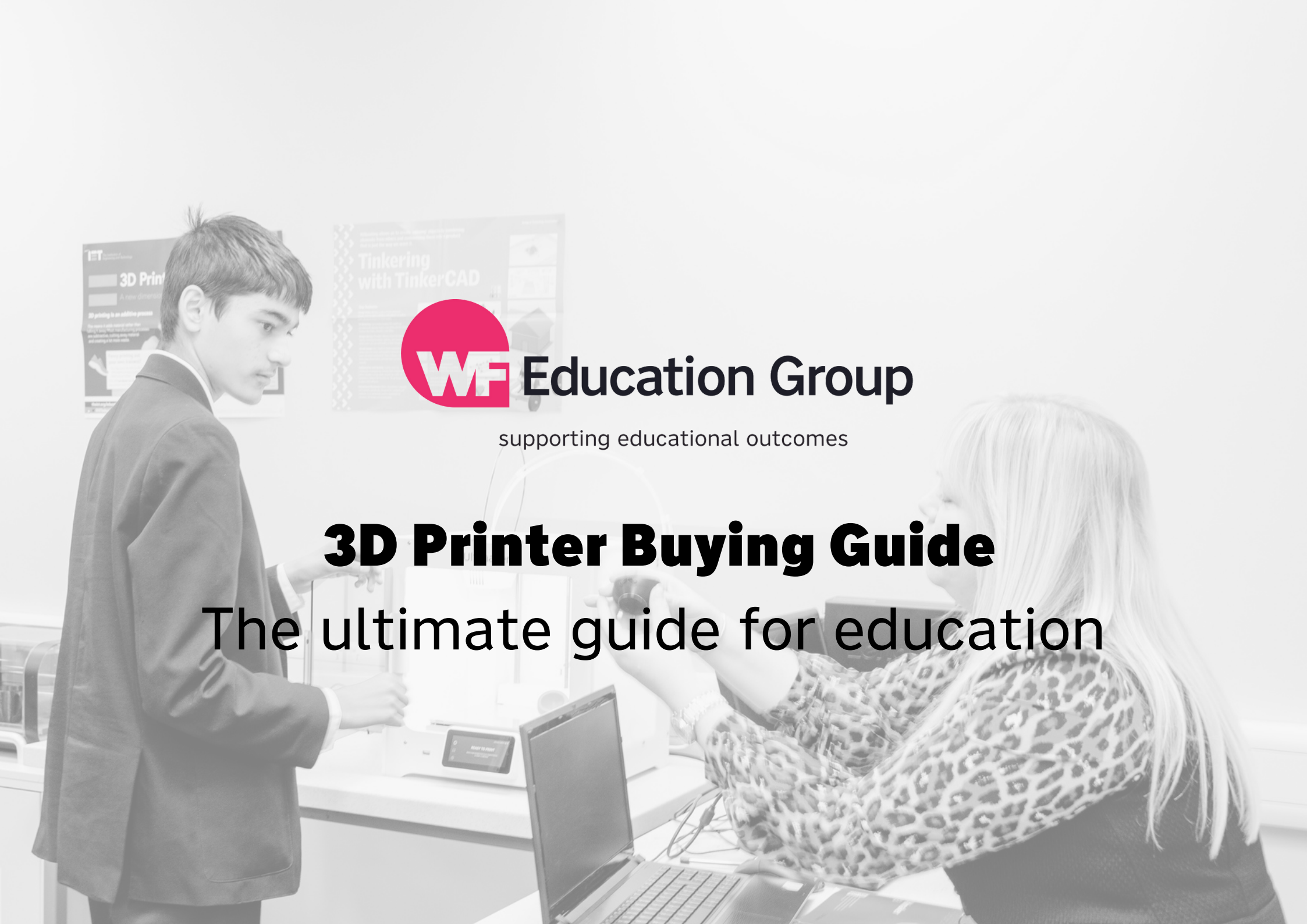

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3D Printer Buying Guide

The ultimate guide for education


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