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MARCH 2018

Automotive Technology
Focused Issue Inside

Teaching STEM
through Physics/Engineering Mashup

Introducing Cutting Edge CNC Technology

technically speaking

Vanessa Revelli vanessa@techdirections.com

Troy (MI) High School got an amazing new space this year—a new Automotive Technology lab—with the help of local businesses. Business leaders in the area have serious concerns about the shortage of skilled workers who can work on today's technology-heavy vehicles. They decided to invest in the lab so that students are ready to enter the workforce right out of high school.

The auto lab's curriculum prepares students to take the Student ASE (Automotive Service Excellence) and Michigan State Mechanic tests. Passing these opens the door to immediate employment as auto technicians, working in dealership service departments and other repair facilities, according to the school's automotive instructor Dustin Warner.

"Schools are recognizing the needs of businesses and providing the right learning opportunities to students," said Troy School District Superintendent Rich Machesky. "We're a pipeline to employability, connecting kids with jobs in much-needed fields."

David Easterbrook, owner of Troy-based AME companies, got the ball rolling. He shared his ideas for the new auto shop with the school principal Remo Rencone. "It's nice to have a dream, and then somebody else tells you to dream bigger," Roncone said. "The new lab would not have happened without his guidance and support."

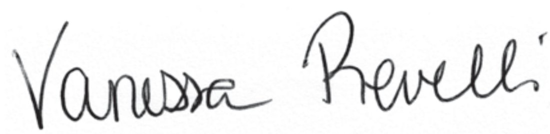
Easterbrook also founded Ashley's Dream, named after his daughter who was killed in a drunk driving accident, five days before her high school graduation in 1997. Since then, the foundation has awarded one student a scholarship through The Ashley Marie Easterbrook Scholarship Foundation. This year that scholarship money went to Troy high school to help create the lab, which was redesigned by AME. It includes new workstations, desks, shelving, roll carts, and tool boxes. Easterbrook reached out to other local businesses for additional donations which included dealership graphics, signage throughout the lab, new lab coats, and money for new tools, and equipment.

"It was easy to get other companies on board," Easterbrook said. "The district is providing a good background in automotive technology and preparing students to be certified. When they finish their training after high school, they can have a great job making six figures with no college debt."

The lab is set up to look like a service center, and offers three lifts and the same diagnostic tools the students will encounter when they enter the workforce after school.

"Our vision is to provide world-class learning opportunities to all of our students," Machesky said. "Often times, the skilled trades get left out of the conversation. The district made the decision to partner with these companies and generate a win-win situation for everyone."

To see the lab, visit: https://www.wxyz.com/news/metro-detroit-high-school-unveils-state-of-the-art-auto-technology-lab



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March 2018

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contents

March 2018
Vol. 77, No. 7

page 13

About the cover: Taking an artistic approach to looking at the intricacies of a vehicle's engine. Cover design by Sharon K. Miller.

page 12

the news report

Vanessa Revelli
vanessa@techdirections.com

Autonomous Vehicle Test Facility Offers Real-World Advantages

In January PPG announced its partnership with the University of Michigan's (U-M's) Mcity, a public-private partnership that brings together industry, government, and academia to improve transportation safety, sustainability and accessibility for the benefit of the society. Mcity's work includes operating the Mcity Test Facility, the world's first purpose-built proving ground for testing autonomous vehicles, connected-vehicle systems, and related technologies. PPG is the first paints and coatings manufacturer to join the Mcity partnership.

A leader in advanced paints and coatings technologies for the automotive industry, PPG is developing a broad portfolio of coatings to improve functionality and enable broad deployment of autonomous vehicles. These developments include exterior coatings that enhance vehicle visibility to radar and light detection and ranging (LIDAR) systems, as well as easy-to-clean coatings that help prevent obstruction of autonomous vehicle sensors.

The Mcity Test Facility, which opened in 2015, was developed by U-M with support from the Michigan Department of Transportation. The facility aims to re-create a range of operating challenges faced by vehicles on the road with simulated urban and suburban environments. Located on U-M's North Campus, the facility offers more than 16 acres of roads and traffic infrastructure, including approximately five lane-miles of roads with intersections, traffic signals, street lighting, sidewalks, fire hydrants, simulated buildings, and obstacles like construction barriers and pedestrian crash dummies. Mcity also funds academic research and works with its partners to deploy connected and automated vehicles in Ann Arbor and Southeast Michigan.

