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technically speaking

Vanessa Revelli vanessa@techdirections.com

Welcome back to another school year, readers! Our September 3D printing issue is always a fun one for me. I love researching what new advances the year has brought, and 2017 hasn't disappointed. I wanted to share several of the interesting things I have found.

First off, Eindhoven University in the Netherlands is 3D printing a cycling bridge using reinforced concrete. Manufacturing of the concrete parts has begun, and it's anticipated that bridge construction will start in September. To get to the point where the 3D printed parts were considered reliable, the team at the university first built a 1:2 scale model, which was able to hold 4,400 pounds.

As for why this process is an improvement over standard concrete techniques, printing a bridge will use far less concrete than pouring it into molds. There's an environmental benefit as well. The production of concrete cement releases CO_2, so reducing the amount of concrete that needs to be produced will cut down on those emissions. There's also more freedom of design, as a 3D printer can create shapes that are much harder to produce with a mold.

An additional benefit is that the steel reinforcement cables can be printed at the same time as the concrete parts, leading to pieces that are "pre-stressed" for additional stability. Of course, this bridge is meant for much lighter weights than those that handle auto traffic are meant for – it's not clear that this production technique would be able to scale up to handle a more intense load. But even if 3D printing can only be used for less strenuous jobs, there's still plenty of places where it could be useful.

Another interesting company, Formlabs, who is known for its desktop SLA 3D printers, announced at this year's CES the Form X program, which includes the company's newly released ceramic resin. The resin is an experimental material which produces post-cured prints with a distinctive aesthetic that looks and feels like ceramic. After firing, prints become pure ceramic parts, suitable for glazing. The resin is scheduled to be available sometime this year.

They also showed off some other applications using their 3D printers including a custom bionic arm. The arm was created by GE engineer Lyman Connor who has a goal to make prosthetics affordable for anyone. His journey started when he was released from the hospital after a bicycle accident and happened to meet Sean O'Connor and his mother in the elevator. He tried to lighten the heavy mood "I said, 'Hey, things can't be that bad. Take a look at my face,' because my face was still pretty messed up..." Lyman said. "Right away the boy just raised his hand and said 'At least you were born with your whole hand,' and his mother immediately replied 'If we had $50,000, we'd get you one.' I didn't know what to say." To read about where this chance encounter led him, and to see a video, visit: https://formlabs.com/blog/3d-printing-powered-startup-manufactures-affordable-custom-prosthetics.

Vanessa Revelli

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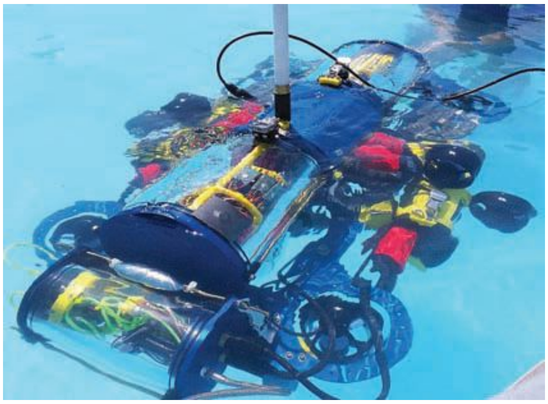

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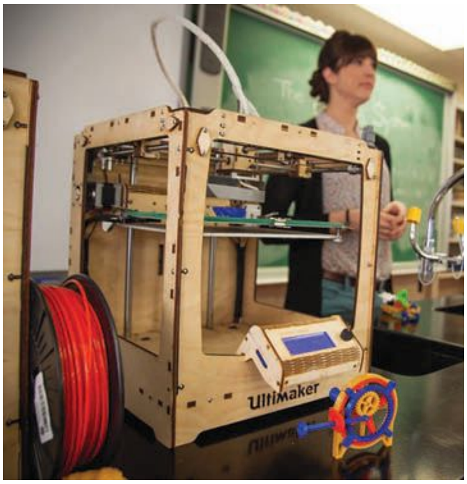

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About the cover: Mark Peeters created a 3D printing process, the drooloop, that was used to 3D print these flowers. For more, see page 12. Photo courtesy of Mark Peeters and Ultimaker. Cover design by Sharon K. Miller.

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the news report

Vanessa Revelli
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Solar Power to Provide Clean, Renewable Energy and Save the School District $5.1 Million in Energy Costs

Lake Park High School District 108 in Roselle, IL, hosted a ribbon cutting event June 15th at Lake Park West High School to celebrate completion of two solar photovoltaic (PV) systems, making it one of the first public school districts in Illinois to adopt solar power on a large scale. The declining installed cost of solar has made this cost effective for the District and will result in an estimated net savings of $5.1 million over 25 years. Both Lake Park West and Lake Park East high schools now have roof-mounted solar panels expected to generate 1.86 megawatts of clean energy. The solar array will provide 2,215,247 kilowatt hours of power to the grid.

The district was looking for ways to dramatically increase the energy efficiency at the East and West campuses and selected Performance Services, accredited with the National Association of Energy Services Companies (NAESCO), to implement a guaranteed energy savings project. Implemented in two phases, energy conservation measures at the high schools included new energy efficient vertical classroom units, lighting upgrades and a cooling tower replacement.

To further reduce energy costs, district 108 pursued the use of solar power and is now distinguished as one of the largest public school solar installations with net metering in Illinois. Solar renewable energy credits (SRECs) will become an income source for the District as they sell excess solar credits to utility companies that need them to meet certain energy use requirements. Expected revenue from excess solar renewable energy credits is projected to exceed $5.1 million over 25 years.

"District 108 has been working for years to model energy stewardship throughout our campuses with energy efficient lighting, HVAC systems and more. This solar project is an exciting and financially sound way to produce clean energy and provide a learning tool for our students," said Lake Park Superintendent Dr. Lynn Panega.

Solar array at Lake Park High School District 108

In addition, a curriculum program developed by the National Energy Education Development (NEED) project and sponsored by Performance Services is available to the district for use in the classroom. "This is an important extension of our value proposition for schools to provide high performing, energy efficient buildings that provide optimal learning environments," said Tim Thoman, President of Performance Services. "The available education component reinforces our commitment to renewable energy and education in a way that directly benefits teachers and students by engaging and teaching how their own school's solar-generated electricity systems work."

This solar project is a continuation of Lake Park HSD 108 initiatives to reduce the District's carbon footprint of its buildings and grounds. The energy produced by the solar array is equivalent to the electricity needed to power an estimated 164 homes in a single year. The project will reduce greenhouse gases by 1,557 metric tons, equivalent to taking 329 cars off the road in a single year.

Calculator Donation Adds Up to a Great Start!

As September approaches, many families, teachers and school districts are tasked with Back to School shopping to prepare for the upcoming school year. For some, the cost of school supplies can be a burden.

The dedicated people at Kids In Need Foundation understand this trying situation. Through their robust network of donors, distribution centers, employees and volunteers, Kids In Need Foundation supported 5.4 million students and more than 150,000 teachers in 2016 with the school supplies those students and teachers needed to have a successful school year.

Victor Technology is proud to partner with Kids In Need Foundation for the 2017-2018 school year with a donation of over 200 Sharp and Victor branded scientific calculators worth $2,600. The donated calculators range from basic scientific calculators needed for algebra classes up to advanced scientific calculators for courses such as calculus, physics and engineering.

Want to help students in your community? Kids In Need Foundation accepts donations from the public. Learn more on their site: www.kinf.org.

Calendar

Oct. 6-8. Magna Teaching with Technology Conference. Baltimore, MD.

Oct. 14. SkillsUSA's WorldSkills Competition. Abu Dhabi, UAE.

Oct. 27-29. ASCD Conference on Educational Leadership. Kissimmee, FL.

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Elon Musk's Boring Company

Some of Elon Musk's projects seemed impossible when he first proposed them, but none of his ideas have ever been boring. His Boring Company is a play on words, where the name of the company sums up what this company will do; that is bore tunnels to move new transportation systems underground. It is no accident that Godot, the new boring machine that his engineering teams have created (see Photos 1 and 2), actually bore tunnels that are the exact size needed for the hyperloop's giant tubes. My May column covered Hyperloop and you will find it online at: www.omagdigital.com/publication/?i=406477&ver=html5&p=8.

Once all the engineering problems and feasibility studies necessary to build a Hyperloop system are completed it is reasonably easy to weld together a system on barren land. However, to connect the city centers of metropolitan areas you would either need to create a construction corridor by ripping down buildings and displacing their inhabitants or move the construction into tunnels underground. People don't want new highways in their backyard; imagine their reaction to their neighborhood being cut in half by the super large steel tubes of a hyperloop system. Look at the photos in my May column and try to imagine such large tubes running down your main street.

Photo 1—Hyperloop One test track

Hyperloop One

The New York City subway system has been up and running since 1904. It is the perfect example of how efficiently people can be moved from one place to another, through a metropolitan area, without destroying neighborhoods if you build the transportation system underground. Elon Musk's ultimate objective when he proposed Hyperloop was the creation of a 21st century land transportation system that could link major cities. Now that it is becoming a reality, Musk has created the Boring Company to dig the tunnels necessary to send Hyperloop or other 21st century transportation systems underground.

