stratasys

Empower Brilliance

Harnessing the Power of Highly Realistic 3D Printing for Students and Educators

E-Book

Introduction

Having the right tools is crucial to success in any field. For students and educators, especially those in science, technology, engineering, art and math (STEAM), learning on real-world technology is critical to career readiness. 3D printing is one of those tools that has helped many educators and researchers improve how they teach and research.

3D printing makes it possible to build things that aren't feasible with traditional processes like machining or injection molding. It creates models, prototypes, tools and some finished products faster and with fewer constraints. It empowers users to make better-informed decisions and refine their design more quickly.

For students, it means acquiring technology skills urgently needed in today's workforce. For institutions of higher learning, sophisticated 3D printing technology makes new research breakthroughs possible and attracts the best and brightest students, researchers and faculty.

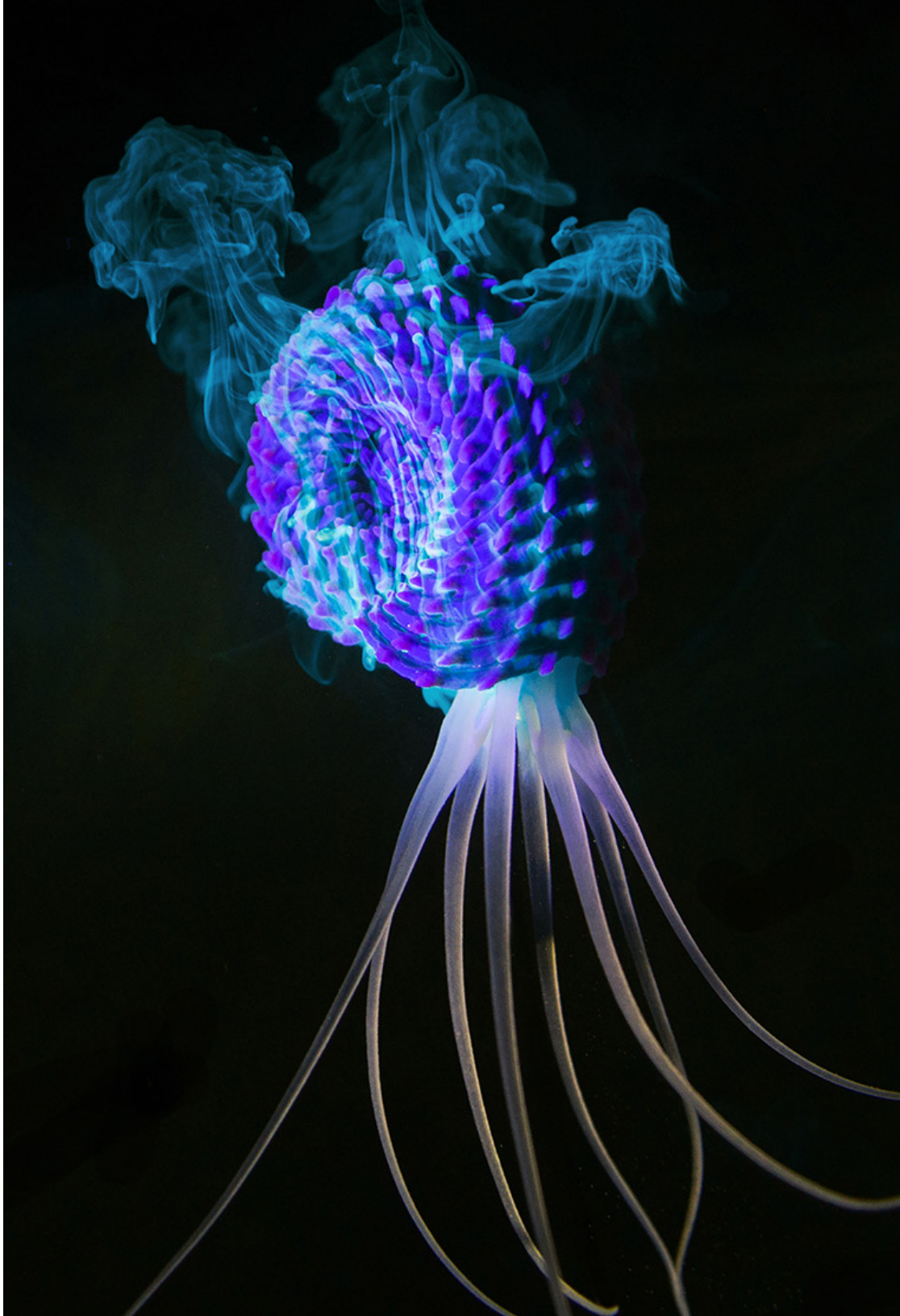
In the rest of this eBook, we'll look at how highly realistic 3D printing technology benefits the educational community, and a select group of 3D printers that helps make it all happen.