"Autonomous vehicle technology offers numerous real-world advantages, and the ability to test such technologies safely and thoroughly is essential for proving the viability of advanced mobility solutions," said Huei Peng, director, Mcity. "Our state-of-the-art facility offers a controlled environment for manufacturers like PPG to develop and hone the capabilities of autonomous vehicles and related technologies."

University of Michigan

Mcity autonomous vehicle test facility

Driving the Conversation Podcast Keeps Listeners Up-to-Date with the Industry

I-CAR is introducing an informative new hot-topic industry discussion audio series through internet podcasts. The monthly series of podcasts, called *Driving the Conversation*, includes informative and engaging discussions from industry thought leaders on noteworthy topics.

The series features industry leaders providing their view on a variety of topics related to the rapid changes within the collision repair industry. The audio series offers listeners access to current and valuable information to give them better insights into the opportunities and challenges facing the collision repair industry.

"We are confident that listeners will find the new podcast series to be a valuable resource," said John Van Alstyne, I-CAR'S CEO & president. "They can expect to hear about how I-CAR is supporting the collision repair industry with innovative solutions to help them navigate the many ongoing technical challenges."

The first episode, entitled "The Future of Diagnostics," offers reflection and perspective on one of the most pressing issues industrywide. It is hosted by Elise Quadrozzi, I-CAR's vice president of education & technical services. This episode features Jake Rodenroth, director of client services, Collision Diagnostics Services, Plano, Texas; Mike Anderson, president/owner of Collision Advice Consulting, Alexandria, Virginia; and Gerry Poirier, national APD strategy manager, Farmers Insurance®, Atlanta, Georgia.

The discussion centers on perspectives from industry thought leaders regarding the concerns, needs, solutions, and advancements related to diagnostics. The discussion includes questions that were included in I-CAR's inaugural *Collision Reporter* magazine, focusing on Diagnostics, published in July.

These podcasts bring together a multitude of industry resources to provide relevant and accessible information. The *Driving the Conversation* series looks at technical issues through various levels of business impact. It is focused around technical training, information, and related services to equip the collision repair industry with the resources needed to contribute to complete, safe, and quality repairs that optimize business performance, reduce risk, provide career development pathways, and advance industry professionalism. Listeners can subscribe to the podcast series on iTunes or Google Play Music.

Vanessa Revelli is managing editor of **techdirections**.

Alan Pierce
pierceaj@techtoday.us; on Twitter @ TechToday_US

Samsung's S-Ray Demonstrated at CES 2018

The Consumer Electronics Show (CES) is held in January in Las Vegas. When it comes to consumer electronics, CES is the place to go to see evolutionary, revolutionary, and/or incremental technology advances.

In the 1965-1970 TV series *Get Smart*, the "cone of silence" was a fictional device that was supposed to keep a conversation completely secret by preventing anyone outside of the cone from hearing what was said inside the cone. Like most of the tools that the bumbling secret agents of the show used, the cone of silence didn't work. You can find an episode that includes Agent 99 and the Chief using the cone of silence online at https://www.youtube.com/watch?v=HWtPPWi6OMQ .

The concept behind this prop, designed to make the audience laugh when they watched the show, was actually unveiled by Samsung at this year's CES. Samsung's S-Wave focuses sound waves into a directional wave that can be projected as if the sound was a focused narrow beam of light. The light beam is a tool to help you understand how the sound is focused into a directional beam. Their directional sound beam, which is totally invisible, can only be heard if you are located in a physical sweet spot aligned with the beam of sound.

At the Samsung Creative Lab booth I had the opportunity to discuss S-Wave with the project team that developed the S-Ray. I also tried out the prototype units they brought with them to demonstrate their technology. The black neck band I am wearing in Photo 1 focuses the sound so it reaches only my ears. A person standing next to me wouldn't be able to hear the audio coming from the head band.

To show just how small the sweet spot for sound can be, Dr. Tae-Young Kim, the project leader, used a Mini S-Ray sound speaker that was designed to have an extremely narrow beam. He moved the sound speaker as if he was shining the sound wave beam toward my ear. When he moved the sound speaker, which was about 2' from my ear, so it was no longer aimed at my ear, the sound disappeared. A small movement in either direction from the sweet spot eliminated my ability to hear the music. Photo 2 shows the different size units that the Creative Lab team brought to CES to demonstrate their technology.

Photo 1—The black band around the author's neck projects the audio directly into his ears.

Samsung

Photo 2—To demonstrate this technology, the engineers from the Samsung Creative Lab brought three different sized and shaped sound projectors.

