The Case for 3D Printing at Your School

February 2015

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THE JOURNAL

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12 Teacher Hacks for Adding 3D Printing to Your Classroom

1. From the moment the 3D printer arrives in your classroom, let the students handle unpacking and setting it up. Hand out the manuals and let them assist you in getting it to run.

2. Show students that there are three ways to do their modeling: creating their own geometry with computer-aided design, performing 3D scanning to "reverse-engineer" physical objects and downloading (and revising) models from "galleries" where others have uploaded their designs for sharing.

3. Keep a light touch when assigning students projects; the best 3D design and printing is about allowing the student to learn how to plan, design, make, evaluate and revise.

4. Integrate the design and printing of a small gear, such as objects with school logos, which the students can cost out, market and sell as part of math and business curriculum.

5. Consider how students can design and print their own parts as part of scientific experiments.

6. Teach students history by having them design and print 3D models of important buildings and structures from the period.

7. Change up your 3D design and printing projects from year to year to keep them fresh and relevant.

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In the commercial world, 3D printing is revolutionizing the way products are designed and produced by making the manufacturing process more efficient and cost effective. But there's also plenty of anecdotal evidence that 3D printing is making an impact in K-12. It's engaging students, teaching them the fundamentals of design and manufacturing, and inspiring them to consider careers in science and engineering. Still, nobody can introduce 3D printing into the classroom without getting access to the technology itself.

Here are insights on how to make the case to your school or district leadership for making 3D printing a part of the curriculum.

3D Printing has become a Movement

Gartner recently predicted that shipments of 3D printers worldwide would double every year for the next four years—most going to consumers. This same kind of buying momentum is reflected in education and 3D printing is on track to become a school staple. The NMC Horizon "Technology Outlook: STEM+ Education 2013-2018" report stated that 3D printing would find mainstream adoption in schools within two to three years, calling the growing interest in rapid prototyping a "clear indicator" that it is "worth following closely."

What's driving adoption? The "Maker" movement is turning out to be a leading force. As the report noted, "Making addresses the sorts of STEM skills that many educators and policymakers consider most important to productivity in the 21st century."

As schools prepare to invest in 3D printing, they're going big. Government budget tracker Onvia found that the average educational 3D printing contract totaled $32,000.

Whether 3D printing is used to create objects that students wouldn't otherwise have the opportunity to handle (such as archaeological findings, science specimens or historic artifacts) or to give kids an excuse to come up with their own uses, the technology has a home in classrooms where teachers look for ways to give students more authentic learning experiences.

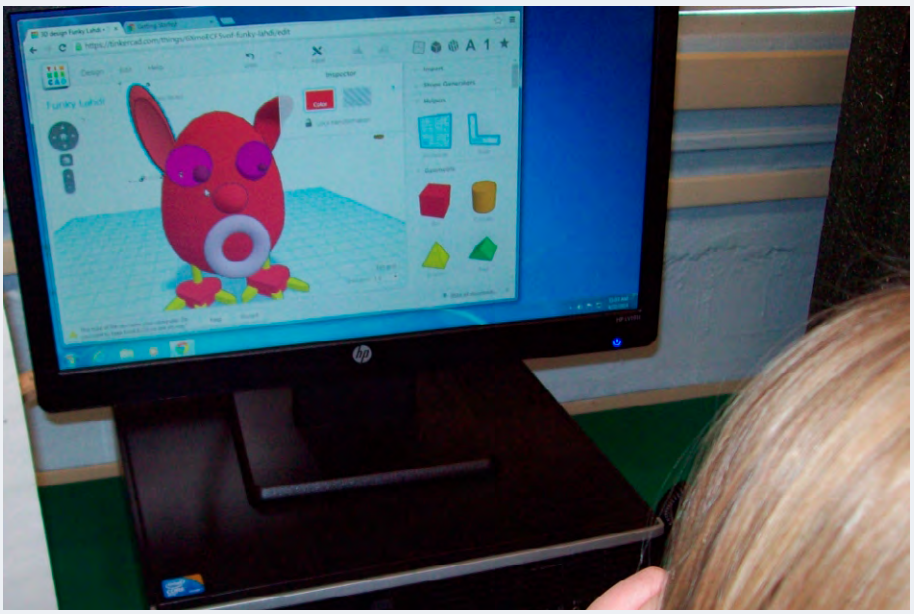
8. As students start new projects, have them keep an "engineering notebook" that records the steps and interesting details of the process they go through.

