** | Languages

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Specifications

SYSTEM SIZE AND WEIGHT
Height: 1960 mm (77.5 in.); Width: 2868 mm (113 in.); Depth: 2102 mm (83 in.); Weight: 2200 kg (4850 lbs.)

BUILD SIZE
1000 x 800 x 500 (39.3 x 31.4 x 19.6 in); Max model weight on tray: 135 kg

LAYER THICKNESS
Horizontal build layers as fine as 16 microns (0.0006 in)

ACCURACY
Up to 600 microns for full model size (for rigid materials only, depending on geometry, build parameters and model orientation)

BUILD RESOLUTION
X-axis: 300 dpi; Y-axis: 300 dpi; Z-axis: 1600 dpi

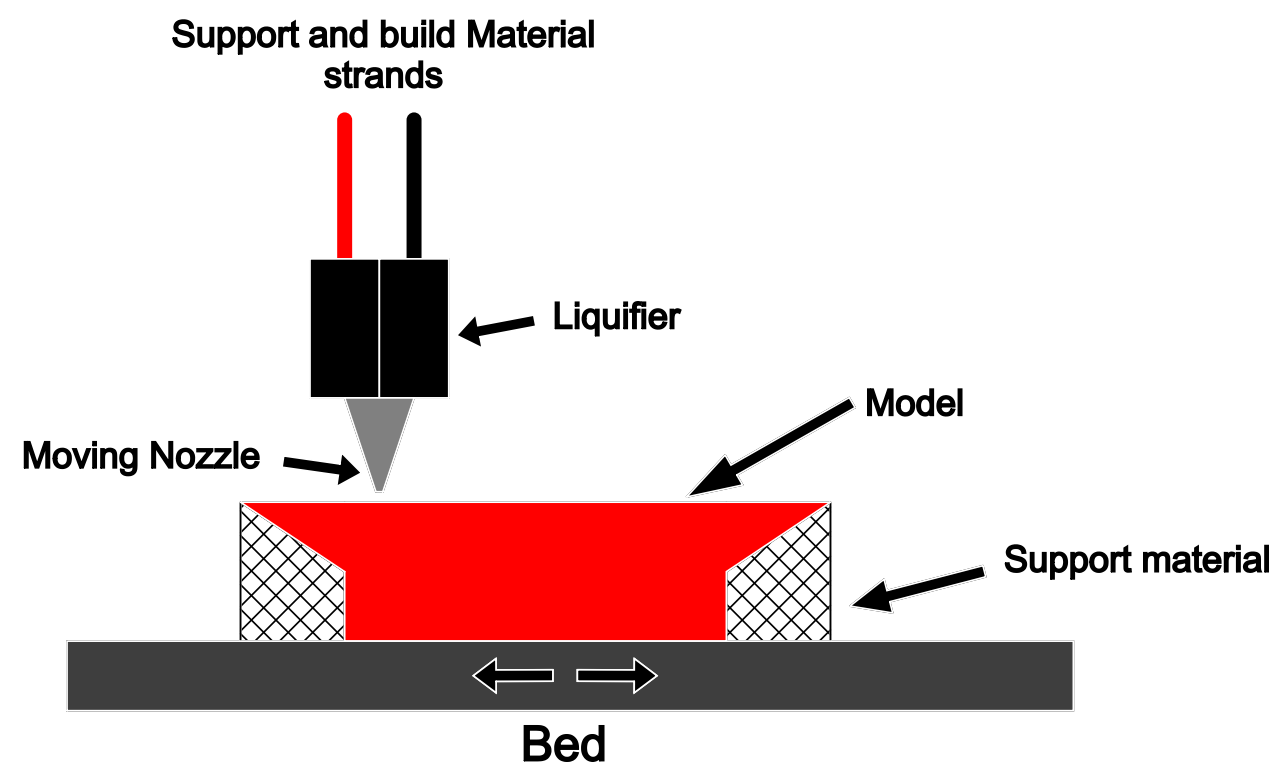
[Download the Spec Sheet](#)



Windows Taskbar: I'm Cortana. Ask me anything. | 16:30 07/01/2018

Fused Deposition Modeling (FDM)

FDM (Fused Deposition Moulding), more commonly known as 3D printing is an addition process which involved a computer controlled nozzle which moves in relation to a bed layers the building plastic in a number of different patterns or in solid layers to build up a 3 dimensional model of what the designer created on the computer.



What materials are used in FDM?

There are a number of different types of plastics used in FDM processing. The most common is ABS, a tough plastic with a variety of different versions which allow for increased impact resistance, heat resistance and toughness. Second most common type of plastic used in this type of processing is Polycarbonate (PC). This is another very tough material however it lacks the hardness of ABS, this means that it becomes prone to bending if no precautions are put in place. Where this material is required to be hard, it is usually treated with a hardened outer plastic coat. Perhaps the rarest type of plastic used in this type of processing is Ultem or PEI (polyetherimide). It comes in many different variations in varying impact resistances and heat deflection ratings. The most common types of Ultem are ULTEM 9085 and ULTEM 1010.

Time/Rate of Manufacturing

The rate at which the printer can deposit material is heavily dependent on the machine used, the type of material used and how it is being deposited. However, there are benchmark models that are used to test speed. For example the boat to the left. It is known as 3Dbenchy and has been used to test a number of different machines. The model is 6cm long, 4.8cm high and 3.1cm wide and a good printer can be expected to print it in around 2 hours.

Volume of manufacture

The maximum size of the thing which can be produced is dependant on the material. Since the process differs from personal use to industrial use I will specify both. Firstly, personal use machines. The Ultimaker 2+, this is a reasonably sized machine (13kg) capable of fairly sizable model making. It has a bed size of 342 x 493 and capable of 588 mm of height. For industrial use, the Objet1000 Plus. This is a very large machine weighing in at 2200kg and has a bed size of 1000x800x500, over 4 times the size of the Ultimaker.

Volume of manufacture

The cost to print a model using this type of process depends on the type of material used. The specialised plastic Ultem 1010 and 9085 are £50 and £60 (250g) respectively from 3DXTech. PC (polycarbonate) printing filament priced at £30 (500g) on the same site. Standard ABS filament reel (750g) has an average price of £20 - £25.

Credits

<https://all3dp.com/3d-printing-speed/-printing-speeds>, dec 2017-

<http://www.3dbenchy.com/download/-printerbenchmarking>, dec 2017-

<https://gepi.org/-Image>, middle left, Jan 2018-

<https://www.3dxtech.com/-materialprices>, dec 2017-

3D Alchemy
-Sample Supply-
Received Dec 2017

3D Creation Lab
-Sample Supply-
-not shown-
received Nov 2017

3dprinting.com
-general information-
last accessed Nov 2017