To be honest, if this demonstration was taking place at a booth without Samsung's reputation, I would have had difficulty believing what I was hearing and seeing. They were showing me that sound waves could be corralled into a tight beam. Besides the obvious use of eliminating ear buds and headsets, this technology can be used in museums to provide audio for the exhibits, on airplanes to provide individual audio that matches the movie playing at your seat. It could also be used in stores to provide customers with information about a specific product that they are looking at.

In each case people in close proximity to each other could all hear different audio beamed to their location. Everyone outside of the sweet spot for sound would be completely oblivious that a person sitting or standing inches from them is hearing what they cannot hear. Samsung did not have pricing, or even a date when this technology will become available to the public. This Samsung YouTube video can provide some more insight into this new technology: https://www.youtube.com/watch?v=3dbZuzs46E4.

Taking It a Step Further

1. How do you see this technology being adopted for use in all the different areas of technology?

2. What do you see as the most unusual applications for this technology?

3. Active noise cancellation is now used to silence environmental sound. Do you feel the engineers who developed this technology should explore using their system to not only coral sound waves into a directional beam but also to silence environmental noise that is not part of their audio? Why?

If this column sparked an activity please email me photos and a short description for posting on my website.

technology's past

Dennis Karwatka
dkarwatka@moreheadstate.edu

Powel Crosley and His Technical Successes

Americans living in the 1930s and 1940s were familiar with the Crosley name. They knew about Crosley radios, Crosley automobiles, and Crosley Field in Cincinnati, OH. All were named after Powel Crosley, a self-made innovator who had a variety of interests.

Powel Crosley, circa 1920s

Born in Cincinnati in 1886, Crosley was the oldest of four children. He was close to his brother Lewis throughout their lives. Their father was a businessman who provided a middle-class lifestyle for the family.

Crosley attended local public schools and the University of Cincinnati, although he did not graduate.

One of his early jobs as a chauffeur required that he maintain the automobile as well as drive it. He enjoyed the work and, until about 25, Crosley was employed at various automobile businesses. He was earning about $20/week when he invented a device that allowed quicker repairs of flat tires. Crosley borrowed $500 from his father for part interest in a manufacturing business he named Insyde Tyre, which he later purchased from his other investors. It was the first of his many successful ventures. Crosley married Gwendolyn Aiken at that time, and they had two children.

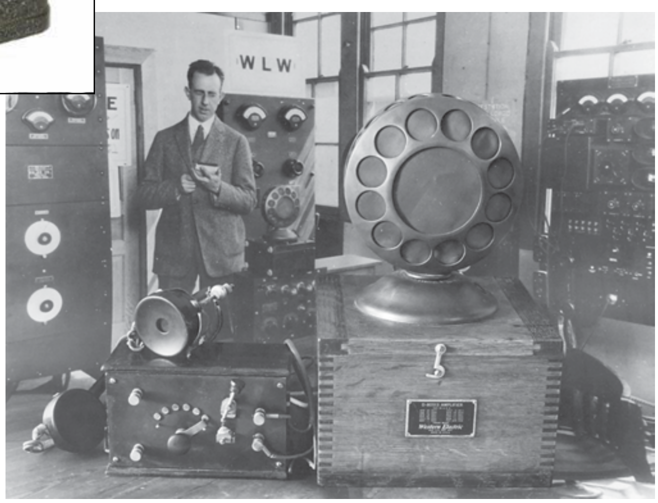
Crosley's brother Lewis returned from World War I service and became the company's manufacturing manager. The two brothers operated smoothly as a team throughout their professional lives.

In looking for new technical opportunities in 1921, Crosley was attracted to radios for the consumer market. They were increasing in popularity but he felt they were overpriced. The cheapest radio he found for his young son cost $130. Like almost all those purchased in stores, it was a large and heavy floor model. It took Crosley only a few months to establish a factory to make less expensive radios. His small Pup model cost less than $10. Crosley became the world's largest radio manufacturer in 1924. He went on to obtain a commercial broadcasters license for Cincinnati station WLW ("World's Largest Wireless" at 700 AM). A nominal 50,000-watt radio station, it had the most powerful transmitter in the world.

But the automobile was always at the back of Crosley's mind. He wanted to provide cars that were inexpensive both to purchase and to operate. His first Crosley automobile was built in Richmond, IN, and came out in 1939. He displayed it at the World's Fair in New York City. The small car used a two-cylinder air-cooled 12 hp engine built by the Waukesha Engine Company. The car was 4' wide, 10' long, weighed 925 pounds, and cost only $325. The Crosley's fuel economy was a remarkable 50 miles per gallon.