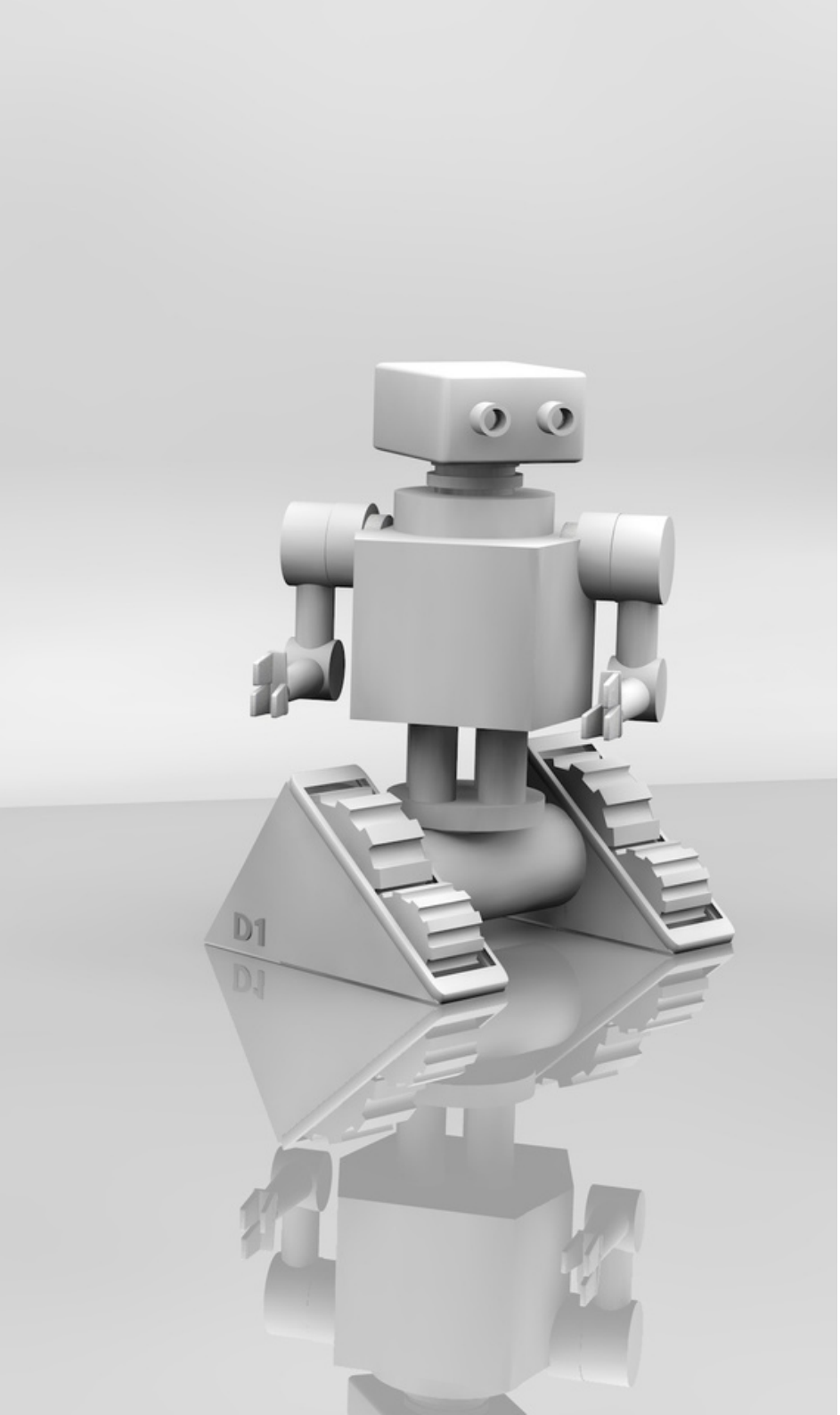

3D Printing in education

3D Printing (also known as rapid prototyping and additive manufacturing) has been around for over 30 years.