He wants to alleviate traffic by using a system of tunnels that will connect multiple points within a metropolitan area. He is now proposing a two prong approach. Where feasible build the transportation system above ground on barren land between cities. When you reach civilization move the transportation system underground so it has access and exit points throughout a metropolitan area just like the NYC subway system.

Hyperloop One

Photo 2—The Hyperloop One test track has 11' diameter cylinders. You can see how big it is compared to team members standing inside and around it.

Elon Musk's Godot boring machine weights 1,200 tons. What makes it significantly different than other boring machines is its size and efficiency at cutting through all different types of rock and soil that it will hit while boring a tunnel anywhere on earth. Godot is now drilling a tunnel near LAX (Los Angeles International Airport) on land that is part of SpaceX's sprawling headquarters. Check out the video at https://www.youtube.com/watch?v=bOHdGp9-0Jo. You can also view a test run through this first tunnel at https://www.youtube.com/watch?v=QI_4HWF42NQ.

As this column went to press, Chicago Mayor Rahm Emanuel just requested a proposal from the Boring Company for an underground

---

Alan Pierce, Ed.D., CSIT, is a technology education consultant. Visit www.technologytoday.us for past columns and teacher resources.

The Boring Company

Photo 3—Side view of Godot, the boring machine that Musk's engineers have created.

transportation system that will connect O'Hare Airport to downtown Chicago (https://www.youtube.com/watch?v=1piaadkGxRM). It is clear that a new transportation system is definitely needed to alleviate traffic congestion and air pollution. U.S. cities and foreign governments might soon keep the employees of the Boring Company from ever having a chance to get bored.

Elon Musk's Hyperloop idea sounded more like science fiction than an engineering proposal when he first published it five years ago. He has proposed another new transportation system when he started the Boring Company that utilized sleds to move people in their own vehicles through Boring Company tunnels. Access and egress from these tunnels would be through street elevators. Since a video is worth thousands of words please watch the video that his team created: https://www.youtube.com/watch?v=u5V_VzRrSBI.

Taking it a Step Further

1. Research the process that the U.S. government uses to acquire land to build a new highway. A possible approach to this research activity is to select a new highway that was built in your area in the last 60 years and determine how your local government procured the land for its construction.

2. Do you feel the sled transportation system that moves personal cars through Musk's tunnels will ever be feasible? Why? Before you answer, remember the Hyperloop sounded just as sci-fi five years ago when Musk first proposed it. Before you answer this question be sure to watch all the videos.

3. In your opinion, would such a system be too claustrophobic for most people to use?

4. If you are in your own vehicle on the sled, how could they create the illusion that you are not flying through an underground tube at nauseating speed?

5. If the sled transportation system was built, would it, in your opinion, alleviate traffic or just cause new lines as people wait their turn for access?

6. Could such a system be safe if non-electric vehicles also have access to this system?

The Boring Company

Photo 4 —Cutting end of Godot. It can cut through all kinds of rock and soil, and not get bogged down in mud or other impediments that clog other machines.

technology's **past**

Dennis Karwatka
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Titus Salt—Manufacturer and Philanthropist

It was not unusual for manufacturing cities in 19th-century Britain to be undesirable places to live. Some had serious air and water pollution problems, as well as poor housing accommodations. But one planned community from that era was so well conceived that it was declared a United Nations World Heritage Site in 2001.

Titus Salt

That community is Saltaire, located about 15 miles west of Leeds. It was built by textile manufacturer Titus Salt on the River Aire during the 1850s. Salt also built a school that has evolved into a modern STEM academy.

Salt was born in 1803 near Leeds. He was raised, with a sister, in a farming family and was educated in the local schools. His father moved the family to nearby Bradford where he became a wool supplier for many of the city's textile mills. The son completed an apprenticeship in 1822 and became his father's business partner two years later.

The younger Salt's job was to locate various types of wool and persuade factory owners to purchase them. He was not always successful in that endeavor, so he opened his own small factory in 1834 to produce a textile that combined alpaca wool with silk and other fibers. The lustrous fabric was so popular with dressmakers that Salt eventually owned five textile mills. He said the key to his success was specialization in fabrics. By the 1840s, he had about 4,000 employees.

Salt married Caroline Whitlam in 1830 and they had six children. He was a private person of few words and uncomfortable speaking to a group. But the citizens of Bradford respected him enough to vote him mayor and a Member of Parliament. Queen Victoria knighted him in 1869.

In each of his elected positions, Salt worked to clean up the air in factory cities by using specialized smoke burners. He had little success with that and decided to construct an entire town that would reflect his idea of an ideal community. He purchased a large tract of land about three miles from Bradford and commissioned a team of architects for his Saltaire project. He decided to construct one large mill and all the necessary community buildings to provide an unprecedented quality of life for his employees.

Salt first built the textile mill between 1851 and 1853. It was an enormous six-story factory with a floor area of over 11 acres. Two huge twin-cylinder 1,800 hp steam engines drove 1,200 power looms. On a good day, the factory produced 30,000 yards of cloth, which measured about 17 miles in length. An adjacent canal and rail line provided the necessary transportation for raw materials and finished products.

Employees at first commuted by train from Bradford

Above, a view of the mill building today

Contemporary view of Salt's employee housing

Dennis Karwatka is professor emeritus, Department of Applied Engineering and Technology, Morehead (KY) State University.

The original Saltaire School

and moved in as houses were completed. It took over 20 years to construct all of the town's stylish buildings, which eventually included 824 comfortable houses, a hospital, library, shops, concert hall, park, and a school to educate 750 boys and girls. The school building had an elaborate front and a playground at the back.

Salt retired from factory activities in 1867 when his city's population was about 10,000. He turned the business over to his children. Salt was once a very rich man but after his death in 1876, his family discovered that his personal wealth was almost all gone. He had used it to build a comfortable community for his employees and gave the rest to charitable causes.

Saltaire merged with the city of Shipley and the current combined population is about 15,000. The textile mill closed and has been repurposed for businesses, offices, restaurants, shops, and an art gallery. The Titus Salt School is in a different building about a mile away and today is a STEM academy for students aged 11 to 18. It has 1,400 students.

Today's Titus Salt School, a STEM academy

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An Ultimate Educator's Guide to 3D Printing

By Lana Lozova

3D PRINTERS open up a new world of possibilities in the classroom. Multi-disciplinary lessons combine core curricula with art and technology to showcase the student's academic skills. We discussed the challenges and rewards of incorporating 3D printing in the classroom with Mark Peeters, a 3D print artist and technology director at Comstock Public Schools in Kalamazoo, MI.

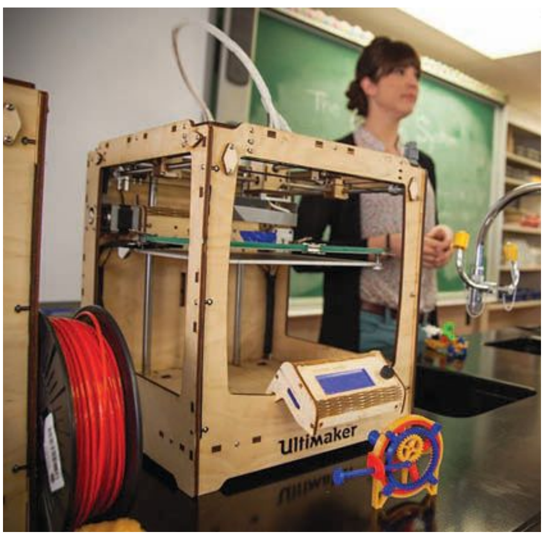
3D Printing in the Classroom: The Challenges

Introducing 3D printing to the classroom isn't always easy. You might think the biggest challenge is the lack of grade-level specific lessons ready for purchase or download, but Peeters sees a greater challenge.

"The main challenge to introducing design and 3D printing into the classroom is time. Time is a precious commodity," sas Peeters.

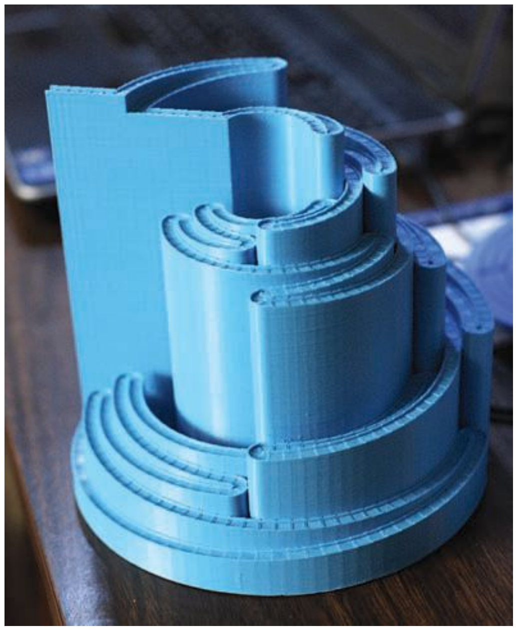
Annually teachers are faced with more educational standards than instructional time in which to teach them. It's a balancing act to decide what receives time and what doesn't make it into the lesson plan. Teachers must also spend training time learning the latest trendy teaching initiative. So, new lessons require personal learning time on the part of the teacher and they must fit into the existing instructional time budget.