About 6,000 were built through 1942, when World War II caused American automobile production to cease. Crosley resumed production after the war and built small sedans, sports cars, pickup trucks, panel vans, and other vehicles. Those vehicles had more powerful four-cylinder engines and some were the world's first production models to feature disc brakes. In all, Crosley sold a total of about 75,000 cars before

Above, Crosley Pup model was the world's smallest tube-type radio



Right, Crosley with WLW's transmitter in the 1920s

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

Right, 1947 convertible, with Crosley in the driver's seat

Left, 1951 Hot Shot model

Right, Crosley Field in the 1960s

ending production in 1952.

Crosley owned the Cincinnati Reds baseball team between 1934 and 1961. He arranged major league baseball's first night game in 1935. The stadium where the Reds played was named Crosley Field. It was torn down in 1972.

Crosley personally knew American presidents, movie stars, and industrial giants. He became quite wealthy and owned eight homes, six yachts, 14 airplanes, and Bull Island off the coast of South Carolina. He also established companies that built household appliances, private airplanes, and military equipment. A tall, pleasant man who enjoyed hunting and fishing, Crosley died unexpectedly in 1961. td

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Reid Goldsborough
reidgoldsborough@gmail.com

A Quarter Century of the Graphical Web

Twenty-five years ago, the world as we know it changed when Mosaic was released.

This was the first useful, and first widely used program that let people more easily navigate this newfangled Internet service called the World Wide Web. Most important, you could see images on the same page as text. This caused the Web to explode in popularity.

Mosaic was developed by two graduate students, Marc Andreessen and Eric Bina, with the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign.

With Mosaic, not only could you see text and graphics on the same page and click your way from one site to another, you could do so ad infinitum. Mosaic was free for noncommercial use, with public funding provided by programs initiated by then Senator Al Gore of Tennessee.

The Web itself came into existence four years earlier. It was invented in 1989 by Tim Berners-Lee, a British physicist and computer scientist who was working at the time for CERN, the European Organization for Nuclear Research. CERN currently operates the Large Hadron Collider, the world's largest subatomic particle accelerator, which sits underground along the border between Switzerland and France. The first Web browser, text based, was released to the public in 1991.

And the Internet preexisted the Web, with the U.S. government building connected computer networks in the 1960s to support its research activities. This included ARPANET, the Advanced Research Projects Agency Network, created in 1969 and

With Mosaic, you could see text and graphics on the same page and click your way from one site to another.

considered to be the founding of the Internet.

The Web was predicted earlier, by the science fiction writer Arthur C. Clarke in his groundbreaking novel 2001: A Space Odyssey, published in 1968. Much earlier than this, another science fiction writer, H. G. Wells,

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Reid Goldsborough is a syndicated columnist and author of the book Straight Talk About the Information Superhighway.

predicted a "World Brain" in a collection of essays between 1936 and 1938.

The year after Mosaic was released, in 1994, the World Wide Web Consortium was created at the Massachusetts Institute of Technology. It received funding from the U.S. Defense Advanced Research Projects Agency, an agency of the U.S. Department of Defense responsible for the development of new technology for use by the military and which had pioneered the Internet in the 1960s. The World Wide Web Consortium's purpose was, and still is, to create standards and recommendations to improve the quality of the Web.

In 1994 Marc Andreessen moved on and cofounded the for-profit Netscape Communications (originally known as Mosaic Communications Corporation), which released an improved version of Mosaic called Netscape. Netscape dominated the Web browser market through the 1990s, and Mosaic, which started it all, was discontinued in 1997. Netscape was eventually swept aside by Microsoft's Internet Explorer, and Internet Explorer was later swept aside by Google Chrome.

Netscape used original programming code, though Microsoft licensed Mosaic's code to create Internet Explorer. Microsoft's bundling of Internet Explorer with Windows, later determined by courts in the U.S. and Europe to be an illegal monopolistic practice, is what doomed Netscape. After being acquired by America Online in 1999, Netscape was discontinued in 2008. Mozilla Firefox, released in 2002 and still in existence, also used programming code from Mosaic.

Private companies began realizing the profit potential of having a Web presence beginning in 1996, and the commercialization of the Web kicked in between 1996 and 1998. This led to the dot-com boom and bust of 1999 to 2001 when trillions of dollars were made and lost as a result of what Federal Reserve Chairman Alan Greenspan at the time accurately termed "irrational exuberance."

