

YSOFT®

AN EDUCATOR'S GUIDE TO INTRODUCING 3D PRINTING INTO THE CLASSROOM

Everything you need to know to ensure successful adoption
of 3D printing for your school or university.

This eBook is a reference document based on a twelve-part Y Soft® blog series, **[INTRODUCING 3D PRINTING INTO THE CLASSROOM.](#)** It is highly recommended the reader of this eBook refer to the blog series for additional information and links are provided throughout and summarized at the end.

Additional resources are listed in this eBook for easy reference to our website where the material can be accessed. Finally, information and resources about YSoft be3D eDee® is presented as a 3D print management solution for Education.

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WHAT IS 3D PRINTING?

3D printing, a type of additive manufacturing, is the process of making a physical object from a three-dimensional digital model. The 3D printing process converts a 3D digital model into 2D layers – a process often called slicing.

There are many types of 3D printing technology; the most common is FFF (Fused Filament Fabrication.) **The 3D printer uses a filament to print the layers, one by one, on a surface.** Depending on the size and complexity of the model, hundreds of layers are added on top of each other. The object is created from the bottom up and the layers harden into a solid 3D object.



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3D PRINTING HELPS STUDENTS LEARN

Let's look at why so many schools and universities are adopting 3D printing.

PROMOTES ACTIVE LEARNING

3D printing brings subject lessons to life and helps to hold the students' interest. Increasing engagement within the classroom improves student participation and students can absorb and retain the information being taught much better and longer, especially on complex topics. Hands-on learning is a powerful teaching technique.

ENCOURAGES CREATIVE THINKING – LEARN THROUGH DISCOVERY

The key principle in discovery learning is that by using problem solving situations, students draw on their past experience and existing knowledge to discover new facts, truths and relationships. **3D printers encourage students to use this knowledge** to innovate, test new theories and adjust their idea through trial and error.



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3D PRINTING HELPS STUDENTS LEARN

URNS SUBJECTS INTO CAREERS

3D printing can play an important part in a student's career choice. 3D printing opens up new opportunities in areas that students may previously have considered as boring or beyond their capability. They are empowered to choose how they want to make a difference in the world.

In particular, STEM (science, technology, engineering and math) subjects can translate into interest in careers that may not even exist yet. However, 3D printing is not just for STEM subjects; educators find 3D printing useful for other subjects as well. See [page 17](#) on building curriculum around 3D printing.

[LEARN MORE ABOUT HOW 3D PRINTING HELPS STUDENTS LEARN](#) 

UNDERSTANDING HOW WIND TURBINES WORK:

When learning about the concepts behind wind turbines, which involves physics and math, students can create a 3D digital model, print it on a 3D printer in order to study the construction, test its ability to generate wind energy and adjust accordingly.

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PREPARING FOR 3D PRINTING

To realize the true benefits of 3D printing, there are several key factors to consider. Let's now look at these and help you evaluate if your school or university is prepared for 3D printing.

HOW WILL STUDENTS ACCESS 3D PRINTERS?

It is understandable that schools and universities want to protect students from injury and ensure that other students do not take 3D objects that don't belong to them. These concerns are caused by open air 3D printers which require careful policing and hence access is limited. Because students are often not able to freely use the 3D printer, it may not be used to its full potential.

An enclosed 3D printer with lockable doors that requires a user to login means that **you can place the printer(s) in a more accessible location and encourage students to use 3D printing** to enhance their learning experience.



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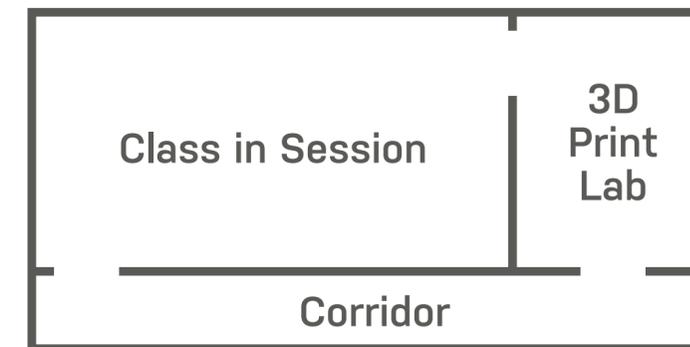
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WHERE DO WE PHYSICALLY PLACE 3D PRINTERS?