It has always been a key feature of research and development within industry. Various factors have led to an explosion in interest in 3D Printing in education, including: advances in equipment and software design, widening demands for its use, and descending machinery prices.

Careers in Additive Manufacturing are becoming increasingly popular in industry. This demand means that the role of the teacher becomes more and more vital in equipping students with the fundamental skills they need to learn and develop in this continually advancing and somewhat future changing technology.

This guide is designed to help you make an informed decision about what kind of 3D Printing technology to invest in specifically for educational usage in schools, colleges and universities. It covers all the key features you need to consider when selecting from the different types of 3D Printer now available.

Top Tip!

Look for a supplier who is knowledgeable in 3D Printing and has printers on site. This will not only help answer your questions but also offer you the chance to go and see machines in action so you can see the differences and capabilities for yourself.

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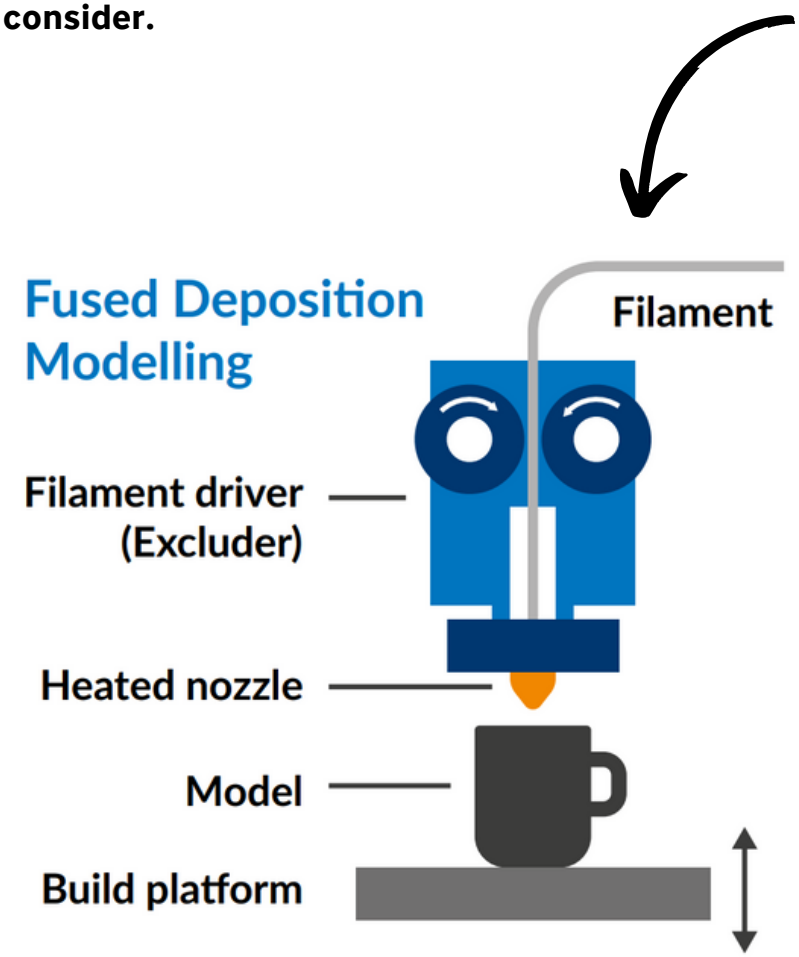
3D Printing technologies

The first step is to get an understanding of the range of different established 3D Printing technologies. Each one offers different advantages and disadvantages. They also vary in terms of ease of use and cost. So let's look at the main 3D Printing technologies to consider.



