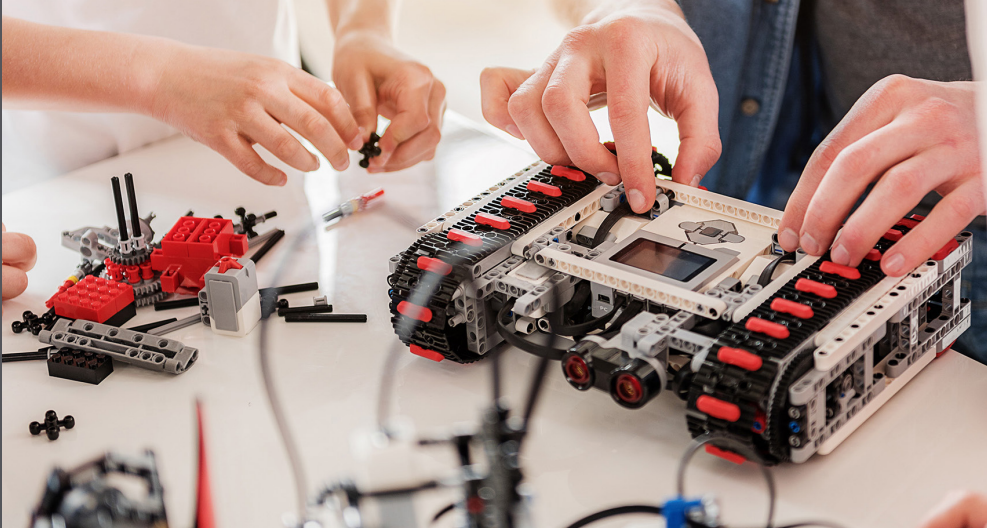




Shaping The Talent of Tomorrow

Making It Happen
For Future Innovators



Shaping The Talent of **Tomorrow**

3D printing's benefits for the design and manufacturing industries aren't new. It's been available in various forms for over 30 years and is often labeled as the next industrial revolution. Despite some of the hype, 3D printing, or additive manufacturing as it's also called, has become an invaluable technology, and a cornerstone of innovation across every industry.

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Additive technology continues to expand and adapt as the industries depending on it continue to improve and innovate. It plays a key role in making companies more competitive by streamlining and enhancing the product-creation process.

Maintaining a competitive edge requires a tech-centric workforce adaptable to the changing requirements of each industry. But a few obstacles in today's global economy are making that a challenging prospect.

First, according to the National Student Clearinghouse Research Center, student enrollment in higher education programs is down by more than two million in the U.S. It has continued to decrease every year since 2011, which means a smaller emerging workforce.

Second, and perhaps more alarming, of the students enrolled in the U.S., studies show graduates' skills in literacy, numeracy and critical thinking, key skills for a global economy, have steadily declined over the past two decades.

As manufacturing technology evolves, there's a widening gap between advanced solutions and the number of skilled workers who can use them. The use of additive manufacturing will continue to increase, but the emerging workforce is smaller and less prepared than ever before. Over the next decade, experts predict a shortage of skilled workers could lead to millions of unfilled jobs in the design, engineering and manufacturing industries. Globally, manufacturers look to community colleges, vocational and technical schools, and universities to attract and retain talented students, and prepare them to work in advanced technology sectors using knowledge and skills far beyond what was required a generation ago.



Making A Difference

The gap between industry and prepared graduates can be bridged by fueling the student experience with access to the same cutting-edge tools professionals use every day. Industry leaders are looking for those who not only know how the tools of the trade work, but who have a clear understanding of how to choose the tool that does the job with the highest quality and lowest impact on resources; in other words, in the most reliable, repeatable and cost-effective way.

Providing access to 3D printing gives students hands-on experience with real-world industry solutions, a key advantage for every stakeholder, from institutions, vocational programs, educators and students, to businesses and ultimately the global economy.



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Well-known industry leaders in automotive, aerospace and manufacturing, companies like Ford, Lockheed Martin and Airbus, use 3D printing to streamline their workflows with advanced applications. Many have placed a 3D printer right at each designer's desk. Giving students access to this same technology opens the door to industry opportunities. The more experience students have with the tools currently used to solve real-world problems, the more opportunities they'll have to become the future innovators.

Making It Affordable

In a survey of educators currently using 3D printing in their curriculum, 94% said it keeps students engaged, 87% said it helps develop students' critical thinking skills and 86% said it provides unique skills for the next stage of a students' career.

However, embracing this technology or broadening its use, is often avoided for a number of legitimate

reasons. Professional 3D printers pose a financial hurdle and many companies find it difficult to justify the cost. But this perception doesn't mirror reality because there are professional 3D printers that are affordable, efficient and designed to increase the simplicity of 3D printing while increasing critical thinking skills.