Increasing Knowledge and Innovation

The Engine Of Innovation

Research is the fuel that powers development of the innovative products and services we enjoy today in business, technology, the arts and medicine. In essence, it's society's investment in its future.

To accomplish this, research institutions need the best tools, resources and technology available. And 3D printing is a key tool that gives the educational community the power to innovate. With 3D printing, faculty, researchers and students can explore engineering concepts by redesigning everyday products to increase their performance, reduce their environmental impact or improve their usability. In the process, they develop persistence and critical thinking by going deep into a problem and solving it through real-world testing and refinement.



Increasing Knowledge and Innovation

For New Zealand's **Victoria University of Wellington (VUW)**, 3D printing is an outstanding educational tool, helping students across many disciplines understand complex theories and prepare for the workforce. VUW turned to 3D printing not long after much of the nation's production industries moved offshore. "We lost most of our mass production jobs, and as a result, our university started exploring emerging technology that would lead to new job creation," said Ross Stevens, the university's Industrial Design Department program director.

"The industrial design profession has historically used 3D printing technology to make prototypes of products that will be mass produced using traditional mechanical engineering methods," Stevens said

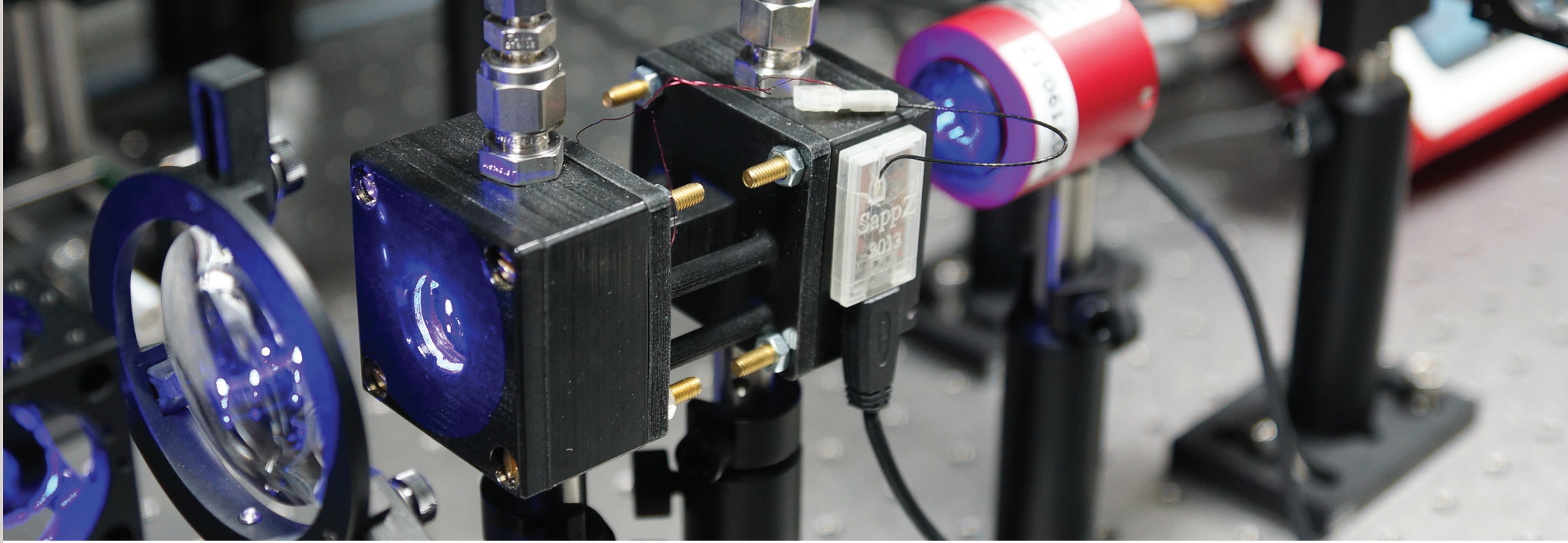
"As my experience with 3D printing processes grew, I became more interested in the printers' ability to make the traditionally un-makeable. This shift led to intricate and diverse objects more derived from bio-engineering than mechanical engineering."