Fused Filament Fabrication or Fused Deposition Modelling (FFF/FDM)

This is the most accessible 3D Printing technology. A thermoplastic, such as ABS, is fed into an extruder through a 'hot end', which melts the plastic. This creates a workable string that is applied onto a build bed – the surface upon which the 3D object rests. FFF and FDM are broadly the same printing technologies. The difference is that FDM is a trademark for 3D Printer manufacturer Stratasys.

Note: Because FFM/FDM is the most accessible 3D Printing technology in education, this guide puts a particular focus on desktop versions of the technology.

SLA (Stereolithography)

SLA was the first 3D Printing technique to be developed. A laser or other light source is used to cure – harden – a liquid photosensitive resin drawn from a vat to create a solid object. Traditionally, SLA can produce objects of a much higher definition than those printed with FFF or FDM.

CJP (Colour Jet Printing)

CJP is also known as binder jet printing or plaster printing. A fine powder material, such as gypsum plaster, covers the build area in layers. Then a standard inkjet print head prints a binder solution, which hardens. By using an inkjet print head, 3D models can be printed with colour.

Polyjetting

Polyjetting is used in certain high-end machines. It uses elements of inkjet printing and SLA. Inkjet nozzles spray a photosensitive resin onto a build plate. The resin is cured by ultraviolet light.
This hardens the layer, ready for the next one.

3D Printing technologies

Advantages and Disadvantages

Fused Filament Fabrication / Fused Deposition Modelling	SLA Stereolithography	CJP (Colour Jet Printing)	Polyjetting
✓ Lowest prices –beginner level option ✓ Classroom environment friendly ✓ No post-printing curing needed ✓ Can print with a variety of materials ✓ Easy material change-over ✓ Low material costs	✓ Good surface finish ✓ High level of detail, including the ability to create thin walls ✓ Highly accurate, so good for building large parts ✓ Strong presence in key industry sectors, so it's useful for understanding the technology ✓ Some can print moving parts	✓ Established technology ✓ Fast and simple build process ✓ Opportunity to print multiple colours ✓ Can print moving parts ✓ Prints are 'self-supported' ✓ Used in industry so demonstrates real world application & prototyping	✓ Wide range of materials can be printed ✓ Different types of materials can be printed at the same time, to create objects with different functionality at different locations ✓ Multi-colour parts ✓ Good accuracy ✓ Good surface finish ✓ Can print moving parts
✗ Not good for small or detailed features, and making thin walls ✗ Supports needed for some materials and shapes ✗ Support design, integration and removal may be difficult ✗ Because of the way layers are built, surface finish may not be perfect ✗ Slower to print large or dense objects	✗ Limited build size on affordable machines ✗ Higher consumables cost than FFF/ FDM ✗ Post-processing equipment and consumables often needed ✗ UV-cured parts can be affected by long-term exposure to sunlight	✗ Requires post-print processing ✗ Limited range of materials ✗ Multiple consumables can prove expensive	✗ Objects not durable over time when exposed to sunlight ✗ Materials expensive ✗ High initial machine costs

3D Printing Safety Considerations

It is important to consider the suitability of each 3D Printer for use in education, and especially what safety features it offers.

Enclosures

Many 3D Printers have doors that can be closed during the printing process. Others have open sides or are completely open.

The suitability of a specific design will depend on:

Where the printer will be

Enclosures act as a defense against dust, drafts and other elements that may affect the print process. They are also quieter and often more stable than an open-framed 3D Printer.

Who will be using it

If students are likely to use the machine, then an enclosed printer would ensure protection against touching of the heated heads and bed during printing.

View the range

How much of the process you wish to see

Enclosed machines will restrict how much of the print process you and your students can visibly see during the printing process. This may impact visual and kinesthetic leaners within your class.

Materials you wish to print with

Enclosures will maintain a constant temperature of the machines print area. This stable temperature is fundamental when printing materials such as ABS, Nylon and PETG that require higher print temperatures.