Staff and students need to interact with 3D printing regularly and should also be able to use the 3D printer outside of formal lesson times, after all, 3D printing can take hours to complete.

This means that the **ideal location for your 3D printer is an easy to access area** of the school or university and somewhere that doesn't disturb ongoing classes but is also accessible to students during class.



Consider having several dedicated 3D print labs on campus accessible by students during class time and to those who may be working on their projects outside of classroom time.

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PREPARING FOR 3D PRINTING

HOW DO WE CREATE 3D COMPUTER MODELS?

If you have CAD (Computer Aided Design) programs as part of your schools' student software library, then students can create their **own designs**. There are several **free and for purchase resources** available. Alternatively, students can **use existing 3D models** that are freely available.

CAD DESIGN SOFTWARE PROGRAM RESOURCES:

- ◉ ripp3d.com
- ◉ thingiverse.com/tag:3D
- ◉ TinkerCad
- ◉ AutoCAD by Autodesk
- ◉ OpenSCAD
- ◉ Fusion 360

ONLINE RESOURCES FOR EXISTING 3D MODELS:

- ◉ Tinkercard
- ◉ Vectary
- ◉ Solid Works
- ◉ Thingiverse

[LEARN MORE ABOUT 3D DESIGN RESOURCES.](#) [↗](#)

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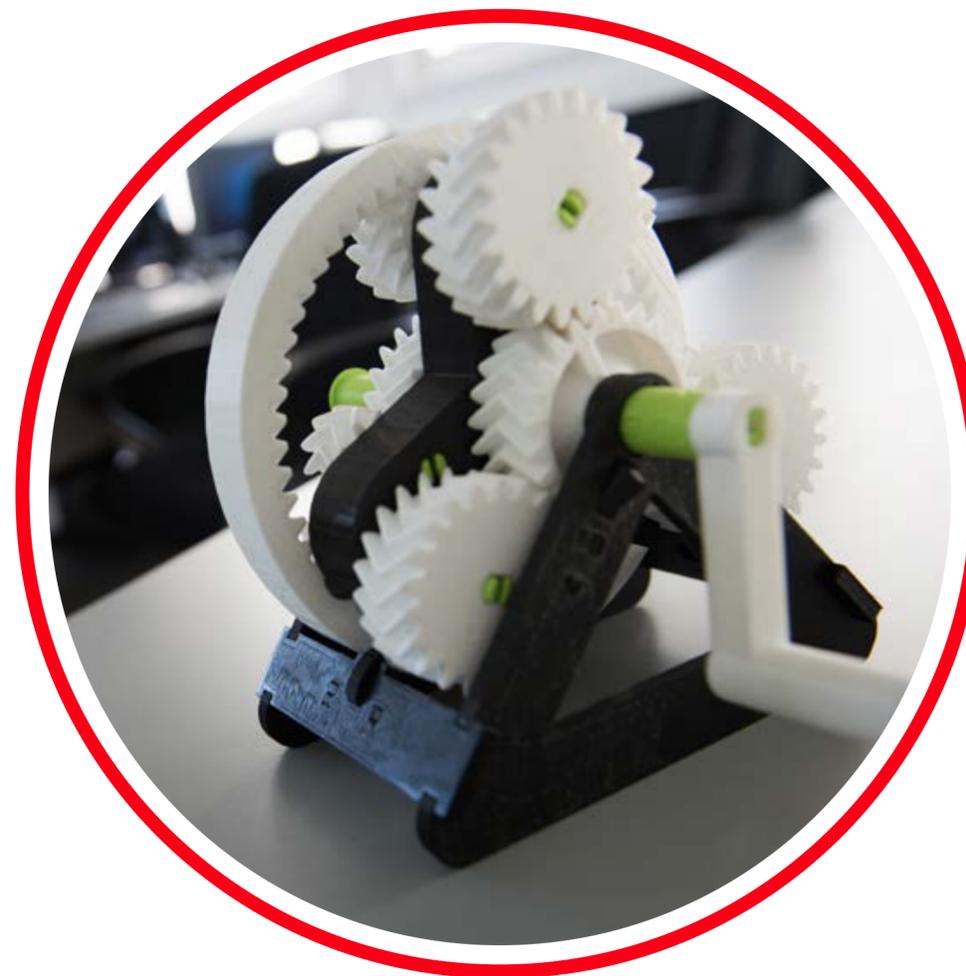
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HOW MUCH DOES 3D PRINTING **COST**?