Stevens' curriculum helps students in non-engineering disciplines prepare for the future with applied learning. He uses 3D printing to help the classes build fictional scenarios using coding, rendering and multimaterial 3D printing. "We can achieve a lot with today's materials, but with emerging materials, we'll be able to do much more very soon," said Stevens. The university prefers multimaterial 3D printing technology because it offers the multicolor, multiproperty capabilities the school needs.

Students at VUW have 3D printed a custom facial prosthesis that costs just $100 to produce (versus $1,000 for a traditional product) and shoes that use accurate 3D scanning to make a personalized pair with enhanced biomechanical performance. Students also created hi-fi speaker drivers that incorporate structurally intricate details printed in both hard and soft materials during a single printing process.

In another research project, students designed 3D printed aquatic creatures for use as dynamic and interactive film props. The project presented a more physical and realistic alternative to using computer generated imagery in film.

To other schools considering 3D printing, Stevens believes the best is yet to come. According to Stevens, "The possibilities are virtually limitless."



Increasing Knowledge and Innovation

Changing Students' Mindset

OTH Regensburg (OTH) is one of the largest technical universities in southern Germany and offers more than 45 programs in engineering, business studies, social services and design to 11,000 students.

OTH is also home to the Sensorik-Applikationszentrum (SappZ), a center where students use applied research and engineering together with 3D printing to develop sensor applications for the automotive, medical, industrial, electronic and mechanical industries. 3D printing has a significant impact on the center because of its speed, accuracy and multimaterial capabilities.

"As a facility that acts as an interface between the research activities of the university and the world of business and industry, we have the enabling technologies to make concepts become realities," said Florian Olbrich, researcher for the department of applied sensor technology at OTH. "Our 3D printer really has transformed the way we work."

The capabilities of multimaterial 3D printing and the increased access to it has not only improved the quality of student projects, but it is changing something else even more important. "It's all about changing the mindset of students," said Olbrich. "Previously, engineers would think, 'Can I do this with milling?' or 'Can I reach it with a drill?', but with 3D printing, you don't really have limitations. How they go about constructing things shifts dramatically once they've used a 3D printer a few times. You lose the barriers in your head and know pretty much anything will work, no matter how complex. It really is construction without limitation."

By enabling more students to use the multimaterial 3D printer, Olbrich feels the quality of education has improved as it allows students to develop new ways of thinking about design and production.

Increasing Knowledge and Innovation

Pushing The Boundaries Of Research And Innovation

The Anthropological Institute of the University of Zurich (UZH) uses 3D printing to advance its research and understanding of human evolution.

An important tool in anthropological study is the ability to accurately replicate fossils. They are too fragile to be handled frequently and too valuable to risk damage or destruction from repeated examination. The ability to scan the fossils and 3D print accurate models for reconstruction and study is an invaluable tool for UZH researchers. They used this capability to reproduce skull fragments of a Neanderthal infant, enabling them to reconstruct the skull and compare it with other skeletons. This ultimately led to a better understanding of brain development during this time period. “Solving the puzzle on a computer screen is challenging,” said university professor Dr. Christoph Zollikofer. “After printing the CT-imaged parts using the 3D Printer, the fossils were much easier to understand and reconstruct.”

The accuracy and fine details that are possible with 3D printing, combined with the ability to scale fossil reproductions up or down as needed lets UZH researchers find answers to questions and push the level of knowledge and understanding in archeological study. “The 3D printer makes for a perfect copy of the original,” said Professor Zollikofer. “This in turn allows experiments to be performed that would otherwise be impossible.”

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Exploring Full-Color, Multi-Material 3D Printing in Education

Establishment of an on-campus 3D printing innovation center with full-color, multimaterial technology encourages entrepreneurship by letting students incubate their ideas, and see them through to implementation and sometimes even commercialization.

Rochester Institute of Technology (RIT) established the New York State-funded Additive Manufacturing and Multifunctional Printing Center for Advanced Technology (AMPrint Center), equipped with a full spectrum of world-class additive manufacturing and 3D printing technologies available to every discipline and department. Among the installed equipment base is a professional-grade, full color, multimaterial 3D printer. This cutting edge technology situated in the AMPrint Center supports innovative applications in nearly every college on campus, including design, health care, science, marketing, engineering and more.

A New Depth of Learning

For example, RIT Industrial Design Professor Melissa Moukperian and industrial design graduate student Brad Dunn took advantage of the printer's digital material capabilities to design and 3D print a woven dress in a flexible, selectively colored digital material.