3D Printing Safety Considerations

Door interlocks

This feature is more common on higher-end 3D Printers and is starting to become more available on more accessible machines. It prevents the build chamber – the space within which printing takes place being accessed during printing.

Top Tip!

“Consider ‘volume printing’ and the benefits of running multiple 3D Printers in your classroom”

This will not only save time for whole class projects requiring multiple part prints or a range of prints within a project; but will also ensure availability of a machine if others need maintenance.

Filters

Fume extraction is not considered a requirement for 3D Printing. However, some materials, such as ABS, produce odours when extruded. There is also some concern about the airborne ultrafine particles (UFP) produced during ABS printing.

As a result, some manufacturers have started to incorporate HEPA filters into their 3D Printers. That said, current health and safety advice is that placing machines in a well-ventilated room is usually sufficient.

Although not a legal requirement, recent CLEAPSS reports recommends the use of extraction.

Visit CLEAPSS website for more detail.

View the range

Build

Build quality and specification can vary significantly across 3D Printers. This can affect their reliability.

It should be of particular concern if your machine is going to get heavy use or be operated by people with relatively little technical experience.

Build size

Build size defines the size range of the obǰect the 3D Printer can create.

Build sizes can range from 100mm3 to up to 500mm high. Consider the type of obǰect and the number of obǰects you want to print during any particular session

Print heads

In FFF printing, extruders, otherwise known as print heads are used to lay down the melted plastic on the print bed.

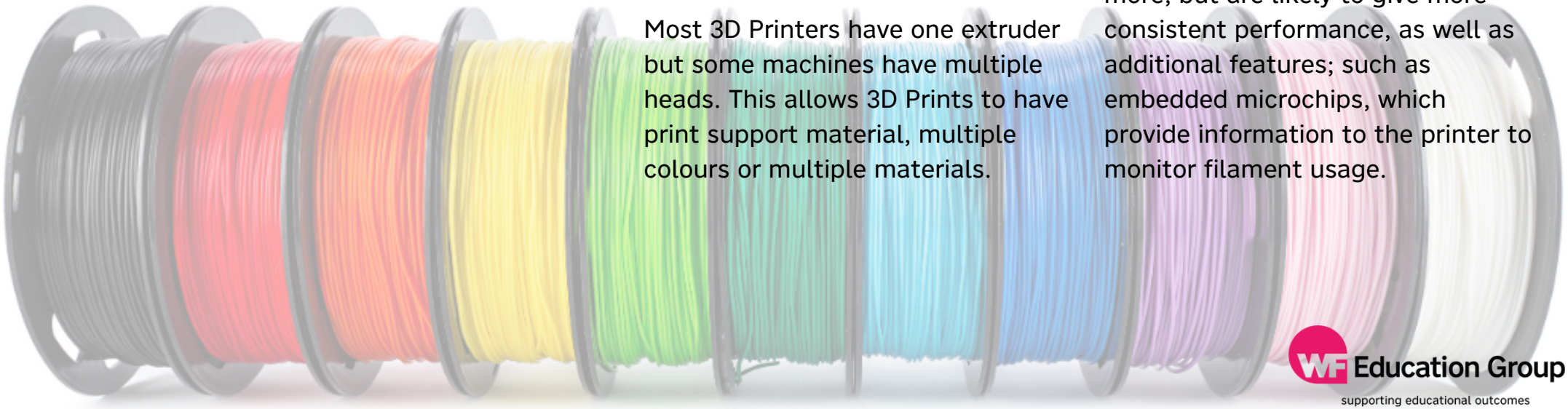
Most 3D Printers have one extruder but some machines have multiple heads. This allows 3D Prints to have print support material, multiple colours or multiple materials.

Bed type

With conventional FFF 3D Printing, the printer will have a heated or cold print bed. Beds can be made of plastic, wood, metal, glass or acrylic. Some will need to be covered with a glue or tapes, which ensures the first layer sticks to the bed.