Let's look at the **total cost of ownership of 3D printing**. As with any technology, there are direct and indirect costs to consider. And, a 3D printer by itself will not help your school manage its use and its costs. A full solution that includes print management features is recommended.

If you need to build a business case for 3D printing in your school, this information may be helpful.



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HOW MUCH DOES 3D PRINTING COST?

DIRECT COSTS

3D printer

Desktop 3D printers suitable and safe for the use in Education can range from \$2,000 to \$3,500 (as of 2017).

3D printing materials

Called filaments, the price is determined by the type, quality, weight, diameter and color of the filament, ranging from \$10 to \$160 per spool.

Modeling software

3D modeling software, also known as CAD (Computer Aided Design) programs can cost into the hundreds or thousands of dollars with features for professional designers. However, for the students it may be wiser to use free or low cost software or existing models shared by an enthusiastic 3D community. See [page 9](#).

HOW MANY PRINTERS DO I NEED?

A good rule of thumb in Education is 15 printers for every 500 students on campus.

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INDIRECT COSTS

Maintenance and service

Maintenance and service costs vary considerably depending on the number of printers, level of support required and frequency of servicing. If you have an agreement for your 2D print environment your provider should be able to provide you with an estimate to add 3D printer(s) into the agreement.

Print management software

Education has specific 3D printing needs that are solved with 3D print management software. As your fleet of 3D printers increases, a print management solution can work across both 3D and 2D (paper/copy) devices providing more value to your school. Learn more about 3D print management software on [page 18](#).



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HOW MUCH DOES 3D PRINTING COST?

Administration costs

Whether it is your IT administrator or one of the teaching staff, you need to consider the cost of their time. This is difficult to estimate, however to minimize the time and effort spent administering your 3D printing solution, look for one that offers the following features:



- ⦿ **Reporting:** 3D printing reports help your school make accurate decisions based on hard facts on how the printers are being used, their utilization rate and costs.
- ⦿ **Monitoring:** 3D printer monitoring will highlight any issues across your fleet of printers, allowing you or your third-party service provider to react quickly and solve any potential problems.
- ⦿ **Admin notifications:** Immediate notification of an issue with a printer so that quick resolutions can be made.
- ⦿ **Simple, user friendly interface:** Look for a solution that offers a simple, intuitive admin interface.

HOW MUCH DOES 3D PRINTING COST?

WHO CAN HELP ME ESTIMATE OUR 3D PRINTING COSTS?

It is highly recommended to involve your IT department when considering and purchasing your 3D printing solution. Using your **IT department and existing service providers** will greatly assist in finding the right solution to ensure that you are getting the ROI you expect from the 3D printing program including maximizing student access and managing costs.

HOW CAN MY SCHOOL COVER THE COSTS OF 3D PRINTING?