In addition, teachers must have a deep understanding of the subjects they present and new technology takes them out of their comfort zone. Unless they are already familiar with 3D design software, slicing software, and the actual 3D printer, they need time to learn.



An Ultimaker Original+ in the classroom

Peeters discovered the best solution to the time challenge is using a team approach to creating lessons. He usually starts with an existing lesson and develops what he calls a "3D enhanced project," or they start with multiple standards to be combined or standards that they want to teach in a deeper or more engaging way. This team approach is carried into instruction where team teaching is used for at least the first few times. This way teachers don't have to be the expert on the technology right away.



A 3D model printed on an Ultimaker

One District's Approach to 3D Printing in All Grades

Peeters thinks that 3D printing should be viewed as any other creative tool such as crayons or modeling clay. His district incorporated 3D printing into the classroom in all

---

Lana Lozova is the Marketing Specialist at Ultimaker, one of the world's leading 3D desktop printer manufacturers, and the developers of Cura *software. Article courtesy of Ultimaker.*

grades. For grades K-8, 3D printing was woven into existing core area curriculum so the printers are part of multi-disciplinary lessons. New lessons continue to be added. Here's their approach.

K-3. At this age, the goal is to make 3D printing part of their everyday reality and less about the technology. Students create 2D designs with basic age-appropriate artwork software. Kids create something personal on the computer and see that design become a physical object to take home and share with their families.

Grades 4-6. *openSCAD* is introduced in 4th grade, which naturally incorporates math and programming. By the time they are in 5th and 6th grade, students use loops, variables, and data arrays to make complex shapes. Starting with 6th grade, students do their own slicing with *Cura* and run their own print jobs.

Grades 8-12. Once students are old enough to use the internet, they use online resources like *Tinkercad*. In high school, 3D Design and Printing is offered to focus on 3D printing tech and software. Students use *openSCAD*, *Tinkercad*, *MeshMixer*, *123D Catch*, *Thingiverse*, and various 2D programs like *InkScape* and *Paint.net*.

Learning CAD design

Guidelines and Resources for Lessons with 3D Printing

Peeters's experience crafting lessons for all grades had led him to identify a set of broad guidelines for developing successful lessons. He's also identified some great resources.

- Lessons should be open ended while still having clearly defined design constraints and goals.
- Students will be creative and will see their own hand in the printed objects.
- Lessons are tied to one or more existing core curriculum standards. 3D printing shouldn't be the only outcome.

▶

• Age appropriate software is used, scaffolding when needed with templates or starter files.

• Lessons build in complexity from grade to grade, reinforcing previous skills while introducing more tools and deeper ways of using existing tools.

• It's OK if the lesson is team taught by technology staff and teaching staff. It's a huge treat for the tech staff who normally don't get to work with kids and can help teaching staff get comfortable with the new technology. It's good for kids to see adults working as a team since they are often asked to work in teams themselves.

Peeters finds that the best resources for creating lessons are teachers, product manuals, and the Ultimaker online forum. He brainstorms with teachers to decide what standards to cover and what the printed object will be. Then he chooses the best age-appropriate workflow and identifies what might need to be taught.

He finds software documentation to be a great resource for creating templates for younger kids or streamlining production flow. Peeters describes the Ultimaker forum as "a very active online forum filled with kind and generous users that I have turned to for help many times." He makes it a point to tell others about his own struggles and how he gets help from the forum as an example of life-long learning and how to learn something that isn't in a book.

Peeters has created the "Drooloop" process, used to 3D print these flowers. For directions on making your own, visit https://ultimaker.com/en/resources/20921-drooloop-flowers

The Perfect Classroom 3D printer

We asked Peeters what he thinks makes a good 3D printer for the classroom and why he prefers the Ultimaker Original+. Here's what he looks for in a 3D classroom printer.

• **Reliability.** Machines should have low downtime and be end user serviceable. When the printer isn't happy, nobody is happy.

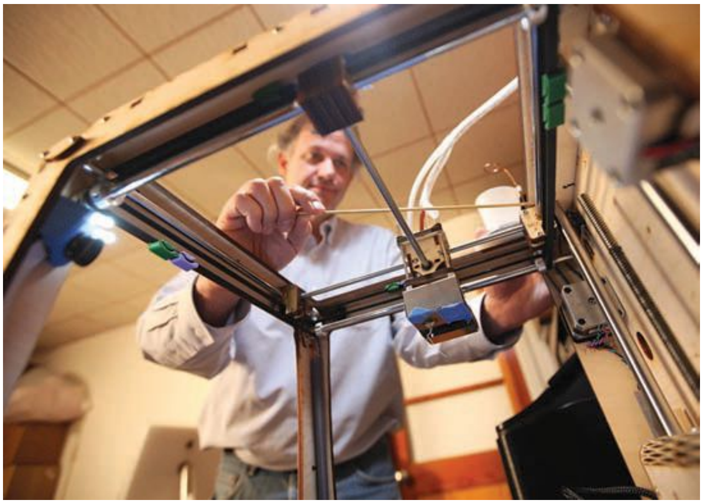
• **Precision and accuracy.** Every kid deserves a good print of their model. The first print should be as good as the 500th.

• **Speed and build volume.** When printing for a class of over 25 kids, you need to print several objects at a time.

• **PLA printing.** You are printing in a closed environment around children. Non-toxic fumes and biodegradable materials are a necessity.

• **Open-source.** You want no limits on the depth of tinkering a student can do.

The Ultimaker Original+ is a great printer for schools. It strikes a perfect balance between reliability, durability, and cost. It comes as a kit which is really nice because building the printer is extremely educational, fun, and empowering.



Peeters working on an Ultimaker Original.

Seeing a 3D printer in action is just fascinating.

Importance of open source

"With an open source 3D printer, there will never be a student question that they or myself will not be allowed to get the answer to. An interested student can use the Ultimaker as an entry point to learn more about robotic controls, g-code language, stepper motor control, all the math that the firmware does to calculate accelerations of the tool path, how PID and PWM controls work, etc. The list goes on and on," says Peeters.

Benefits to the Classroom and Learning

The benefits of using 3D printing in the classroom are undeniable. According to Peeters, it lies in student

A 3D-printed chess piece featuring Peeters' drooloop technique

engagement and ease in creating multidisciplinary lessons. Kids are more willing to play and experiment with concepts since they want to make cool 3D printed objects.

Affordable open source 3D printers change the educational process. A world of ideas and possibilities is opened to young and idea-filled minds. Students are exposed to cutting edge technology that doesn't bust the budget and teachers have an exciting platform for building multidisciplinary lessons for all ages.

Building an Ultimaker Original in the classroom

Building Robot Subs, Reinventing STEM Learning

Learn how the robotics team at Carl Hayden High School uses 3D printing to push the boundaries of STEM learning, mastering the skills that ensure success in a rapidly changing world.

By Josh Snider

HIGH school robotics teams have never been more popular, and perhaps none are more impressive or well known as the talented crew of 9th-12th grade students in Phoenix, AZ, that make up Falcon Robotics. Led by the inspiring coach Faridodin “Fredi” Lajvardi (Lah-jeh-var-dee), a marine science teacher at Carl Hayden High School, Falcon Robotics was catapulted to notoriety in 2004 when they competed as underdogs against high schools and universities to win a national championship.

The school shocked the STEM establishment, and their Cinderella story was widely covered on ABC Nightline, *Wired* magazine, and even the 2015 film *Spare Parts*. Now 13 years later, Falcon Robotics is a titan incumbent in the FIRST Robotics series, and has been dipping its toes in robotic submarine competitions like RoboSub, sponsored by the Office of Naval Research and AUVSI.

“Falcon Robotics works sort of like a small company” coach Fredi explains. “Different teams collaborate to design things like navigation software or propulsion systems, solving smaller problems, then fit them together to solve the broader challenges set out by the competition.” With access to reliable and intuitive MakerBot 3D printers in their growing makerspace, this team is able to learn new skills while prototyping robots at a breakneck pace.

Dividing into 3D design, mechanical, software, and marketing teams, the club is equipped with a computer lab and a makerspace that sports a CNC machine and 3 MakerBot printers. Year after year, they continuously iterate on their robosub, HABOOB (Arabic for sandstorm), and improve on its ability to perform different autonomous, underwater tasks.

Shop class used to build spice racks, now robotics class prototypes drone submarines.

Before they had 3D printers, their various robot parts had to be made from metal at a local machine shop or outsourced to a 3D printing service. The parts worked, but outsourcing the creation of their designs didn’t give students the level of hands-on experience, ownership, and feedback they needed. Plus, outsourcing for metal or 3D printed parts was expensive, took weeks, and was unforgiving to making adjustments on different iterations.

Once students were able to make parts in-house, they were shocked by how easily and quickly their MakerBot printers could deliver physical objects. Remarking on how that change affected the team’s learning outcomes, Fredi elaborates that “the reduction in time and skill needed to create objects increased the students’ learning cycles. They are able to jump right in again and design modifications or go on to new challenges.”