Nonetheless, the Web transformed the business landscape. It eventually did-in previous online services such as CompuServe, America Online, Prodigy, and Genie; forced many newspapers and several prominent encyclopedias out of business; and dramatically changed the television, music, radio, film, and travel industries, among others.

Multimedia offerings through the Web have been made possible with the popularization since 2000 of high-speed cable, fiber-optic, and satellite access to the Internet. The Web has also become even more interactive during these years with the introduction of social networking sites such as Facebook and Twitter, blogs at sites such as Blogspot, wikis such as Wikipedia, video-sharing sites such as YouTube, and photo-sharing sites such as Instagram, available now not only through computers but also smartphones and other devices.

The World Wide Web was key to the development of the Information Age, and Mosaic, released a quarter century ago, was key to the development of the Web. td

Mineola HS Introduces CNC Technology into Their Curriculum

By Maryann Valentine

EAGER to learn, the students at Mineola High School (MHS), Long Island, NY, work hard day to day, not only in their core classes like math, science, and ELA, but also enthusiastically in the woodshop, to learn everyday skills. The school recently updated their entire Tech Ed woodworking and metalworking classroom, switching from conventional methods of producing projects to an exclusive "Fab Lab" that consists of some of the most advanced technological equipment used in the industry.

The new Fab Lab at MHS is equipped with machinery that few other schools have on the Island—a CNC plasma cutter and CNC router from Techno CNC Systems. Whitney Smith, principal at MHS, spoke proudly about the new lab and how it has effectively and efficiently changed the way the students are learning.

"Adding CNC to our high school program was really the next step for us," stated Smith. "We are always on the cutting edge of technology. We are always searching for the best tools for our students. We have always had a traditional woodshop and metalshop, but now we are focusing on showing the students the latest and greatest technology in automation, and the students are very excited about it. We already knew our students had great ideas, but now, it is incredible to be able to see these students take their ideas from inception to completion, using CAD/CAM technology," said Smith.

"The school was able to transform the lab from a conventional shop to an advanced lab for students to learn and enhance their engineering skills. The technology in the Fab Lab has changed everything. All our 8th graders get introduced to the equipment and do a problem-solving activity. They get introduced to Aspire CAD/CAM software by choosing a letter of the alphabet, setting up the job, and creating a toolpath. The students are shown how to setup and operate the CNC router under the direction of the instructor," said Paul Sommer, tech expert/teacher at MHS.

"Having a space like this is unique. We are the only school on Long Island to have made the commitment to adding this technology and advanced learning which benefits our students. Another benefit about the space is that the 8th grade students are all given a chance to find a passion in CNC, thus getting them excited for the more advanced tech courses offered in grades 9-12. We also partnered with Queensborough Community College, where students can receive college credits for courses taken," Smith said.

Determined technical education student from Mineola High School operating Techno CNC System's HD Series CNC Router for her senior project

Continued on page 25.

Maryann Valentine is the marketing manager at Techno CNC Systems in Bohemia, NY.

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Special Focused Issue

contents

March 2018

AUTOMOTIVE TECHNOLOGY

page 15

page 18

page 21

About the cover: An automotive student testing a vehicle's exhaust system. Cover design by Sharon K. Miller.

Home, James

Your autonomous chauffeur could be here sooner than you think

By Jeff Bogue

I HAVE to admit that trying to keep up with the throngs of technology bombarding the automotive industry is like trying to juggle cats. It seems like every other day an engineer says something completely outrageous and then some company puts it in a new car. Active Vehicle Tracking, Heads Up Displays (HUD), Remote Vehicle Shutdown, and Biometric Access are just a few.

The Autonomous Vehicle and Driver Override Systems are the two that have me most intrigued. These are a pair that, and I love this, were touted just a few years ago as being "in cars within the next 10 to 20 years". Well, that was the quickest ten years I have seen yet. Google has sent their self-driving car out on several excursions, but Tesla, always thumbing their nose at conventional automotive ideals, had one of their vehicles cross the U.S. in just 58 hours while being "driven" mostly autonomously.

"Mostly" is the key word here, but cars are parking themselves, and even finding their own parking spots. On top of that they are overriding active human control to apply the brakes in accident avoidance situations. I do believe that "mostly" is going to get smaller and smaller very quickly, and I am excited. Now don't get me wrong, I love my four-wheel drive pickup truck with the manual transmission, crank windows, and smell of hound dog, but sometimes it is just not universally practical.

Google self-driving cars begin tests on city roads this summer.