Some schools and universities have budget set aside to invest in new technology, and in a few school districts, grants are available specifically for adopting new technology in education. Many schools allocate lab fees or printing fees to cover paper printing. These can be extended to 3D objects. Additionally, many schools charge students for printing on a pay-as-you-go service. Look for a 3D print solution that enables you to **track and accurately allocate costs** and, if required, offers a pay-to-print service.

[LEARN MORE ABOUT BUILDING A BUSINESS CASE FOR 3D PRINTING.](#) 

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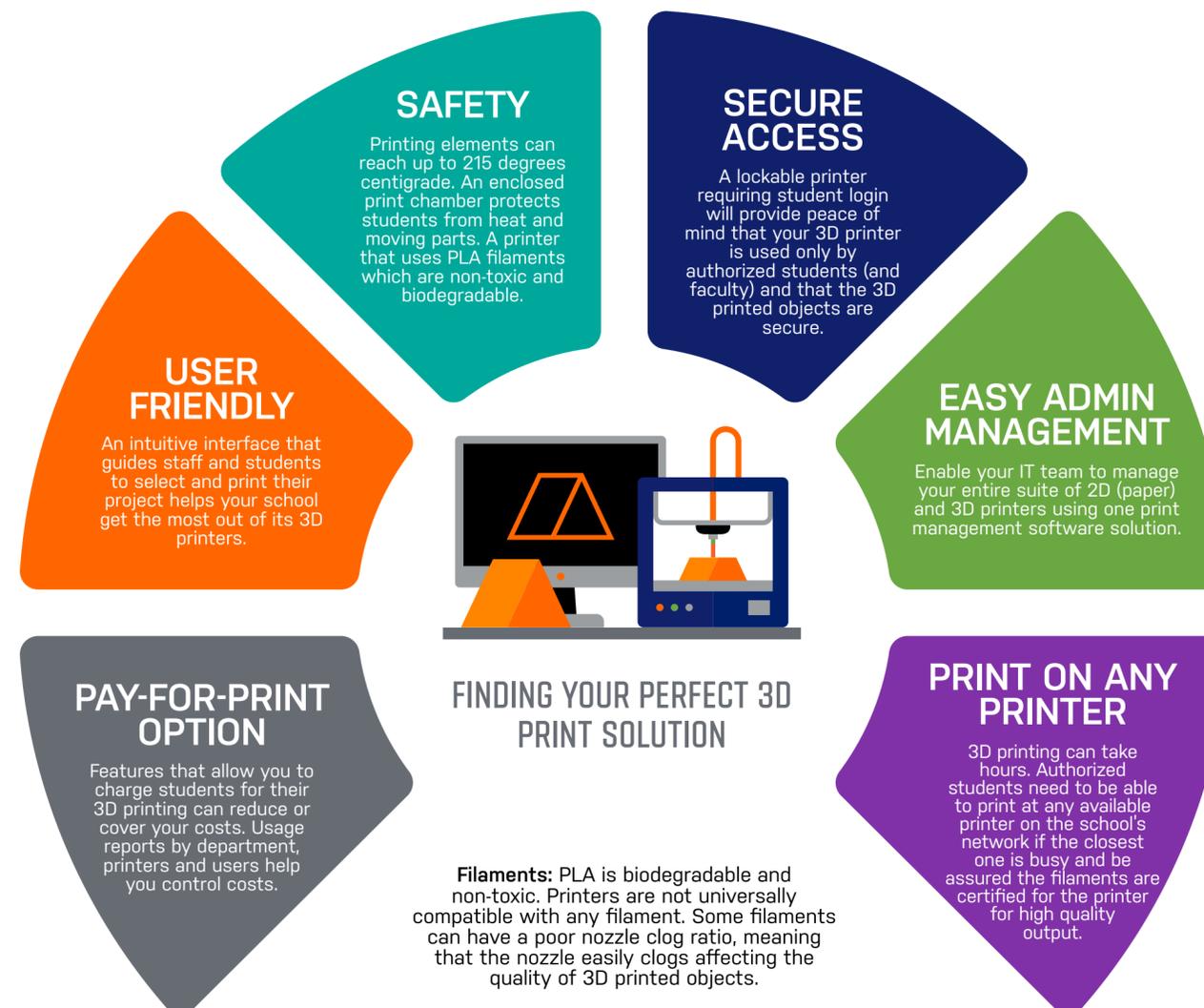
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FINDING YOUR PERFECT 3D PRINT SOLUTION