Speed is critical in engineering sprints like robotics competitions, and access to MakerBot printers enabled Falcon Robotics to fail early, learn from their mistakes, and fix them fast—the same process that makes R&D projects successful in industries from aerospace to consumer product design. Fully utilizing MakerBot printers accelerates the proto-

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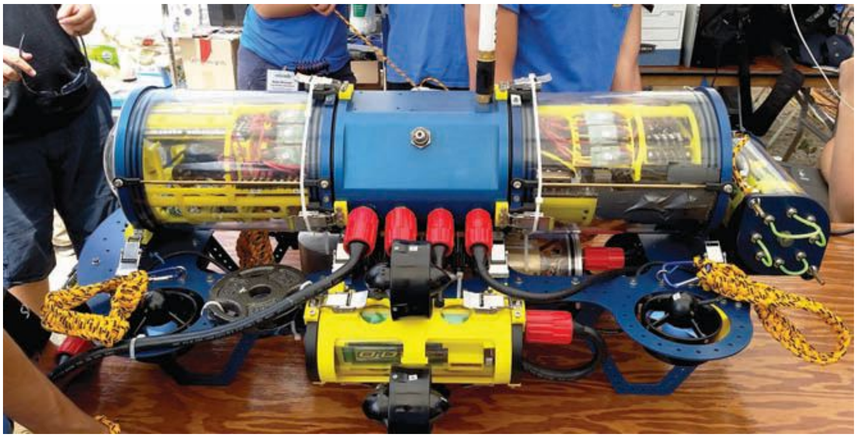
Josh Snider is a NYC-based writer, marketer, and MakerBot’s public relations manager. Republished courtesy of MakerBot.

typing and design cycle in the same way it accelerates student learning.

The HABOOB is a vehicle for various learning styles and STEM objectives. Designing an effective torpedo launcher isn't about training the team for specific careers, it's about training them for any and every career. There's CAD involved in designing a torpedo, physics in figuring out its center of gravity and buoyancy, but the true lesson is in knowing how to approach a problem and how to point all of your grit, skills, and resources in the right direction until you solve it. Fredi summarizes it well, noting that “the interpersonal and analytical skills they build upon in this club are the kind that will carry them to success in any job, any industry.”

Problem solving is the goal, 3D printers are the tools, robotics is just the medium



With MakerBot, classes learn like students but perform like professionals.

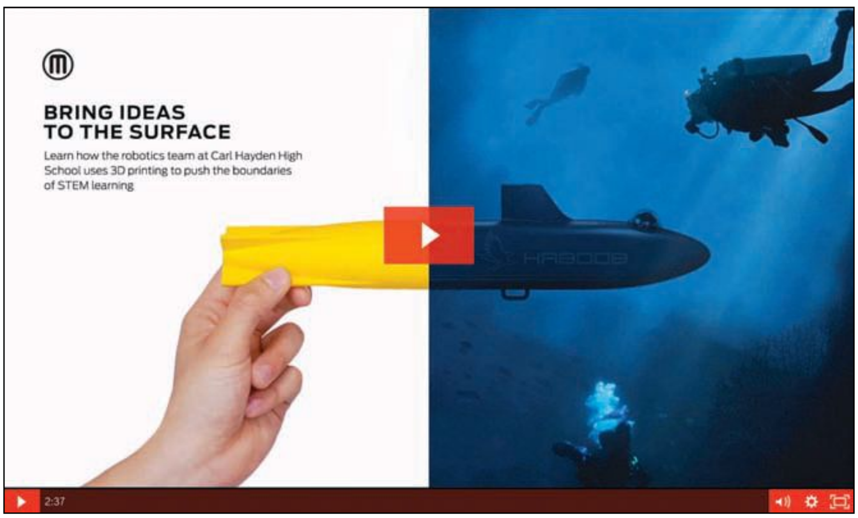
3D printing is an invaluable tool for improving student engagement and revealing their potential as dynamic thinkers. At first, team Falcon's torpedoes were poorly balanced with bad hydrodynamics and an unreliable launching mechanism. By using a variety of MakerBot printers, they were able to test and refine designs in only a week, solving a challenge that would have otherwise taken more than a month.

The team's 3D printers speak to their unlimited potential, but they're also a symbol of their adaptive mindset. From the internal lattices that organize the sub's onboard electronics to the external pieces that support its battery and propulsion, the HABOOB is designed to be easily modified so that when team Falcon gets next year's challenge they can 3D print new, tailored parts without a complete overhaul.

Intuitive software and reliable hardware are essential to a makerspace and are especially important to a robotics team that's under the gun to build a submarine. MakerBot is leading the way by innovating shorter learning curves and simpler workflows, all things essential for schools to implement and get the full value from their 3D printers.

It's easy to be in awe of engineers tackling the technical challenges of autonomous vehicle design, but when those engineers are 10th-graders in high school, it's downright impressive.

With MakerBot solutions, Falcon Robotics is able to learn faster, enhance their STEM skills, and learn broader problem solving skills—all while tackling professional level rapid prototyping and engineering.



To see more about Falcon Robotics, click the image above.

STEM Defined

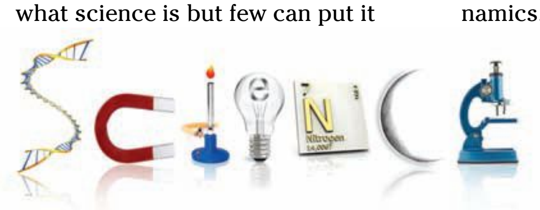
Helping Students Explain STEM

By Phillip Jelinek
pjelinek@calautoteachers.com

I HAVE attended many STEM symposiums and have discovered that after students explain their projects, they are unable to separate which part of their project is either the science part, the technology part, the engineering part, or the math part. To improve understanding, here are some definitions you can share with your students.

Science!

Many people believe they know what science is but few can put it into words. They believe that science has variables and is subject to opinions or preferences. Nothing could be further from the truth. Science has to do with the laws of the universe that have NO exceptions! If there are any exceptions, it just is not a science law.



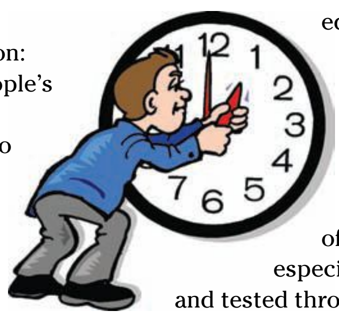
Consider the simple question: Can we change time? Most people's first response would be to say no! Then I ask them what we do each November and March? We change time.

Some people say yes! To them I ask, can we change the physical time it takes the Earth to rotate one revolution? We could change the 24 divisions of that day we call hours into 10, 20, or 50, but we can't change the time of the actual 24-hour day.

The correct answer would be another question: what do you mean by "changing time"?

These are the laws I am talking about, laws that have no exceptions, opinions, or preferences: the Laws of Fluid Dynamics, the Three Laws of Motion, the Four Laws of Thermodynamics, and the Laws of Gravity, to name a few.

So what is science? ***Science is a systematic and logical approach to discovering how things in the universe work.*** The word "science" is derived from the Latin word *scientia*, which translates to knowledge. Unlike the arts, science aims for measurable results through testing and analysis. According to Webster's New Collegiate Dictionary, the definition of science is "knowledge attained through study or practice," or "knowledge covering general truths of the operation of general laws, especially as obtained and tested through scientific method [and] concerned with the physical world."



So here is a simple sentence to help you understand what science is: Science deals with the physical laws of the universe where there are no exceptions, opinions, or preferences.

Technology!

Technology today has come to mean some sort of electronics, which by and large means computers. Is that really what technology is? We need to change this perception. In the 16th century, the lead pencil was considered the latest technology of its day. Paper clips, circa 1867, were the technology of their day.

On the third day of class, I presented the Six Simple Machines to my students. They can be defined as "the simplest mechanisms that use mechanical advantage to multiply force." These six simple machines go back to the third century BC. They are: the lever, wheel and axle, pulley, inclined plane, wedge, and screw. Knowing them will change the way you look at your world.

These six simple machines are a foundational technology and can be regarded as the elementary building blocks for complicated machines.

Let's take the first one, the **lever**. From it, we get the term *leverage*; it is used throughout the automobile and the tools we use to repair it. There are three types or classes of levers, according to where the load and effort are located with respect to the fulcrum. Class 1 has the fulcrum placed between the effort and load. Class 2 has the load between the effort and the fulcrum. Class 3 has the effort between the load and the fulcrum (Fig. 1).

Do some research to find out how many levers are around you at home, in your vehicle, and at school. They are everywhere from the scissors we use (Class 1), to the diving board at a pool, to the shovel used to dig up

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Phil Jelinek, who is now retired, was an award winning automotive instructor for over 25 years. This article is a combination of articles published in the January, February, and March 2016 issues of ATech Educator News.

dirt (Class 3), to the wheelbarrow (Class 2) into which we put the dirt.

The **Wheel and Axle**: You don't have to go far for this one, all you have to do is turn a door knob. In the automobile, we have a steering wheel, with the axle being the shaft to the steering mechanism (Photo 1). Then we have the drive axle turning the wheels of the vehicle.