From http://wot.motortrend.com/1505_google_self_driving_cars_begin_tests_on_city_roads_this_summer.html/photos/#3

I remember just six or so years ago reading that most people owned phones that had more computing power than what was used to put a man on the moon. Now that rough estimate seems grossly understated and modern vehicles are making modern phones seem like weak little cameras.

How does all of this technology work together and where will it end? What are Telematics and what do they do? Well, Telematics is a term to describe the connectivity of the vehicle (think OnStar and others) and they are increasing that exponentially each year. (in 2010 less than 10% of vehicles had factory installed telematics. We are looking at about 62% for the 2016 model year).

The last couple of years at the Consumer Electronics Show (CES) have proven themselves as automotive showcases. In 2016, Audi sent an A7 from San Francisco to Las Vegas fully autonomously. BMW had a car that could roam a parking lot by itself looking for a parking spot. Nvidia (all you gamers know these guys, and Tesla has a partnership with them) developed two computer systems specifically designed to handle the information generated by self-driving systems.

In January 2017, it became even more abundantly clear that tech in vehicles was going to be a format to be reckoned with. BMW debuted a new user interface concept for the interior of the car called the HoloActive Touch system at the show. The system features a virtual "free floating" display that's controlled via finger gestures, not a touchscreen, and also features haptic feedback. It uses sensors to detect where your finger is pointing and then a vent shoots air to that location to provide the haptic feedback (which tech services that?).

That is just touching the surface (pun intended) of all of the other vehicles that were capable of complete autonomous operation and/or incorporating artificial intelligence

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Jeff Bogue is an electronics specialist focused on research and development. He works at ATech Training as a product representative and contributor to ATech Educator News*. This article is reprinted from the December 2017 issue of* ATech Educator News.

to entertain and chauffer. The 2018 CES was not any less automotive-centric either with multiple speakers from the automotive industry and manufacturers on high alert to be jaw dropping or go home with a participation trophy.

The automobile has seen this transitioning into a giant computer become more and more prevalent every year. These technological marvels employ a vast array of sensors, cameras, and inputs that generate an amount of data that is absolutely amazing. This data is handled primarily by multiple bus systems, depending on the sensor, but CAN and FlexRay are predominant with Media Oriented Systems Transport taking care of the video and GPS.

New vehicles can contain infotainment, connectivity, driver assistance, and autonomous driving technologies

From http://infotreeservice.com/infotainment-and-telematics-consulting/

The computing power alone to handle and process this data stream is truly astounding. The modern vehicle has the equivalent of several computers just to run the vehicles' motor in the most efficient way possible. Now add a couple more computers to monitor and respond to the non-engine inputs. These inputs consist of several different types that work in conjunction with each other to survey the automobiles' surroundings and driving conditions.

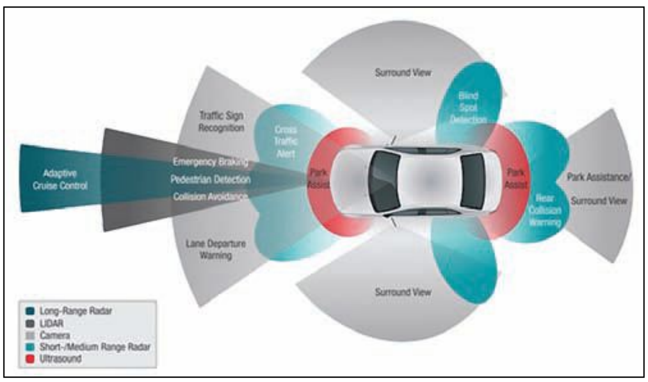
Here is just a tentative list of sensors for a modern vehicle.

1. Long- and short-range ultrasonic sensors
2. Front and rear radar systems
3. Lidar—laser imaging systems
4. Front- and rear-facing cameras
5. GPS—integrated global positioning
6. Vehicle to vehicle (V2V) and Vehicle to infrastructure (V2I) communication.

It may seem a little redundant, but all of these sensors work in conjunction with each other to give the vehicle and occupants a full moving picture of their active surroundings and V2V is set to complete the picture.

The Long- and Short-Range Ultrasonic Sensors

Long-range ultrasonic sensors are primarily used for vehicle-positioning and tracking in the lane adjacent to the host vehicle in order to identify free areas around the vehicle and provide information to an automatic avoidance collision system that can perform autonomous braking and lane change maneuvers. Short-range ultrasonic sensors have a limited range and are more specifically relegated to the close-in work around the vehicle.