It is essential that you choose a 3D printing solution designed specifically for Education. Schools and universities have requirements unique to Education compared to a business. By using this checklist, and other information in this eBook, you can find the solution that meets your unique needs.



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SUCCESSFULLY INTRODUCING 3D PRINTING INTO YOUR SCHOOL

Now that you know what kind of solution you need, you will want to plan for introducing its use with faculty and students. Communicating effectively, training users, showcasing successful projects and managing demand all help ensure ongoing success.

Use this guide to put your plan into action.

TRAIN YOUR CHAMPION(S)

To support your champion(s) you need to provide them with education specific 3D printing training. Find a local trainer that can help you train your champions and work with you and them to train others and ensure successful adoption.

LAUNCH

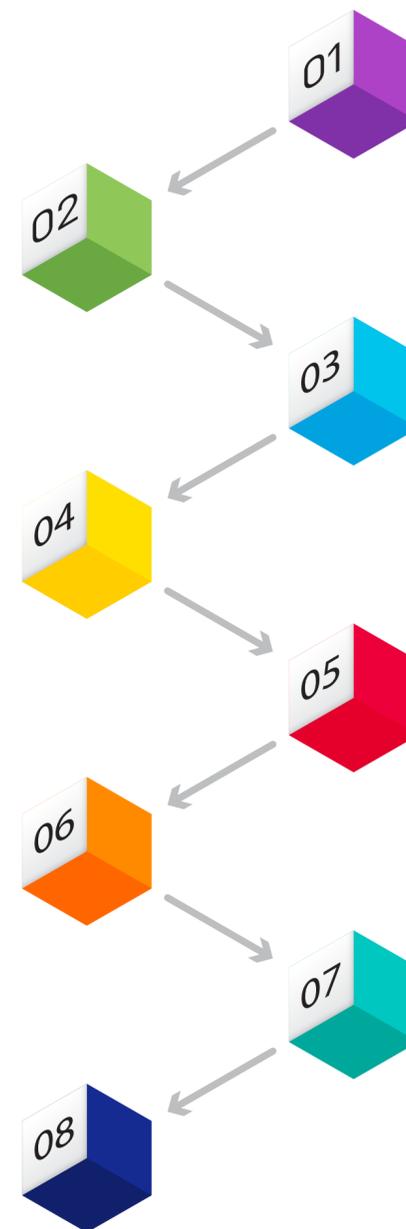
When you officially launch 3D printing use the popular communication channels in your school or university to raise awareness and promote training sessions. Emails, posters, use of TV screens, newsletters and public address announcements can be considered.

MANAGEMENT PLAN

If you have just 1 or 2 teachers that understand 3D printing then start small with 1 or 2 printers to make it manageable. Your 3D printer(s) will have periods when they are at maximum capacity and other times when they are sitting idle. Once your 3D printers are in use, utilize your 3D print management software to monitor and manage usage and communicate quiet times to improve consistency and reduce "wait" times.

EXPANSION PLAN

Successful adoption will naturally lead to an increase in demand for 3D printing in your school or university. Using your 3D print management software's reports, you can calculate the required number of printers you will need as more faculty adopt 3D printing as part of their curriculum and more students are brought into 3D printing. As a guide work to 10/15 printers per 500 students.



FIND YOUR CHAMPION(S)

Find the person(s) who will help you drive interest and engagement. Your champions will be naturally interested in new technology such as 3D printing. They will openly and passionately talk about the technology with colleagues and support them when they have questions.