Pulleys: While we are familiar with sailing ships using blocks and tackles to support masts and to raise and lower sails, we use a belt and pulley system on our engines to turn water pumps, power steering pumps, cooling fans, and alternators that are mounted at the front of engines (Fig. 2, Photo 2).

Inclined Plane: Also known as a ramp, an inclined plane is a flat supporting surface tilted at an angle, with one end higher than the other, used as an aid for raising or lowering a load. We have many examples of inclined planes: on/off ramps and roads up mountains (Photo 3), driveways, loading ramps, and skate parks. The concept is that it is easier to push/pull something up a ramp than to pick it straight up.

Wedge: A triangular-shaped tool, a wedge is a portable inclined plane. It functions by converting a force applied to its blunt end into forces perpendicular to its inclined surfaces. We use wedges to split logs, raise the corners of machines, and to keep the head on hammers (Fig. 3, Photo 4).

Screw: A screw is a mechanism that converts rotational motion to linear motion. It is an inclined plane wrapped around a rod. The longer the inclined plane, the closer the threads are together. Coarse screws go in faster but don't have the clamp-

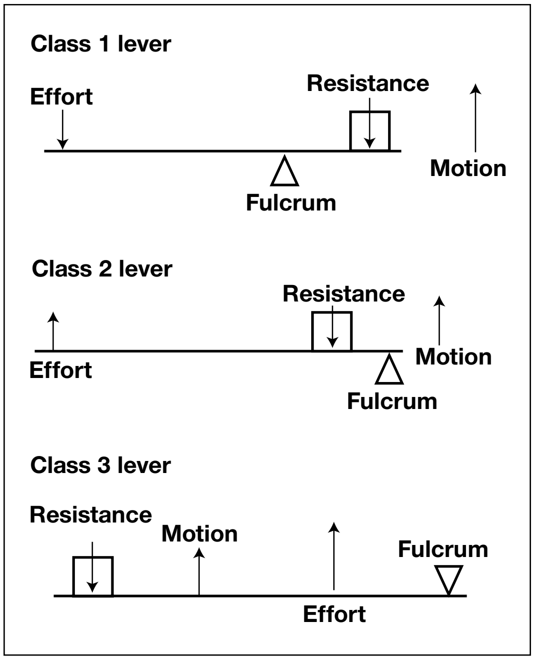


Fig. 1—Types of levers

Photo 1—Wheel and axle example

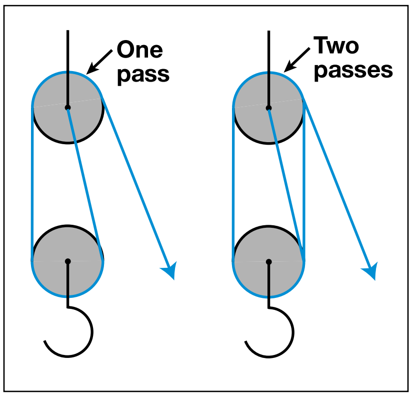


Fig. 2—Pulleys

Photo 2—Pulley example

Photo 3—Inclined plane example

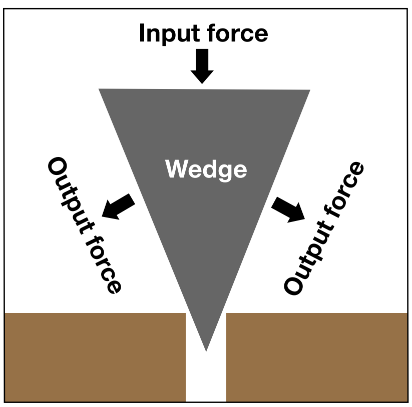


Fig. 3—Wedge

Photo 4—Wedge example

ing strength. Fine thread takes longer to go in but has greater clamping strength. This knowledge, along with a couple of models (Photos 5 and 6), will go a long way to help students understand the differences between coarse and fine thread bolts and screws.

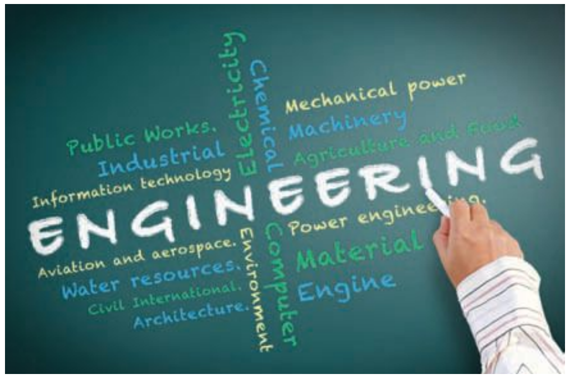
Photos 5 and 6—Showing how a screw is an inclined plane wrapped around a rod

So we can define technology as the "What"—tools, machines, techniques—that are used to solve problems and perform functions.

Engineering!

Engineering combines the fields of science, technology, and math to solve real world problems that improve the world around us. Engineers apply the Laws of Science, using the technology available to them and applying mathematics to develop economical solutions to technical problems.

According to the Bureau of Labor Statistics, there are 17 engineering categories: Aerospace, Agricultural, Architectural, Biomedical, Chemical, Civil, Computer Electrical/Electronic, Environmental, Health and Safety, Industrial, Marine, Materials, Mechanical, Mining/Geological, Nuclear, and Petroleum.



Engineering is the "who" and the work of engineers is the link between scientific discoveries and the commercial applications that meet societal and consumer needs.

People who invent make prototypes and are able to get the principles of theory and design across, but these prototypes are not able to handle the rigors of continual usage of the public. So engineers bridge this gap.

Math!

Math is probably the most misunderstood of the sciences. To many, it is difficult, scary, or unfathomable. To others, math teaches, instructs, and opens doors to wonders beyond our understanding without it. Sir Isaac Newton (1642–1726), one of the most influential scientists of all time, laid the foundation for classical mechanics. He formulated the Laws of Motion and Universal Gravitation (gravity), which dominated scientists' view of the physical universe for the next three centuries.

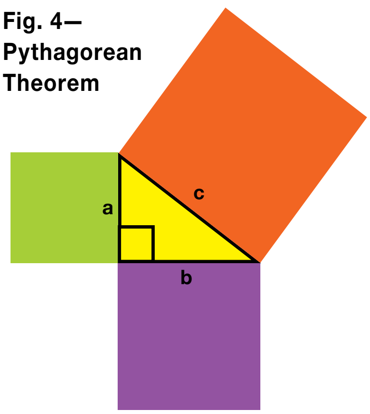
In order to explain to other scientists the Laws of Motion and Universal Gravitation, he needed to create a new language. That language was calculus! Galileo Galilei (1564–1642) said it best: "The universe cannot be read until we have learned *the language* and become familiar with the characters in which it is written. It is written in mathematical language, and the letters are triangles, circles, and other geometrical figures, without which means it is humanly impossible to comprehend a single word. Without these, one is wandering about in a dark labyrinth."

Like any language, you first have to learn the "alphabet". Math's alphabet are the "letters' we use to make all the "Words." These letters are: 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0. We call it the decimal system since it has 10 "letters". We put the "letters" together to make "words." 12 is a math "word", when we put letters from our own alphabet with them, they make it meaningful, like 12 a.m.

The "sentences" are the formulas we use with the letters to make sense of the world around us, such as the Pythagorean Theorem: $a^2 + b^2 = c^2$ as stated in math language, or as stated in our words: In a right-angled triangle, the square of the hypotenuse is equal to the sum of the squares of the other two sides (Fig. 4).

Math is all around us; it is the building block for everything in our daily lives, including mobile devices,

Fig. 4—Pythagorean Theorem



architecture, art, money, engineering, and even sports.

What would we do without math? It tells us the size of the football field, how to keep score, the size of the ball, and more. Math tells us how fast we are going, especially in a vehicle, say 70 mph. We use math to tell time throughout the day, when to do or not do things.

Part 1

How Does FERPA Affect You?: 2017

By Thomas V. Toglia
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IT'S been 10 years since the article "How Does FERPA Affect You?" appeared in **techdirections**. During this time Career and Technical Education (CTE) and STEM instructors and administrators have applied the guidance offered to numerous real-world classroom situations. The information I provide here updates various components of the Family Educational Rights and Privacy Act (FERPA) and how they apply to situations frequently encountered by CTE and STEM educators. (Note that I do not intend this as legal advice and recommend consulting a lawyer if a legal issue arises).

While much of the original information is still relevant, FERPA has been amended several times since 2007. Additionally, over the last 10 years the Family Policy Compliance Office (FPCO) of the Department of Education has produced a number of guidance letters, and several court cases have shed light on individual FERPA issues. Specifically, clarity has been provided regarding how FERPA applies to health and safety emergencies, email, social media, video surveillance of hallways and school busses, dually-enrolled students, requests for public records, and its intersection with Section 504, the ADA, Title IX cases involving harassment and discrimination, and the Clery Act.

FERPA, also known as the Buckley Amendment, was enacted in 1974 to oversee the privacy, discharge, and accuracy of educational records. Many administrators and instructors that manage CTE and STEM programs are uncertain how FERPA applies to their secondary and postsecondary students. Moreover, because today nearly all student records are digitized and communicated electronically, CTE and STEM instructors have an even greater responsibility to protect students' privacy to avoid discrimination, identity theft, and unauthorized disclosure (U.S. Department of Education, n.d.).