Faculty in the life sciences benefit greatly from non-perishable 3D printed color models of plants, flowers, insects and more for use in the classroom. A color 3D model can be enlarged to multiple times the real scale to allow for more effective demonstration and learning without the need for microscopes. True 3D coloring lets students see actual depth of features that are not apparent with surface coloring of molded plastic parts.

Manufacturing engineering students learn complex mold design principles from 3D printed tooling splits that are produced in a fraction of the time it would take to machine them. Likewise, investment casting patterns that would be impossible to produce via conventional wax molding processes can be 3D printed quickly. Time-saving assembly jigs and fixtures can be produced with molded text, color and/or icons intended to error-proof assembly operations.

Improving Medical Education

Anatomical Models For Surgery Prep And Education

Scanning technology such as computed tomography (CT) and magnetic resonance imaging (MRI) lets doctors see a patient's anatomy with intricate detail. But as helpful as these tools are, they don't offer the benefits a 3D model can in terms of being able to study all aspects of an anatomical structure like a human heart. 3D printing is the natural extension of this scanning technology, providing the ability to create anatomical models in intricate detail. These models are multi-purpose too, used for surgical preparation and training as well as educational aids for medical students.

Perhaps the most remarkable and beneficial example of this application involves modeling a specific patient's anatomy, including pathology. This lets doctors study the best approach for surgical intervention and provides students with a realistic study model. The 3D printer's ability to easily produce any shape is perfectly suited to the uniqueness of an individual's anatomy, and the variety of Shore A values rendered with multimaterial printers means models offer the proper tactile resistance as well as appearance.

These realistic 3D printed models help train doctors perform medical procedures, become familiar with new devices, and educate medical students on general anatomical structures. Training models can mimic the look and feel of living tissue and can integrate instructional elements, such as labels or contrasting colors. These models can be produced on demand and avoid the challenges associated with human cadavers, like availability shortages and handling and storage expenses.

Improving Medical Education

Nicole Wake, A Ph.D. candidate in biomedical imaging at the **New York University School of Medicine** realized the potential of multimaterial, color 3D printing. She worked with the University's LaGuardia Studio, a high-end 3D printing studio to solve complex problems. Through conversations with a surgeon in NYU's urology department, Wake recognized the need and opportunity for innovation. "Together we started a new, collaborative project combining radiology and urology for 3D printed kidney and prostate tumor models," Wake said.

"The 3D models help explain the disease to the patient, which is really helpful, because patients don't typically understand how to interpret radiological images. Having a model to show the patient their cancerous structure or lesion, and the organ itself along with the surgical plan, is very helpful for all involved."

"We can also use the 3D models to teach our medical students and residents about patient-specific anatomy and pathology," Wake said.

Ultimately, Wake hopes her application of 3D medical models will help lay the groundwork for a new standard of patient care.

How the J8 Series Fits

More Than Just Effective Tools

Based on case studies and evidence from the field, it's clear that 3D printing makes innovation possible, from the way things are made to the expansion of knowledge and understanding. The decision for schools and educators is which specific tool to choose to take advantage of these possibilities.

Many 3D printers are capable of colored models. But only the Stratasys J826™, J835™ and J850™ have the unmatched realism many projects demand. The J8 Series' multimaterial capability doesn't just produce parts with flexible and rigid characteristics. Rather, it helps educate physicians and medical students through accurate anatomical training models, letting them create new procedures and enhance their skillset, ultimately enabling them to improve health care outcomes.

The J8 Series also addresses the frustration of design students and educators who want to create realistic models for teaching, learning or innovative research projects but previously didn't have access to multimaterial colored printing. This solution allows them to focus on academic outcomes or research findings instead of worrying about inconsistent color results, rough finishes or messy processes from current 3D printing technologies.

How the J8 Series Fits

Incredible Part Realism

A hallmark of the J8 Series is its true, full-color capability, a breakthrough in 3D printing technology. The ability to 3D print with various colors is not new, but previous offerings forced users to sacrifice either color range or part quality. J8 Series printers change this by producing smooth parts with over 500,000 colors, including color textures and gradients.

This color range is made possible because these printers operate with all of the colors in the CMYK color process plus white, enabling a virtually endless palette of shades to choose from. What's more, J8 Series printers are PANTONE Validated™, making the PANTONE MATCHING SYSTEM® available for the first time in a 3D printing solution. Choosing a Pantone color is a simple one-click operation, giving users a valuable tool when communicating with color in the design process.