BUILD A RESOURCE LIBRARY

Before officially launching, make sure you have a library of resources prepared to support students and other faculty. Check out MyStemKits.com and Google Group K12 Fablabs for resources to support your school.

TRAIN YOUR USERS

When you have completed steps 1 through to 4 you are ready to train students and other staff. Divide them into small groups of between 5 to 10 people per printer and conduct workshops to walk them through using your new 3D printing solution. Use your champions to help run the workshops and as ongoing "go to" help for students.

SHOWCASE

To sustain use and encourage students and teachers to develop their skills, showcase your best projects to celebrate success and share ideas.

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BUILDING A CURRICULUM AROUND 3D PRINTING

3D printing helps teachers of all subjects revolutionize their lesson plans and inspire students. Coordinating the use of 3D printing across multiple subjects can also help students connect topics and gain a greater understanding and appreciation of the world around them.

This simple **diagram provides guidance on how you can use 3D printing** to bring subjects to life and engage your students in the classroom while getting the most out of your 3D printer investment.



Historic artifacts

Students can analyze historic artifacts in their own hands rather than viewing them through a museum display case.



Music

Students can print their own instruments and understand how changing the size or position of a hole can affect the sound produced.



Mathematics

Printing geometric patterns can help engage and hold your students' attention. This is very useful for complex subjects such as mathematics.



Literature

3D printing can bring a book to life, particularly helpful for students studying classic literature. They can print a landscape from Tolkien or the vial from Romeo & Juliet.

Biology

3D printed models allow students to inspect cross-sections of organs to better understand biology.



Geography

For geography, using 3D printed models of oxbow lakes and volcanoes all help students better understand the world around them.



Engineering

Engineering students can print their own designs. By interacting and testing them they can amend and optimize their designs.



Chemistry and physics

For students studying chemistry and physics, printing and studying items such as molecules can help them grasp complex subjects.



Art

3D printing their own, unique designs can enhance an art student's experience.



Sports and biology

Teachers can coordinate lessons bringing together subjects such as sports and biology. This can help students better understand how our body reacts to different sports.



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WHY 3D PRINT MANAGEMENT

Throughout this eBook, we have stressed the importance of 3D print management as a key consideration when choosing a 3D print solution. Many schools already use print management software to manage their 2D print fleet. If you already have a service agreement for your 2D print environment then you are well positioned to easily add 3D printers (Your school's IT department can answer this). If not, be sure to select a 3D printer with print management features.

Let's look at **why 3D print management is important for your school** (and how it can benefit student's use too). The most important features are highlighted here.



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WHY 3D PRINT MANAGEMENT

**77% OF SCHOOLS WHO HAVE
ADOPTED 3D PRINTING PLAN
TO EXPAND THEIR USE OF
THE TECHNOLOGY.**

Source: 3D Printing in Education 2016 Report Card, Dimensional Research, 2016

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WHY 3D PRINT MANAGEMENT



MANAGING SECURE ACCESS

Look for a print management solution that offers secure access through **identity authentication via ID badges, PIN, username/password** or a combination of these. This gives you greater flexibility on where you locate your 3D printers because you don't have to manually police them. It also ensures printed models can only be picked up by its owner.



2D & 3D PRINT MANAGEMENT INTERFACE

A print management solution should be able to manage your entire 2D and 3D print fleet with **the same print management software tool**. Be able to add users and additional 3D printers with ease.



PAY-FOR-PRINT

Research shows that nearly 90 percent of schools with printers restrict student access due to an inability to manage costs. A pay-for-print feature enables you to **charge users or departments for their 3D printing** to recover some or all the upfront 3D printing costs.

Pay-for-print services should be supported with easy tools to manage student/faculty accounts, lets them top of their account with additional funds on their own and enables you to manage refunds when necessary.