Many administrators and instructors that manage CTE and STEM programs are uncertain how FERPA applies to their students.

CTE and STEM programs present unique challenges regarding the privacy of student records. For example, personnel involved in CTE and STEM education are often called upon to write recommendation letters, and must interact with employers participating in various work-based training initiatives. Also, because of tech prep agreements and other such collaborative endeavors engaged in by postsecondary institutions with dual-enrolled secondary students, instructors can be faced with differing criterion regarding the disclosure of information under FERPA with students and parents.

FERPA Overview

FERPA guidelines apply to elementary, secondary, and adult students in public and private institutions that receive federal funds and provide very explicit regulations regarding the privacy and release of students' educational records (Hall & Marsh, 2003). FERPA defines an "education record" as "records that contain information directly related to a student and which are maintained by an educational agency or institution or by a party acting for the agency or institution" (U.S. Department of Education, 2011, p. 2).

More specifically, education records may include a student's date and place of birth; parental information; grades, test scores, and courses taken; special education records; disciplinary records; medical and health records; attendance documentation, schools attended, awards, and degrees earned; and personally identifiable information such as the student's identification code, social security number, picture, and other information that can used to identify the student (NSBA, 2017). These records may appear in handwriting, print, computer media, video or audio tape, film, microfilm and microfiche and are not necessarily maintained in an official student file, but may be in a teacher's pos-

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session (Hall & Marsh, 2003). Equally important, there are certain types of documents that FERPA does not define as education records. These include sole possession notes made by teachers such as grade books, treatment records pertaining to adult students (e.g., notes from a physician), records developed by law enforcement agencies, employment records pertaining to student employment, and alumni records (Hall & Marsh, 2003).

The release and access procedures governing these records are quite different depending on the age of the student. For example, parents and legal guardians of students under the age of 18 have the right to inspect and review their child's educational records, and they can request that a school make corrections to records they believe are inaccurate or misleading. Also, in most cases involving minors, schools must obtain parental permission to release information from a student's educational records (U.S. Department of Education, 2015). Once the student reaches the age of 18 or enrolls in a postsecondary institution, they are designated as an "eligible student" and the rights of privacy and consent provided by FERPA are transferred to the student (NSBA, 2017). When students are dually-enrolled (e.g., a current high school student taking courses at a local community college) the FPCO has provided specific guidance regarding FERPA records. In this situation, the student has the rights regarding records at the college, but the parents retain the rights to records held at the high school. Also, FERPA allows the college and the high school to share information (FPCO, 2012).

There are exceptions where FERPA allows institutions to disclose educational records without the consent of parents or an eligible student. These parties or circumstances include:

- school officials with legitimate educational interest;
- other schools to which a student is transferring;
- specified officials for audit or evaluation procedures;
- appropriate parties in connection with financial aid to a student;
- organizations conducting certain studies for or on behalf of the school;
- accrediting organizations;
- to comply with a judicial order or lawfully issued subpoena;
- to the parents of a "dependent student" as defined by the Internal Revenue Service;
- appropriate officials in cases of health and safety emergencies; and
- state and local authorities, within a juvenile justice system, pursuant to specific state law (Meyers, 2016).

The stipulation containing "legitimate educational interest" requires further consideration. Hall and Marsh (2003) report that school officials have a legitimate educational interest if it is "…specific to their duties" (p. 296). For example, counselors and academic advisors may review educational records of students with whom they are working to assist in planning courses of study, but it would not be considered a legitimate educational interest for the registrar to randomly browse student records (Hall & Marsh, 2003).

There is one notable exception to the release of "personally identifiable information" which relates to compliance reporting in accordance with the Carl D. Perkins Career and Technical Education Improvement Act of 2006 and the Workforce Innovation and Opportunity Act (WIOA). As performance indicators, both Acts require certain wage and employment data that are linked to a student's social security number. To satisfy these accountability mandates, the Department of Education provides guidance regarding the disclosure of FERPA protected information for performance accountability purposes (Joint Guidance, 2016). Essentially, operating under the "audit or evaluation" exception, an authorized representative of a state or local education authority may be provided access to a student's personally identifiable information from education records in order to audit or evaluate a federal- or state-supported education program.

FERPA also permits what is known as "directory information" to be disclosed without specific consent of the parent or eligible student. Directory information is identified as information "…contained in an education record of a student that would not generally be considered harmful or an invasion of privacy if disclosed" (AACRAO, 2006, pp. 7-8). Directory information may include a student's name, address, telephone number, email address, date and place of birth, photograph, major field of study, full- or part-time enrollment status, dates of attendance, degrees, honors, awards, and the weight and height of athletes.

However, directory information may never include a student's race, gender, social security number, grades, GPA, country of citizenship, or religion (AACRAO, 2006). Also, in 2011 FERPA was amended to add to directory information a student identification number or other personal identifier displayed on a student's ID badge as long as the ID number cannot be used to gain access to education records unless used with additional factors that authenticate the student's identity, such as a PIN or password.

Although it is permissible to release directory information without prior consent, institutions must notify parents and students regarding the types of information the school or college has designated as directory information and provide parents and

There are exceptions where FERPA allows institutions to disclose educational records without the consent of parents or student.

eligible students with procedures to opt-out of the release of all or part of its contents (NSBA, 2017). However, to maintain a safe and orderly environment, parents or students “may not opt-out or otherwise prevent…an institution from requiring students to wear [ID] badges that are designated as directory information” (Feder, 2013, p. 4). Likewise, FERPA does not allow a student to opt out of directory information in order to remain anonymous in a face-to-face classroom or online.

At the elementary and secondary levels these rights are communicated annually to parents by formal letter. Community and technical colleges and universities usually publish this notification in student handbooks, course schedules, college catalogs, and post it at the institution’s website.

FERPA’s Relation to Other Federal Laws and Enactments

Since FERPA’s enactment in 1974, it has been amended several times in light of new developments. Also, in the past 43 years much has occurred legislatively and in public policy. As such, additional laws and regulations have evolved that now intersect with FERPA and present new challenges for CTE and STEM educators working with students in the twenty-first century. Specifically, the USA Patriot Act, Every Student Succeeds Act (formerly the No Child Left Behind Act), Protection of Pupil Rights Amendment, the Health Insurance Portability and Accountability Act, the Improving Educational Results for Children with Disabilities Act, Section 504, the ADA, Title IX, and the Campus Security (Clery) Act all include legislation that redefine or extend the privacy provisions afforded by FERPA.

Due to the events that occurred on September 11, 2001, colleges and universities began receiving an increased number of requests for information regarding students that are attending their institutions. These requests raised new questions related to FERPA and the release of educational records. As a result, the Uniting and Strengthening America by Providing Appropriate Tools Required to Intercept and Obstruct Terrorism (USA Patriot) Act of 2001 amended FERPA to allow federal law enforcement officials, with a court order, access to educational records “without the consent or knowledge” of the parents or eligible student when investigating alleged terrorism (Kaplin & Lee, 2014). Prior to this amendment, school officials were required to notify parents and eligible students when educational records were disclosed to law enforcement officials possessing subpoenas. Additionally, Section 507 of the USA Patriot Act released educational institutions from their duty to record such disclosures and from any liability associated with the production of educational records relevant to an authorized investigation of terrorism (Kaplin & Lee, 2014).

In 2009, particularly due to an increase in campus violence and school shootings, FERPA was amended to provide significant guidance regarding the release of personally identifiable information without consent in cases involving health or safety emergencies. More specifically, this FERPA exception was essentially in response to the 2007 Virginia Tech shootings where it was later determined that information that may have prevented this disaster was not shared because many faculty and staff were afraid they would be violating FERPA if they disclosed detailed mental health information regarding the shooter. As a result, the new guidance clarified that institutions "could disclose personally identifiable information, without consent, from education records to appropriate parties, including parents, whose knowledge of the information is necessary to protect the health and safety of the student or others" (Rinehart-Thompson, 2009, ¶ 9).

While this FERPA exception has the potential to save numerous lives, it does come with certain guidelines. The Amendment indicates that "within a reasonable period of time after a disclosure is made [the] institution must record in the student's education records the…threat that formed the basis for the disclosure, and the parties to whom the information was disclosed" (U.S. Department of Education, 2011, p. 4). Also, it is the health and safety exception that allows institutions to include personally identifiable information in timely warning (emergency alert) messages sent to all personnel and students during an active emergency as described in the Campus Security Act.

Another significant Act that amended FERPA guidelines is the No Child Left Behind (NCLB) Act of 2001. Specifically, the NCLB Act (reauthorized in 2015 as the Every Student Succeeds Act [ESSA]) requires schools to provide certain "directory information" (names, addresses, and phone numbers) to military recruiters. However, the ESSA also stipulates that educational institutions must notify parents of this requirement and provide parents the opportunity to opt-out of this disclosure (U.S. Department of Education, 2017). In addition, the ESSA requires schools to transmit disciplinary records of students transferring to any public or private school. The ESSA further requires schools to provide evidence to the U.S. Department of Education that a plan to transfer these records is in place and that schools notify parents in their annual FERPA communication that such disclosure will occur.