Material input

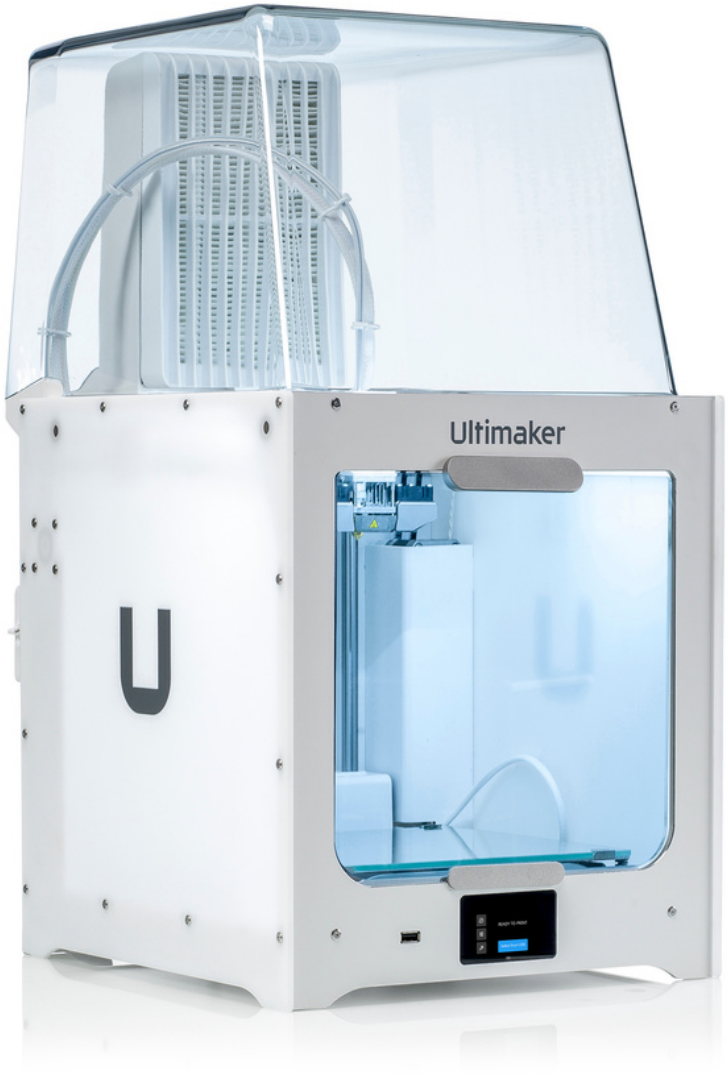
3D Printers use open-reel material or proprietary cartridges. Open reels tend to be cheaper and can be obtained from a number of suppliers. Cartridges may cost more, but are likely to give more consistent performance, as well as additional features; such as embedded microchips, which provide information to the printer to monitor filament usage.



Build

Kits or pre-built

Modern FFF desktop printers have evolved from the RepRap project, which made 3D Printer kits that users assembled themselves available.



Advantages and Disadvantages

Kits	Pre-built
✓ Help you understand how a 3D Printer works	✓ Straight 'Out of box' performance
✓ Less expensive	✓ Greater range of functionality
✓ Easily modified	✓ More comprehensive warranty and support
✗ Takes time to build	✗ More expensive
✗ Requires more maintenance	✗ Does not encourage experimentation

Top Tip!

Two heads aren't always better than one...

The main advantage of having two or more extruders is to print support material (material that supports the object during printing). If this is a key requirement, it may be better to look at advanced printers with proper removable support systems, rather than pay a premium for additional extruders you may not use.

Output and performance

What determines the performance of a 3D Printer?

Resolution

Most FFF 3D Printers have similar resolutions. The final quality of the object depends on a number of factors, including overall build quality and the extruder design. Therefore, we recommend you try to see a printer in operation before buying it.

Take along your own STL file – a data file for a specific object – to a demonstration to see how well it is printed.