[**LEARN MORE ABOUT CONSIDERATIONS FOR EXPANDING YOUR 3D PRINTER FLEET.**](#)

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WHY 3D PRINT MANAGEMENT



REPORTING

An administrator dashboard that includes reporting tools will provide a comprehensive fact-based overview, allowing you to **easily manage your 2D and 3D print environment.**

Reports should be automatically scheduled or on demand, customizable and allow you to get to the granular level for each print job on each printer.



PRINT FROM ANY 3D PRINTER ON CAMPUS

This is very important for students. 3D printing can take hours and **students need to print at any printer** that isn't busy or the one that has the desired filament color.

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ADDITIONAL **RESOURCES**

FULL 12 PART BLOG SERIES:

Introducing 3D Printing into the Classroom.

- 1: [WHAT IS 3D PRINTING AND WHAT ARE THE BENEFITS FOR EDUCATION?](#)
- 2: [HOW DO YOU KNOW IF YOU NEED A 3D PRINTER FOR YOUR CLASSROOM?](#)
- 3: [HOW MUCH DOES 3D PRINTING COST?](#)
- 4: [BUILDING A BUSINESS CASE FOR A 3D PRINTER](#)
- 5: [CREATING THE RIGHT PHYSICAL ENVIRONMENT FOR 3D PRINTING](#)
- 6: [FINDING YOUR PERFECT 3D PRINT SOLUTION](#)
- 7: [SUCCESSFULLY INTRODUCING 3D PRINTING INTO YOUR SCHOOL](#)
- 8: [DESIGNING FOR 3D PRINTING](#)
- 9: [BUILDING A CURRICULUM AROUND 3D PRINTING](#)
- 10: [MAINTAINING AND SUPPORTING 3D PRINTING](#)
- 11: [EXPANDING YOUR 3D PRINT ENVIRONMENT](#)
- 12: [3D PRINTING: OUR TOP THREE TIPS FOR EDUCATION](#)

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CASE STUDIES

Read how other students, schools and universities are successfully using 3D printing.

- ◉ [Prosek Technical School, Czech Republic](#)
- ◉ [Gymnasium des Schulvereins Komensky, Austria](#)
- ◉ [University of West Bohemia, Czech Republic](#)
- ◉ [HTL 3 Rennweg College of Engineering, Austria](#)



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YSOFT BE3D EDEE

A 3D PRINT MANAGEMENT SOLUTION FOR EDUCATION

In this eBook, we have shared how 3D printing can enhance the learning experience.

The YSoft be3d eDee 3D printer is safe, secure and the perfect size for any space. Lockable doors and a retractable control panel add to the design and functionality of the 3D printer, making it ideal for schools and universities. Integrated with YSoft SafeQ® print management software, schools can more easily manage their 3D printing environment, including cost control.

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YSOFT BE3D EDEE A 3D PRINT MANAGEMENT SOLUTION FOR EDUCATION

With the YSoft be3D eDee print management solution, schools get:

- ⦿ 3D printer(s)
- ⦿ Print management software through integration with YSoft SafeQ
- ⦿ DeeControl, layering software
- ⦿ A sample filament spool
- ⦿ Accessory kit

[LEARN MORE ABOUT YSOFT BE3D EDEE FOR EDUCATION](#)

[YSOFT BE3D EDEE DATASHEET](#)

[VIDEO: THREE EASY STEPS TO PRINT A 3D MODEL](#)



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INTELLIGENT ENTERPRISE OFFICE SOLUTIONS THAT **BUILD SMART BUSINESS**

Empowering employees to be more productive and creative. We create intelligent enterprise office solutions that build smart business and empower employees to be more productive and creative. Our headquarters are in the Czech Republic. We employ over 300 dedicated people around the world; our R&D centers are in Brno and Prague, Czech Republic.

Through YSoft Labs, we experiment with new technologies for potential new products. We accelerate the technology growth of other innovative companies through Y Soft Ventures, our in-house investment arm. We also contribute our time, talent and resources to universities and tech forums.

[WWW.YSOFT.COM](http://www.ysoft.com)

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