9. Help students visualize geometric shapes, attempt modeling algebraic equations, study molecules and learn about organs by having them create and print out examples.

10. Enlist IT people and teachers with CAD experience as advisors to help with tech support and assisting students with design problems.

11. Don't tuck the 3D printer into a staff room where students aren't allowed to access it. Put it somewhere they'll be able to watch it work its magic.

12. Showcase student projects and the printer at family nights. Make sure it's turned on and printing something unique and student-designed during the event.



Those educators with experience in the 3D printing process talk about how their students gain mastery in areas that can't be extracted from a textbook:

Bringing designs into existence. Students attending classes run by John Keyzer, a teacher at Lake Zurich High School in Illinois, have long designed buildings, mechanical assemblies and consumer products in class. It was only when they had access to a Stratasys Dimension 3D printer to print out their designs that they could actually interact physically with what they had envisioned.

Understanding the iterative process of prototyping. Keyzer's students surveyed other students on desired features before tackling designs for a new video game controller. But ultimate design refinement happened when the students could hold prototypes in their hands to figure out what they liked and didn't like.

Learning persistence with problem-solving. Richard Osman, a teacher at Campbell-Tintah Public School in Minnesota, says his high school students will willingly stay in class until 6 or 7 p.m. to get 3D design and printing projects done on the Stratasys uPrint.

Practicing collaboration. When Osman's students hit a snag with their design and prototyping efforts, they'll often shout their questions to their classmates and a fellow student, not the teacher, usually provides answers. "The learning is awesome together—it's back and forth," Osman said.

Gaining a view to the future. Osman has taken some of his students to visit a local manufacturer working on prototypes for a new hatchback on the Mini Cooper. "I said, kids, you're seeing something happening before it's on the car," he recalled. "This is just a prototype. Think about how you could use [3D printing]."

Free Curriculum Ready for Download

If you're wondering where to start with 3D printing in the classroom, consider downloading free curriculum and a teaching guide developed by Stratasys and intended for teaching high school and college students. The content also includes presentations, STL files, assessments and grading support.

"Introduction to 3D Printing: From Design to Fabrication" follows a 14-week structure that assumes four to six hours each week in class. Although the curriculum group that developed the materials recommends that the teacher follow the first four weeks of the course structure, after that the instructor can mix and match the units as he or she wants. The lessons are vendor-neutral.

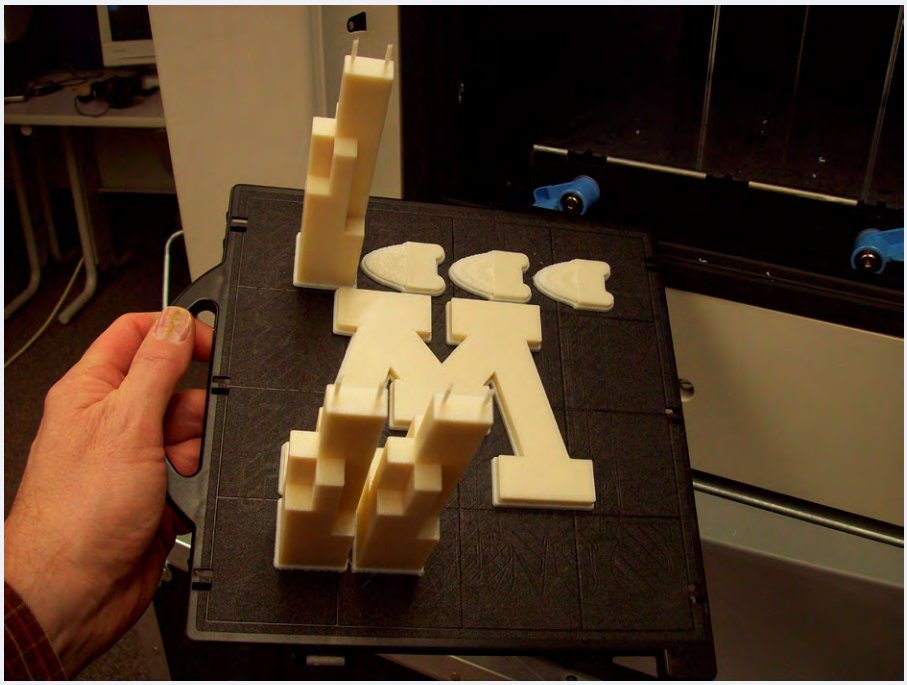
The Case for Buying 3D Printing Technology