Speed

Printing speeds are similar across technologies. Beware, speeds quoted may be the travel speed of the head, rather than the actual printing speed. Machines do offer varying quality modes, which increase and decrease printing time.

Material colours

Different 3D Printers can create objects with different material colours. We would recommend that you do not select a 3D Printer solely on material colour. To do so might limit other performance factors that are important.

Material types

High-end SLA machines use light-sensitive resins. However, FFF desktop printers use fairly standard 'filaments' of ABS and PLA plastics. There is an increasing range of 'open source' 3D filaments – material designed to be used in all FFF printers.

These materials include highend engineering materials, such as nylons, PETG and flexible materials. It would make sense to select a 3D Printer that supports the use of these advanced materials, or that is likely to, in the future, also enabling scope for a wider range of teaching and projects in your classroom.

Material Guidance

Check out our 3D Printing filament guide to help you distinguish the pros and cons of each type.

Top Tip!

Research independent reviews and look at forum discussions about your chosen printer. Speak to users about their experience.

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Output and performance

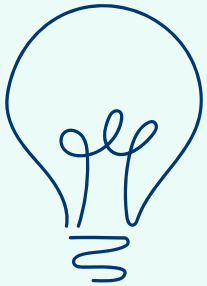
What really makes a 3D Printer easy to use?

Setup/installation

Most desktop 3D Printers are marketed as ‘plug and play’. This may be – in broad terms – the case. However, look out for features that indicate the printer will be easier to use.

These may include:

- Automatic bed calibration
- Material loading systems
- Intuitive control panels



Top Tip!

Is plug and play an excuse to cut support?

Be sure to check the support available from the supplier or manufacturer. Some may use the plug and play classification to offer no, or minimal, support.

Operation

The way 3D Printers are operated is fairly similar across most models.

Steps include:

- Preparing an STL file in the software
- Sending it to the printer
- Completing relevant settings

You should consider how much of this process is already configured on the 3D Printer control panel itself, and how much is contained within software that would have to be uploaded and configured by you.

Support

Questions to ask yourself include:

- Does your chosen printer come with adequate technical support?
- Is that support UK-based?
- Is it managed through the manufacturer or a third-party company?
- What is the availability of spare parts?

Software

File preparation print software is supplied with most printers. This allows you to configure the printer in different ways, including:

- Print mode
- Object size
- Orientation
- Material use
- Duplication

Some software is open source and can be used across many printers, while some will be manufacturer-specific.

Connectivity

Some 3D Printers will need to connect to a computer to receive files. However, some desktop printers will use an SD card or a USB stick. Most models have WiFi connectivity. This may make it easier for larger groups of users to access the machine.

Top Tip!

Teach your students to be ‘greener’ by switching to PLA. PLA is a more environmentally friendly material which is made from corn starch. This biodegradable material is considered a much better and ‘greener’ alternative to other materials.

Software and materials

What you should know about software and materials to print.

Software

Another key consideration will be what 3D design software you use to create designs to print. There are many online file repositories that allow you to download free 3D files. These will help you get to grips with your printer. Some may also be useful. But you will have to use 3D design software to create your own 3D models you can then print.

STL output

You can use pretty much any 3D design software. However, you need to be sure you can export to an STL file, which is the industry standard file for 3D Printing. Most 3D software packages will convert to STL. There are a lot of free 3D design programmes, which are very good and easy to use. But you may choose to invest in a paid-for package, especially if they offer additional benefits, such as increased functionality and support.

Materials

ABS and PLA are the materials of choice for most 3D Printer users and manufacturers. However, material producers are starting to develop many advanced materials such as PETG, Nylon, toughened PLA and conductive materials.

See what manufacturers say about which materials their 3D Printers support. If you want to experiment, it is also useful to consider machines that support open reels and a heated bed.

It’s important to note that using a material not officially supported by the machine manufacturer may well invalidate the warranty if you encounter issues.