When behind the wheel of a vehicle powered with radar, LIDAR, camera, and ultrasound technologies, drivers can feel more relaxed.

From https://e2e.ti.com/blogs_/b/behind_the_wheel/archive/2014/06/10/sun-fun-and-technology-ti-technology-heats-up-the-summer

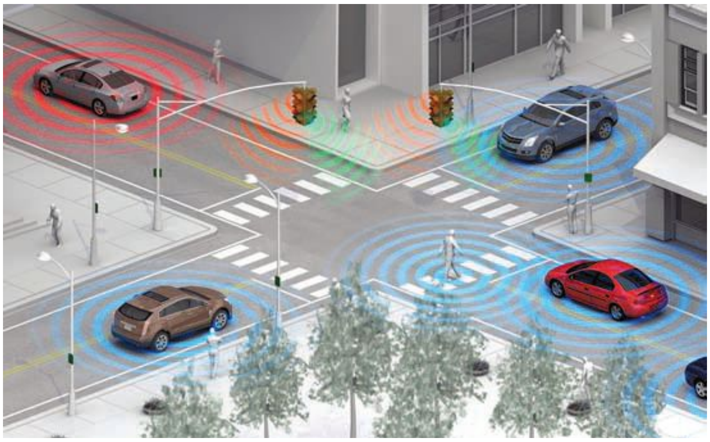
These sensors have a basic range of 30' or less and take care of the light duty work like Park Assist, but their input is deemed no less significant than the others and is added to the fray when the vehicle is in motion.

The Front and Rear Radar Systems support adaptive cruise control, pre-crash protection, and collision warning systems with and without automatic steering and braking intervention. They also take care of the medium- and long-range activity. These systems can range from wide angle (up to 80° and 30 m range) to multi-mode and long-range (60° and 18° respectively and out to 200 m). These give the vehicle a better view front and back out to some distance. This better situates the vehicle in its surroundings and supplies early warning of trouble ahead.

The Lidar System is for the final brush strokes. Laser sensors (Lidar) gather detailed distance measurements of a vehicle's surroundings at a frame rate that matches video's 30 frames a second. This information comes from a vertical array of spinning and/or scanning lasers and mirrors that send and receive pulses of light at more than a million times a second. This forms a complete 3D detailed dot matrix picture (down to the centimeter) of the vehicle's immediate surrounding area.

The Front and Rear Camera Systems monitor and assist low-speed maneuvering and situational awareness for parking assist, active avoidance, and enhanced visual dashboard displays for the modern

From http://wot.motortrend.com/1402_nhtsa_announces_plans_to_submit_v2v_communications_proposal.html/photos/



NHTSA plans to submit V2V communications proposal

"driver." (Note: These can also be infrared, added to the HUD, etc.)

The GPS assists in high-speed situational awareness and tells you where you are, how fast you are going, and when to turn.

V2V and V2I—Vehicle to Vehicle and Vehicle to Infrastructure communications. This last piece of the puzzle is one that is very important, yet a few years out. The Federal Government has started the ball rolling on this and it could potentially be the "golden ticket" as far as autonomous driving is concerned. This would give the vehicle the ability to basically see around corners, spotting and tagging other vehicles, road signs, and traffic signals that it cannot yet get a visual on for better situational awareness and active avoidance.

Tesla, BMW, Google, and others are going all in and Cadillac announced V2V would be standard in 2017 and have "Super Cruise" available too. Things are going to get interesting quick. That being said, the National Highway Traffic Safety Administration has proposed a formal classification system:

- Level 0: The driver completely controls the vehicle at-all-times.
- Level 1: Individual vehicle controls are automated, such as traction control, electronic stability control, and automatic braking.
- Level 2: At least two controls can be automated in unison, such as adaptive cruise control in conjunction with lane assist.
- Level 3: The driver can fully cede control of all safety-critical functions in certain conditions. The car senses when conditions require the driver to retake control and provides a "sufficiently comfortable transition time" for the driver to do so.
- Level 4: The vehicle performs all safety-critical functions for the entire trip, with the driver not expected to control the vehicle at any time. As this vehicle would control all functions from start to stop, including all parking functions, it could include unoccupied cars.

It all sounds mind-blowingly complicated, and it is, from the engineering point of view, but most of these systems are modularly designed. There would be no real troubleshooting of failed systems. Most of that would be taken care of by the host computers before it ever gets to the shop. The technician would be utilized to take care of bad connections, swapping bad components, and adjusting sensors for optimum field of view.