The Every Student Succeeds Act (ESSA) of 2015 continues to provide parents and children additional rights to privacy regarding certain types of student surveys under the Protection of Pupil Rights Amendment (PPRA) of 1998. According to these provisions, schools conducting surveys funded by the U.S. Department of Education must obtain written permission before minor children can participate in surveys that reveal personal information related to political affiliations, mental and psychological problems, sexual behaviors, religious practices, and certain other behaviors, practices, and legally recognized privileged relationships. The PPRA, as amended, also gives parents the right to inspect surveys and opt-out of any survey regardless of the funding source; and gives parents the right to opt their child out of any non-emergency invasive physical examinations not necessary to the immediate health and safety of the student. Furthermore, these additional rights under the PPRA must be communicated directly to parents by U.S. mail or email (NSBA, 2016). Importantly, FERPA and PPRA work to together to protect student privacy. In practical terms "…FERPA protects information the school already has on record and PPRA protects information that schools do not have but can collect" (Garcia-Kaplan, 2015, ¶ 3).

FERPA also has a connection with the Health Insurance Portability and Accountability Act (HIPAA) of 1996. HIPAA was enacted to ensure that individuals have access to their health records and that information contained in those records is not available to unauthorized persons (Teeter, 2017). While the provisions stipulated in HIPAA apply to all individuals, HIPAA specifically indicates that health information regarding minors and eligible students that is maintained by schools is part of the student's "education records" and therefore is no longer subject to HIPAA regulations, but rather falls under all previously discussed policies related to the privacy of educational records defined in FERPA.

Together, HIPAA and FERPA ensure that all individuals are afforded privacy regarding the management of their health records. For example, health information entered by a school nurse becomes part of the student's educational record and is therefore governed by FERPA. In contrast, if health care is available on school property, but is provided to non-students, the disclosure of the non-student's identifiable heath information does not fall under FERPA (which applies only to student records), but rather is subject to HIPAA guidelines (Teeter, 2017).

The reauthorized Improving Educational Results for Children with Disabilities Act (IDEA) of 2004, often referred to as the New IDEA, calls for increased fair record-keeping procedures and confidentiality regarding the records of students with disabilities. These records may include formal and informal assessments, anecdotal records, behavior lists, and checklists. Importantly, "all records pertaining to services provided under the IDEA are considered "education records" under FERPA [and] are therefore subject to the confidentiality provisions of both Acts" (National

HIPAA was enacted to ensure that individuals have access to their health records and that those records are not available to unauthorized persons.

Forum on Education Statistics, 2006, p. 6). Clearly, as more students with special needs are served by inclusive education, CTE and STEM instructors and administrators will need to stay well-informed regarding students' and parents' rights.

Similar to the application of FERPA to IDEA at the secondary level, there are certain FERPA privacy concerns that apply to postsecondary students being served by Section 504 of the Rehabilitation Act and the Americans with Disabilities Act (ADA). Essentially, in addition to Section 504 and ADA confidentiality protocols, FERPA normally prevents the institution's disability office from disclosing a student's underlying disability. Disability office personnel may only provide faculty with the specific accommodations as detailed in the accommodation plan. However, under FERPA, a faculty member may be permitted to inspect a student's disability office records if the student consents or without consent if the faculty member is identified as a person with a "legitimate educational interest" (U.S. Department of Education, 2004, ¶ 13).

Lastly, Title IX, which states that "no person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving federal financial assistance" (Kaplin & Lee, 2014, p. 805) becomes a potential FERPA issue of interest when institutions, in compliance with Title IX, notify harassed students of the outcome of an investigation. However, Helfrich (2013) summarizing the U.S. Department of Education's Office for Civil Rights (OCR) guidance in this matter states "…that sharing such information does not violate FERPA as the outcome of the complaint directly relates to the student who made it. Therefore, this means that a school may share with a student who made a substantiated complaint of sexual harassment that the harassing student has been disciplined and what discipline has been imposed" (Helfrich, 2013, ¶ 4). Moreover, the U.S. Department of Education specifically states:

Together, HIPAA and FERPA ensure that all individuals are afforded privacy regarding the management of their health records.

FERPA continues to apply in the context of Title IX enforcement, but if there is a direct conflict between the requirements of FERPA and the requirements of Title IX, such that enforcement of FERPA would interfere with the primary purpose of Title IX to eliminate sex-based discrimination in schools, the requirements of Title IX override any conflicting FERPA provisions. (2001, p. vii).

Part 2 of "How Does FERPA Affect You?: 2017" will appear in the October issue of **techdirections**.

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Educating the Next Generation of Technologists

By Charles Eaton

RARELY does a day pass without a headline in the technology trades, business magazines, or newspapers about the tech skills gap. Some sources claim there may be as many as half a million unfilled IT jobs open in the U.S. at any given time.

Compounding the issue, the U.S. Bureau of Labor Statistics projects that IT occupations are expected to grow 12 percent by 2024. We also know that many in the tech industry are now nearing retirement age. If most of these tech-related positions go unfilled now, how will we ever close the tech employment gap?

As this gap grows, many parents of teenagers worry about what their kids will do for a living after college —if they can even afford to go to college in the first place. These parents, a group to which I belong, live at a time when College Board statistics tell us that tuition at a private four-year institution costs about $44,000 a year. More than 40 million people are carrying a combined total of more than $1.3 trillion in debt from student loans.

Like the tech skills gap, this situation is daunting and unprecedented. Yet, as the CEO of a philanthropic organization in the IT realm —and a parent with four kids, two of whom are approaching their tweenage years —I'm optimistic. Why? Because some of Generation Z, the large and culturally diverse cohort of children born during the mid-90s and later, is ready to start work. Already making up a quarter of the U.S. population, Gen. Z-ers will account for more than 20 percent of the workforce in the next five years.

> **How do we get Gen. Z-ers onto a tech career path, and who will influence this rising generation the most?**

How do we get Gen. Z-ers onto a tech career path, and who will influence this rising generation the most? Turns out, it's their parents, with teachers coming in second ahead of peers and other family members. According to the "Teen Views on Tech Careers" study from Creating IT Futures, teens rely on their parents for career advice 2:1 over any other source. While not as influential as parents, teachers have the edge on friends and all other categories included in our research—even guidance counselors and coaches.

What should parents and teachers tell kids about technology careers? We believe they should be leading kids to become more than technicians. They should be a team that's raising technologists.

"Technologist" is not a term we hear often in the business world, but it should be. It is a label that applies not only to the day-to-day work of people in companies of all shapes and sizes across the country, but also to a broad spectrum of industries beyond those that create software and build hardware.

So, who is a technologist? Technologists have diverse interests and multifaceted personalities, but most share these five traits:

1. A Technologist Thinks Strategy First.

The definition of "strategy" is a "plan of action or policy designed to achieve a major or overall aim." Technologists favor strategies before tactics —i.e., the actions and activities implemented to achieve an objective. Before they start working with technology or put technology to work, technologists step back and plan.

2. A Technologist Has a Passion for Solving Problems and a General Sense of Curiosity.

Technologists don't see problems as obstacles to avoid. Rather, they consider problems to be opportunities for solutions. Their innate curiosity leads them to confront challenges even when those solutions are not obvious.

3. A Technologist Sees Technology in a Constructive Context

Technologists appreciate that, in the broadest sense, technology is a

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Charles Eaton leads three philanthropic endeavors for CompTIA, the world's largest IT trade association: Executive Vice President of Social Innovation, CEO of Creating IT Futures and NextUp, the organization's initiative to inspire young people to choose technology careers.

tool with a value determined by its application for the benefit and assistance of people, whether in their personal or professional lives.

4. A Technologist Believes Tech Is About Humans, Not Hardware

Technologists see gadgetry as solutions that serve people. No gadget has value unless it helps a customer, colleague, citizen, patient, or any other type of person a technologist may encounter during their career.

5. A Technologist Values Respect, Cooperation, and Collaboration

Technologists maintain a positive, helpful disposition on the job and in relationships in or out of the workplace. They respect their employers' codes of conduct, appreciate the contributions of colleagues, and understand that going rogue isn't the best way to analyze a problem, execute a strategy, or implement a solution in a business context.

Despite their positions of influence, parents and teachers cannot raise the next generation of technologists to close the skills gap by themselves. They will need the support of employers and role models from the array of successful technologists already working in the tech field today. If those technologists share what they love about what they do for a living, the process of narrowing the IT skills gap will accelerate.

But just picking up the pace is not enough. Parents, teachers, and role models from business and other walks of life need information and insight to become good career guides for the next generation of technologists.

So, Creating IT Futures developed *How to Launch Your Teen's Career in Technology: A Parent's Guide to the T in STEM Education*. This handbook helps connect the mounting demand to the growing supply, a primary counselor to the advisors that parents and teachers want to be.

In the book, eager parents and teachers leading Gen Z learn that technology is about logic, creativity, and solving problems. They see that a career in technology is accessible with or without a four-year degree through multiple paths to positions across companies and industries. Not only does the book point the way for parents to direct their teens, it lays stepping stones and shares stories from other parents, other educators, and executives who have made the journey.