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3D Printers and their companion curriculum provide solutions that help students and the programs that adopt them become more competitive and effective. FDM 3D Printers create models and parts directly from digital data, quickly, easily and locally, making it possible to share the resource across disciplines.

When accessible to all students, it's a game-changing advantage in a competitive market where industry is in great need for experienced, knowledgeable employees. The real-world experience creating designs, iterating quickly and holding solutions in their hand can open the door to higher placement rates for graduates, higher enrollment rates for programs and rewarding partnerships with local businesses for both students and institutions.

As additive manufacturing continues to mature, students with experience on the latest solution are a step ahead.

Making It Possible

For some institutions, adopting additive manufacturing presents some challenges. It's often a matter of finding the money, space and the right curriculum, or acquiring staff with the right expertise. Then there's the challenge of finding printers that are easy to use, affordable and include companion resources for teaching and learning. They also need to be reliable and produce professional results. Otherwise, students and faculty will spend more time fixing poor-performing printers than solving the world's problems.

Despite these challenges, finding printers that check all the boxes might be easier than you think. That's because the Stratasys F123™ series printers were designed to meet these specific challenges. They're simple to use, economical, and operate with the reliability that FDM technology is known for. The remainder of this white paper takes a look

at the problems educators typically face when considering 3D printing technology and how the F123 Series tackles them head-on.

The Challenge: Lack of Expertise

"We don't have the expertise to operate a 3D printer, nor the budget to hire additional specialists to work with them. We need 3D printing technology that's easy to use and can be shared by multiple disciplines and curriculums across our campus."

STEM learning is enhanced through 3D printing projects like this Robotis Darwin Mini robot, giving students practical experience with technology professional engineers and designers use.



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How The F123 Makes It Easier

Most 3D printing platforms require trained individuals knowledgeable about printer operation, file manipulation and troubleshooting. But F123 Series Printers don't need a special technician dedicated to operate and maintain them. The printers are designed for ease of use, from the initial setup through the design-to-print workflow. Simply plug-and-print, thanks to an automatic setup and test functionality.

GrabCAD Print™ software makes the task of printing parts easy, too. It's formatted similar to CAD software, which is familiar to designers and engineers. Once parts are designed, the engineer simply hits "print" to print the parts. File sharing is also possible through GrabCAD Print, so students and researchers in design or engineering can collaborate and share access to the 3D printer.

Each printer is also Wi-Fi-ready, making the 3D print function as easy as 2D printing from an office

computer. Or, if Wi-Fi is unavailable, files can be printed via USB or Ethernet cable. Monitoring the progress of a print job is simple, thanks to the printer's built-in camera. Users can check the print status directly from their workstation with GrabCAD Print or through an app on their mobile device. Thanks to this accessibility, the Stratasys F123 Printers can continue working overnight without pause.

The Challenge: Lack of Time and Space

"We've considered adding 3D printing to our institution, but it has a reputation of being a slow process and needs a dedicated, separate space because of the noise and materials that are used. Our campus doesn't have a separate lab space to house a 3D printer."

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How the F123 Makes It Convenient

For fast printing speed, F123 Printers include Fast-Draft print mode, which operates at twice the speed of the standard FDM print operation, typically using only one-third the material. This lets users 3D print models very quickly, allowing more students access throughout a semester and the ability to iterate their ideas quickly.

More importantly, these 3D printers are designed to fit into any classroom environment. They use a clean build process with no hazardous chemicals or materials and operate using standard 110-volt electrical power. 3D printed models are built in an enclosed, insulated build chamber with an auto-locking door for safe operation and no risk of outside physical interference. Noise insulation provides exceptionally quiet operation, under 46 decibels, similar to a home refrigerator.



This motorcross helmet and the attached accessories were prototyped and 3D printed on the Stratsays F370.

The Challenge: Lack of Options

“Our 3D printer uses only one type of material but we’d like to build parts using several different materials. Also, replacing empty material cartridges is messy and time consuming.”

How the F123 Makes It Flexible

F123 Printers are capable of printing with several materials, each one tailored to meet specific requirements.

PLA is an economical choice, providing the best option when you need fast model creation and/or need to print them in greater quantity. ASA, ABS and PC-ABS are engineering-grade thermoplastics that offer flexibility when models and prototypes need differentiation, such as UV light resistance or high strength and durability. These materials can also be printed in Fast-Draft mode.



This rocket was designed following the Stratasys Rocket Learning Module and 3D printed in PLA on a Stratasys F370, a project that helps improve student proficiency in part modeling, drawing theory and assembly modeling.

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To make material changes and replacements easier, F123 Printers use self-positioning filament spools designed for the fastest replacement of any FDM 3D printer in the market. Changing material takes no more than a minute to remove and replace the empty spool and feed the filament into the bay drive. Spools are located in an easily accessed drawer at the front of the printer. When changing between different engineering plastics (non-PLA), there's also no calibration required nor any need to change printer head tips.