View the range

Financials

Value for money

You may find that your chosen machine is the same price or similar across a number of suppliers, so how do you get value for money? The cheapest headline price is not necessarily the best deal. So here are some pointers to consider.

Support

It may be a good idea to look for a supplier who can offer solid product support both before and after the sale.

Ask for:

- A supply of material
- Software
- Other accessories and consumables
- Multiple 3D Printer deals

Bundles

Are there bundle deals available for your chosen printer? Including multiple machine bundles for class volume considerations or all-encompassing bundles including a range of materials and colours, spares and accessories and teaching resources. Just because a readymade bundle isn't advertised, it doesn't mean you can't ask your chosen supplier if they can offer one.

Warranty and maintenance

Most 3D Printers will be supplied with a standard 12-month warranty. Some manufacturers offer longer.

Check the specifics of the warranty. Some parts may be considered consumable.

Also, the use of material filaments outside a manufacturer's range may also invalidate the warranty.

Top Tip!

Good budget buy, or cheap and nasty?

It can be tempting to enter the world of 3D Printing with the cheapest printer you can find. The truth is, some cheaper printers are very good, and some are of questionable quality with poor features. Use the information in this guide to get the best for your budget – and always be aware of the running costs. Beware of imported machines that are not CE certified; as well as potentially hazardous and unsafe, the product lifespan could be significantly reduced and end up costing you in repairs or more likely the need to re-purchase.

Funding

Struggling to afford new machinery?
Keep an eye out for different payment options!

Though the price of 3D Printers is coming down, budget restraints and funding is often an issue. Some schools have strong links with local businesses and apprenticeship programmes, which can sponsor equipment, which is always worth exploring as an option.

A 3D Printer can be used across the school in many different departments, not just D&T, so the cost and use could be shared with other departments such as Art, Geography, Graphics and Science as a few examples. It may even be considered as an excellent tool to enhance extra-curricular activities such as STEM programmes.

Why not download our guide to additional funding opportunities?

Download

Leasing and rental

An alternative to purchasing outright is leasing. This option offers you a package tailored to your requirements with flexible payments and an upgrade path meaning you can benefit from new technology whilst controlling cost.

Key benefits to leasing include: easier budgeting, reduces the need to wait for available capital, you can have your new equipment when you need it, ensures up to date equipment in your classroom and reduces the risk of school obsolesce plus no financial uncertainty with unexpected expenses.

Akira™ 3D Printing Duo Workstation

By WF Education Group

Plug and Play

A ready to use solution, preassembled by WF engineers which includes an Akira™ Workbench and two Ultimaker 2+ Connect 3D Printers.

One plug powers the WorkStation, making the set-up process fast and user-friendly. The unit can be moved between locations quickly and with ease, allowing for time to be dedicated to teaching and learning instead of prolonged set up and assembly each time.

Teach 3D Printing anywhere

A convenient and efficient solution for teaching 3D printing - in any space, at any time.

The mobile Akira™ WorkBench eliminates the need for dedicated workroom spaces and allows flexibility in setting up temporary learning environments.

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Uncompromising quality

All Akira™ frames carry a 25 year guarantee.

Coupled with a modular design, where individual components can be replaced at end of life, not only does the Akira™ system have an excellent lifetime value, but also provides a sustainable option for your spaces.

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Other services

Design Consultancy & Installations

From all-encompassing ‘Innovation Spaces’ to Design & Technology and Library installations including FF&E; our projects team offer a comprehensive, bespoke service from design consultancy and planning through to installation and training covering refurbishments and new builds. We have a team of experienced, in-house designers and education specialists offering a consultancy, design-led solution that will equip your school with next generation, innovative learning environments for your pupils.

Servicing & Maintenance

We also offer comprehensive servicing and maintenance contracts carried out by our qualified engineers on all workshop equipment, including laser cutters.

D&T Supplies

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