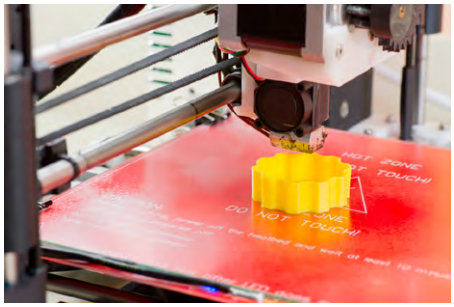
To achieve the desired outcome in 3D printing, you need the right technology. So, how do you go about making a business case to your school or district for acquiring a 3D printer?

Communicate how 3D design and printing will extend the learning in practical ways. Osman advises his peers to answer a fundamental question: "How can they incorporate it with their lesson?" The goal: show how curriculum can be improved through the use of 3D printing. For example, science teachers could teach the parts of the body by printing them out from designs freely available. "Looking at a picture in the book is one thing. When you have it in your hands and you can spin it around and see [the variations], it takes it to a new level."

Promote the results and the potential. Osman promotes 3D printing to parents and others during conferences and school events by showing what the students have produced and allowing them to explain how they produce their gears, cases, tools, frames, name plates and other items. He also leverages videos that feature well-known companies using the same technology students get access to in order to show adults the possibilities for their children's future. Keyzer calls the impact of this outreach the *wow factor*. "The number one thing I hear [is] 'I wish I had that when I was a kid.' It really floors them."

Participate in education research. Several Virginia schools have teamed up with the University of Virginia's schools of education and engineering to launch high-tech labs that introduce advanced manufacturing into K-12. The schools receive technology,





lessons and teacher support; the university gains access to a test bed of students and teachers.

Go after grants to supplement the cost. There's never been a better time to pursue career and technical education grants from companies and the government. That's how Keyzer persuaded his district to provide 3D printing to his classes. A grant that put a high-end 3D printer into his school for a year was parlayed into a discounted purchase through funding made available by the federal Perkins Career and Technical Education Act of 2006 (Perkins IV), which is administered through individual states.

Reduce expense with consortium participation. Osman's school is close to the North Dakota border and part of a consortium of 21 schools that share professional-grade technology. Besides the Dimension 3D printer, the $750,000 collection includes a laser engraver, robotics, hydraulics, a vertical mill, a vinyl cutter and a welding simulator; the components move from school-to-school in a six-week rotation. The program was kicked off through state grants and now is funded through a $3,000 annual consortium fee paid by each member school.

Schools have succeeded in integrating the use of 3D printing into their programs in creative ways:

- by articulating how 3D printer usage will directly tie to lessons and learning outcomes;
- by finding ways to get district leaders excited by showing them the possibilities for 3D printing;
- by teaming up with local colleges and universities to set up "maker" programs;
- by reducing what the district needs to budget by pursuing grants; and
- by seeking consortium options.

Persuading your school decision-makers to consider the addition of 3D printing shouldn't be a barrier to success. The real hurdle will be shooing students out the door of your classroom at the end of the school day.

"This machine is changing how everything is looked at," says Osman. "It takes more math, more science. You start to get kids fired up about it. It is so fun to sit there and watch them. They'll try something and it won't work, and try it and try it and then all of a sudden it does work. You just see the lights come on. That's what it's all about."

About Stratasys

Stratasys® manufactures 3D printing equipment and materials that create physical objects directly from digital data. Its systems range from affordable desktop 3D printers to large, advanced 3D production systems. Its specially engineered 3D printing materials include hundreds of photopolymers and thermoplastics.

Manufacturers use Stratasys 3D Printers to create models and prototypes for new product design and testing, and for low-volume finished goods. Educators use the technology to elevate research and learning in science, engineering, design and art. Hobbyists and entrepreneurs use Stratasys 3D Printing to expand manufacturing into the home — creating novelties, customized devices and inventions.

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