Models produced on J8 Series can combine color with a variety of other material characteristics. VeroClear™ and VeroUltraClear™ materials provide a range of transparencies, from slightly translucent to completely clear. Rubber-like Agilus30™ material imparts flexible characteristics in different durometers.

In practical terms that means being able to produce a rigid medical model representing various internal anatomical structures in multiple colors and gradients. Or it might mean producing a tray of multiple parts, each with different characteristics such as color textures, flexibility and transparency. Both scenarios are possible in a single print run. With very fine layer thicknesses, J8 Series printers provide high surface quality, creating models and parts with very fine, delicate details, with minimal to no finishing steps like painting, sanding or assembly.

Before the Stratasys J8 Series, no single 3D printer could deliver full color, smooth surfaces and multiple materials. Schools that wanted access to all of these qualities would need to adopt multiple 3D printing technologies and still resort to extensive post-processing, such as sanding, painting and bonding. Serving many needs with one system enables schools and universities to:

- Reduce the amount of underutilized and outdated equipment and its associated overhead
- Increase student exposure and maximize use through familiarization with a single technology
- Attract bright students, talented faculty and valuable industry partners with exciting and relevant technology

How the J8 Series Fits

Fast, Efficient Workflow And Ease Of Use

Using the printer is easy, starting with GrabCAD Print™ software. You can import native CAD files directly so there's no need to spend time converting them into STL files. Simply finish your model, open GrabCAD Print and drag the file in. Then select "print" to start the build. The software lets students and faculty easily check printer availability, queues and status, all from one window. And with the mobile app, you can check print status remotely on your mobile device. GrabCAD Print even fixes file problems like open meshes, so you can focus on more productive tasks.

Seven-material capacity is a considerable time and material saver. Multimaterial printers with less capacity need material changes for different colors or material types. This results in printer downtime and wasted material, made necessary to purge the system of the previous material. The larger material capacity lets an operator load their most-used materials and drastically reduce or even eliminate material changes, saving time and resources.

Productivity and design freedom is enhanced with the use of soluble support material. Soluble support can be removed by soaking the models in a cleaning solution, making it a hands-free operation. It also enables the creation of models with small, intricate passageways and channels because the immersion process easily accesses these areas, which isn't possible with water jet hand cleaning.

Multiple print modes give you optimal print flexibility. High Speed mode creates models quickly using several different materials. Super High Speed mode goes even further, letting you print concept models in a single material for the fastest production possible. High Quality mode provides the most options for using multiple materials, colors and high resolution, for models with the most realism.

Some 3D printing processes like SLA (stereolithography) must run in a dedicated facility because of the materials, chemicals and post-processing steps involved. In contrast, the J8 series printers use a clean, easy process, with no hazardous chemicals to handle, compatible with typical school and office settings.

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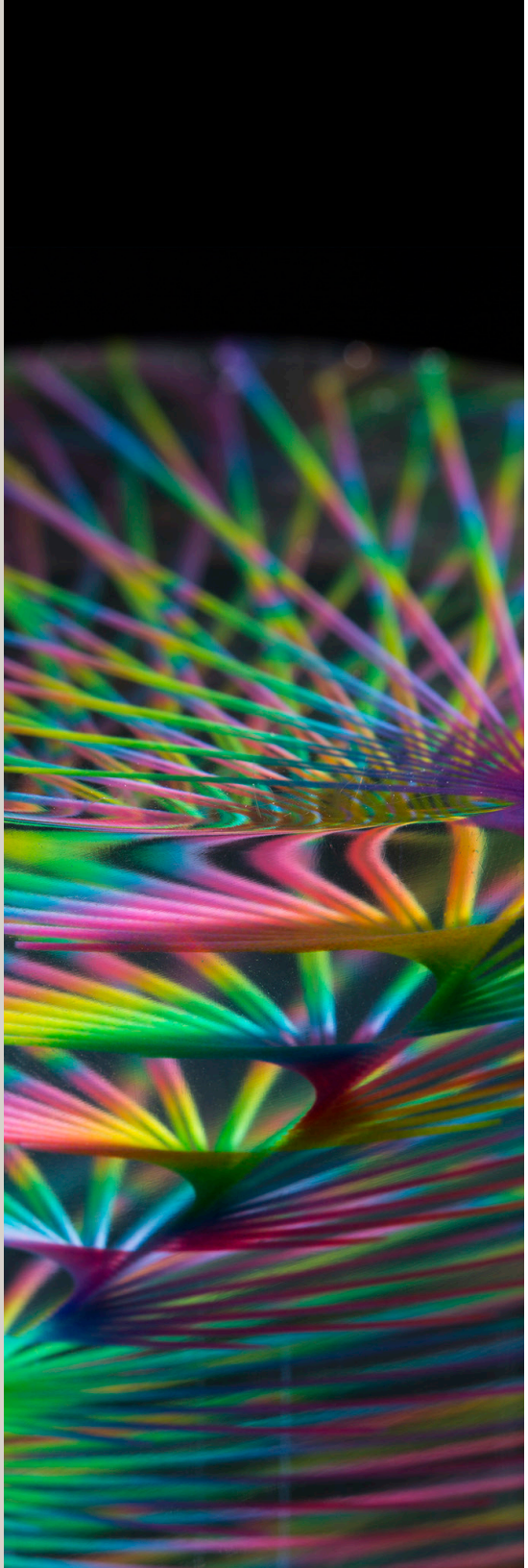