As the guide's author, I have my head and heart engaged in this subject matter for personal, as well as professional, reasons. I have raised two children through college and now, as mentioned early, have two more approaching middle school years. I know firsthand the value of information and insight from committed credible sources.

That's why, in closing, we are offering **techdirections** readers free digital versions of *How to Launch Your Teen's Career in Technology: A Parent's Guide to the T in STEM Education*. Please visit www.TinSTEM.com and enter the coupon code TDCITF17 to download your PDF. td

More Than Fun Answers

Mascot Math

1. Tipton Tigers
2. Brighton Bears
3. Pittsfield Pirates
4. Winston Wildcats
5. Shoreline Sharks
6. Roscommon Rams
7. Hawthorn Hawks
8. Watertown Wasps
9. Springville Spiders
10. Coldwater Cowboys

To solve the puzzle, let A = Shoreline Sharks, B = Springville Spiders, C = Coldwater Cowboys, D = Tipton Tigers, E = Pittsfield Pirates, F = Watertown Wasps, G = Roscommon Rams, H = Brighton Bears, I = Winston Wildcats, J = Hawthorn Hawks. Then you can write the following ten equations:

(1) $D + B = 10$
(2) $A + C = 5 * E$
(3) $H + B = E + F$
(4) $A + J = E + B$
(5) $B = A + I$
(6) $C = F + H$
(7) $G = H + E + 1$
(8) $G + E = H + 7$
(9) $G + H = E + 5$
(10) $A + I + F = 17$

Begin with equations 7, 8, and 9 to solve for E, G, and H. Substitute equation 7 in both equation 8 and 9:

$H + E + E + 1 = H + 7$
$2E = 6 \quad E = 3$
$H + E + 1 + H = E + 5$
$2H = 4 \quad H = 2$

Then $G = 2 + 3 + 1 = 6$

Now substitute the values for E, G, and H in the equations.

$A + C = 15$
$2 + B = 3 + F, \; B = 1 + F$
$A + J = 3 + B$
$C = F + 2$
So $B = A + J - 3$
$A = 15 - F - 2 \quad A = 13 - F$
$A = 1 + F - I$
$13 - F = 1 + F - I$
$I = 2F - 12$
$A + F + I = 17$
$13 - F + F + 2F - 12 = 17$
So, $F = 8$
Now, $A = 5$ and $I = 4$
Then $B = 1 + 8 = 9$ and $D = 1$.
$C = 8 + 2 = 10$ (from equation 6)
$5 + J = 3 + 9$ so $J = 7$ (from equation 4)

How Many F's?

6! (Did you count the 3 OF's?)

Bevy of Barnyard Beasts

He has 30 pigs and 40 chickens.

Let p = the number of pigs, and c = the number of chickens. Then

$p + c = 70$ and $4p + 2c = 200$
$p = 70 - c$
$4(70 - c) + 2c = 200$
$280 - 4c + 2c = 200$
$80 = 2c$
$c = 40, \; p = 30$

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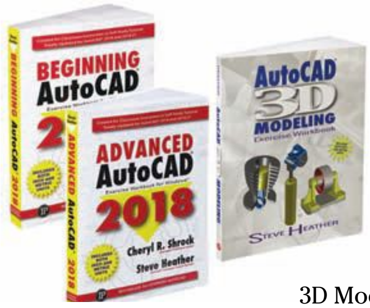

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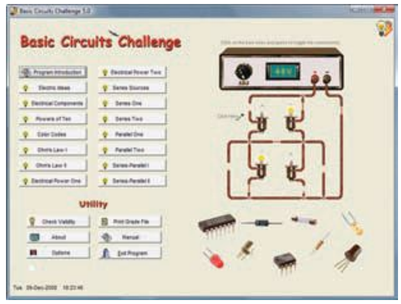

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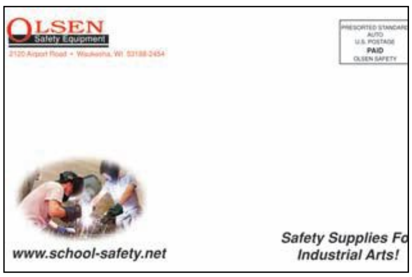

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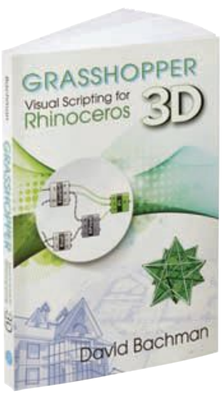

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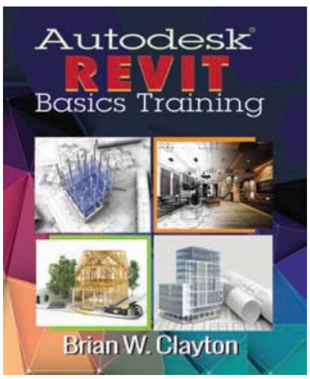

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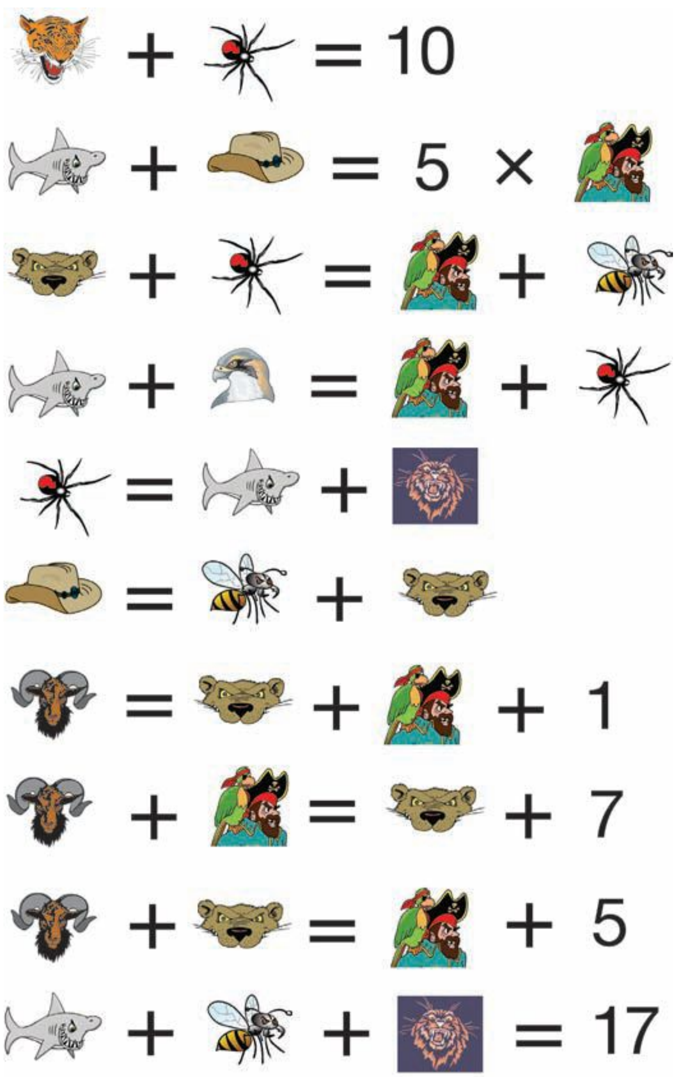
Mascot Math

Determine the rankings of the top 10 teams from the 10 clues below. Each logo has a value from 1 to 10, and no two logos have the same value.

The teams are:

Watertown Wasps
Roscommon Rams
Springville Spiders
Coldwater Cowboys
Brighton Bears
Hawthorn Hawks
Pittsfield Pirates
Tipton Tigers
Winston Wildcats
Shoreline Sharks

Puzzle devised by David Pleacher

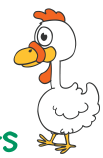


How Many F's?

Read the sentence below:

Finished files are the result of years of scientific study combined with the experience of many years.

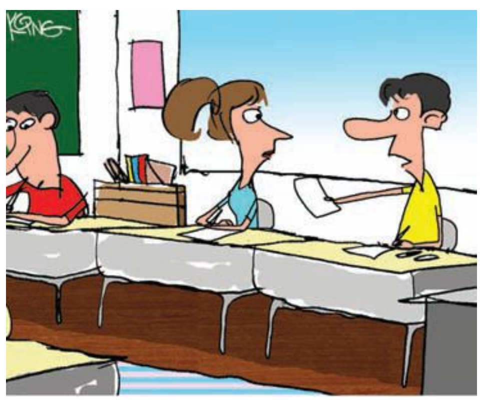
Now, go back and count the number of times the letter "F" appears in the sentence. Only go over the sentence once. Do not "point" to the letters or words with your fingers or a pen or pencil. How many "Fs" are there?



Bevy of Barnyard Beasts

A student has some pigs and some chickens. He finds that together they have 70 heads and 200 legs. How many pigs and how many chickens does he have?

Puzzle devised by David Pleacher



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See answers on page 27.

We pay $25 for brainteasers and puzzles and $20 for cartoons used on this page. Preferable theme for all submissions is career-technical and STEM education. Send contributions to vanessa@techdirections.com or mail to "More Than Fun," PO Box 8623, Ann Arbor, MI 48107-8623.