The Challenge: Lack of Productivity

"Our 3D printer isn't a very reliable system. The downtime is unreasonable, making it an unproductive investment."

How the F123 Makes It Reliable

Stratasys F123 3D Printers offer the most reliable FDM capability in the market, fulfilling a primary design requirement. It starts with the deliberate decision to use industrial quality components coupled with design best practices from over 25 years of Stratasys FDM development. More importantly, over 100,000 hours of reliability testing was accomplished to prove out the reliability performance of these printers.

Making It Cost-Effective

Consumer 3D printers may seem like an attractive option because they're often compact and very affordable. They offer a low barrier of entry to inexpensive 3D printing, but it's not without risk. Investing in low-priced equipment limits long-term goals, day-to-day equipment uptime and student preparedness; industry needs a future workforce with hands-on experience using professional technologies and opportunities to learn above and beyond what at-home hobby printers offer.

In contrast, professional 3D printers provide additional value that justifies the investment, through increased capability, efficiency and reliability. Don't overlook the impact in time and cost to troubleshoot the inevitable problems that occur with maker-style hobby printers.



This prototype carabiner design has a flexible living hinge made possible with Stratasys F123 engineering plastics.

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Making Complex Projects Simple

Certain geometries can't be 3D printed without material that supports overhanging features and nested assemblies during the build process. Most consumer desktop printers lack support material that enable complex geometries like internal cavities and interlocking parts, which limits the design complexities that can be printed.

In contrast, professional F123 Printers use a soluble support material, enabling complex designs and fine details including thinner walls and internal cavities, for unlimited design freedom. The hands-free removal process is also cleaner and saves time.

Made to Keep Its Cool

Controlling the temperature of the "oven," the enclosed build chamber of an FDM printer, is critical for maintaining design specifications as the part

is built. As plastic cools from a melted state it tends to curl. Controlling this behavior is essential to maintain part quality, particularly for long, flat parts. FDM printers achieve this with uniform airflow and complex temperature control throughout the build area.

Desktop printers don't have controlled build chambers. This limits the type of parts you can build with consistent quality results. Stratasys F123 3D Printers use highly specialized electronics and temperature-control algorithms to achieve tight temperature uniformity across the build plane, with no "dead spots." This allows the creation of large, flat parts that can be printed in a variety of densities from sparse to solid-fill modes without the risk of curling.



The Stratasys F370 3D Printer is easy for students to operate, and the speed and accuracy help students at Dunwoody College of Technology test their innovative ideas quickly.

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This 3D printed drone quadcopter is the result of a design challenge given to students at the John Paul II Catholic Secondary School in London, Ontario, Canada.

Made to Last Longer

3D printers used in campus workgroup or lab settings usually experience heavy use, putting significant demands on the mechanical components. You don't want student productivity hampered by poor printer reliability and frequent downtime. F123 3D Printers are designed and built for high utilization, using durable components. For example, these printers use servo motors instead of stepper motors. They're quieter and more robust for high-torque applications and dynamic load variations during printer operation, providing better control and more precise movement. Most low-priced desktop FDM printers use less expensive stepper motors, which typically produce a high-pitch whine, making them bothersome in a classroom setting.

Also, F123 Printer use durable motion-control components like linear profiled rails with ball bearings (instead of sleeve bearings). They provide better repeatability and accuracy, smoother and quieter operation, greater load-carrying capability and maintenance-free operation. Many low-cost desktop printers don't use linear profiled rails, lowering the chance of repeatable part accuracy.

Making You More Productive

Stratasys F123 3D Printers offer multiple features that increase student productivity. GrabCAD Print software enables print queue and multi-tray management. This gives everyone visibility to all the print jobs, making it easier to manage and prioritize important projects. The software also imports native CAD files for a faster CAD-to-print workflow.

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Make The Next Step

If you want to close the skills gap of future graduates, adding the Stratasys F123 3D Printer Series to your on-campus technology gives students a proven path to careers in the global economy with hands-on experience. They enable students in design, math, engineering, aerospace, manufacturing, automotive and other curricula to bridge the gap between learning and doing. They help students go beyond theory, learning how to rapidly bring ideas from concept to functional prototype.

The F123 platform is designed for ease of use and shorter, streamlined workflows with clean, safety-certified 3D printers that are the quietest on the market, using three engineering-grade plastics, plus economical PLA. They leverage the time-tested durability and success of Stratasys FDM technology to offer the highest level of reliability out of the box. Over 100,000 hours of testing support that assertion.

How would your students benefit from accessible, reliable 3D printers and a simple CAD-to-print workflow? With Stratasys F123 3D Printers, there's never been a better opportunity to prepare the workforce of tomorrow.



Engineers went from concept to fully functional traffic signal prototype incorporating UV-resistant ASA material.

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