How the J8 Series Fits

GrabCAD Voxel Print

GrabCAD Voxel Print™ utility enhances the value of 3D printing as a powerful platform for experimentation, discovery and innovation. Voxel Print is a print utility available on J8 Series printers that lets users control the attributes of their models and parts down to the individual voxel* level, within the complete 3D volume of the part. With GrabCAD Voxel Print, users can create their own model layer slicer or use existing third-party slicers and send that information directly to the 3D printer.

In simple terms, Voxel Print lets you dictate precise color and gradient management, for unparalleled control of a model's appearance. It gives you the capability to control a 3D printed part's internal material properties, something that's not possible with CAD modeling. It enables the development of advanced structures and digital materials.

In total, the combination of the J8 Series printers and GrabCAD Voxel Print gives artists, engineers and researchers unprecedented, voxel-by-voxel control over their 3D printed output.

*A voxel (short for volumetric pixel) is the smallest physical element of a 3D printed structure that defines both its position and physical characteristics.

Leveraging The Technology For Optimal Benefit

The versatile capabilities of the J8 Series lets you do what you do best in a more time and cost-efficient way. More significantly, it provides a platform to develop new solutions and inspired research by the educators who use it.

An investment in this kind of technology is rightly viewed as a significant capital expense. But it's often looked at from a limited perspective, without considering how it can positively impact other departments in the same institution. A 3D printer with this capability offers benefits across multiple departments, which helps justify the expense and maximize its use.

Consider the scenario of an institution that offers programs in all of the STEAM disciplines: the sciences, technology, engineering, arts and mathematics. A J8 Series printer can serve all of these departments, avoiding the tendency to pursue disparate technologies within each department that can increase cost.

For example, with the J850, the engineering and technology departments benefit from hands-on experience prototyping with advanced technology. Students are empowered to bring their ideas to life with realistic, multimaterial parts, empowering them to innovate and develop problem-solving skills. Educators and students in the design and art departments can better illustrate abstract concepts in concrete terms, and add visual and tactile interest to their lectures and labs with 3D printed models made with limitless color possibilities.

Researchers can push boundaries and open new doors with advanced technology like Voxel Print. Better yet, this kind of technology spans multiple disciplines, potentially making it easier to attain grants in programs that encourage multidisciplinary research.

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Leveraging The Technology For Optimal Benefit

Ultimately, access to J Series 3D printing technology gives learning institutions the ability to recruit brilliant students and faculty who make technology part of their selection criteria, while also attracting industry partners that build ROI into the curriculum. Business partnerships give students real-world experience by working on authentic commercial projects and let them build impressive portfolios and resumes that showcase their work with real companies.

Regardless of your department, consider the following questions:

- Would your students benefit from more time to explore ideas, analyze problems in-depth and develop the persistence they'll need to excel in today's fastest-growing and most rewarding fields?
- Could your medical students elevate their knowledge and understanding by using accurate, realistic training models?
- Would your university benefit by attracting the best and brightest students and leading researchers through access to state-of-the-art technology?

Stratasys 3D Printing solutions have a proven track record helping schools and organizations meet these goals, and the J Series continues that tradition with the next level of 3D printing capability.

Get a closer look at the Stratasys J Series at www.stratasys.com/3d-printers/j8-series. Then, contact Stratasys when it's time to start the conversation about how this technology can solve your educational challenges.

The Stratasys J850.

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