In reality, what the technician will see is answers on his scan tool. These systems together give the automobile and driver a better grasp of what is going on in and around the vehicle, more so than what a human could gather alone, but there is still work to be done. Computers cannot yet react to certain situations in a way that a human could, but then again, over 80% of all highway accidents are caused by driver error. I'm looking forward to getting in my car and saying "Home, James." td

Five Ways 3D Printing Is Transforming the Automotive Industry

By Stratasys, Inc.

IN the span of a decade, 3D printers have moved from an optional piece of equipment for producing relatively simple prototypes to an absolute necessity—one that is transforming the automotive industry in fundamental ways. Now fixtures in automotive design studios, factory assembly lines, and test tracks, 3D printers are creating complex parts, speeding up tooling cycles, enhancing measurement and testing, and providing customization solutions across all aspects of the vehicle development process.

Davide Ferrulli, Stratasys® Italy-based territory manager, who has been employed at Stratasys for more than 10 years, has seen the shift toward 3D printing, firsthand. "Every single day, I'm surprised to find a new application discovered by a customer."

Whether using fused deposition modeling (FDM®) to create new tooling for short-run testing or production parts, customizing vehicle interiors, or making measurement and production devices such as jigs, the automotive industry is increasingly turning to 3D printing to manage tight production cycles and cut costs.

"We're going more and more into assembly plants of large OEMs (original equipment manufacturers) and discussing how these tools can support them in overcoming long rollout cycles," said Christoph Lindner, Stratasys territory manager GSC. "We are exploring how rapid tooling contributes to productivity in their plant or even on the assembly line." Lindner, who is based in Germany, has been with Stratasys since 2012, but even in that relatively brief period of time, Lindner has seen significant changes across the industry.

"We are moving away from traditionally thinking (only) about rapid prototyping, and going into questions like: How does 3D printing or additive manufacturing contribute to productivity? How does it optimize costs, or even improve workflow?" said Lindner.

Here are five key ways 3D printing is changing the automotive industry, both today and in the near future:

1. From Small to Big: Flexible, Optimized Design

One of the key benefits of early-stage vehicle design with the assistance of a 3D printer is the ability to start small and scale up rapidly, well before assessment or the part reaches the assembly line.

One example of that capability can be found at Bentley Motors Ltd. Nearly every detail of a future production vehicle is first created in miniature using Stratasys PolyJet™ technology. The 3D process empowers designers to test multiple forms and a variety of practical functions, bringing them closer to a final design much more quickly than in the past.

The studio uses two machines, the Objet30 Pro™ and Objet500 Connex™ multi-material 3D printers, in tandem. Designers rely on the Objet30 to model anything from tiny wheel rims to grilles, and then move to the Objet500 to create one-third scale and even life-size parts. In a single printing session, both multiple clear and opaque materials are seamlessly integrated to craft a scale model without assembly.

"The accuracy of the Objet30 3D printer enables us to take a full-size part and scale it down to produce a one-tenth scale model," David Hayward, operations and projects manager at the Bentley Design Studio, explained in a case study. "Once we have approval at this scale, we can move on to our larger Objet500 Connex 3D printer to produce one-third scale models, full-sized parts, as well as parts that combine different material properties, without assembly."

Bentley Motors designers print miniature scale models of vehicle interiors and exteriors.

PolyJet technology also allows companies to print translucent prototypes. "This is an application world for itself," Lindner said. "Anything that has to do with glass, interiors, overmolding materials, such as mirrors and panels—these applications are the main drivers behind the clear material."

At Jaguar Land Rover, the Objet500 Connex 3D printer was tasked with producing a complete fascia air vent assembly for a Range Rover Sport. It used rigid materials for the housing and air-deflection blades,

Jaguar Land Rover used the Objet500 Connex 3D printer to print a complete fascia air vent.

and rubber-like materials for the control knobs and air seal. In a single process, they printed the complete fascia air vent as a working part. Once printed, the model was taken from the printer, cleaned, and tested, proving that the hinges on the blades all worked, and the control knob had the right look and feel.

2. Rapid Tooling with Additive Manufacturing Cuts the Steps, Cuts the Time

A recent survey conducted by Stratasys found that 60% of Italian customers use Fortus® 3D printers to perform at least one manufacturing task. Some Stratasys customers exclusively use Fortus 3D printers for manufacturing, according to Ferrulli. And rapid tooling has become the major focus for many automotive customers, a trend that is only expected to grow in coming years.

"We see a huge adoption around having, for example, pre-series molds produced with a 3D printer and then doing the first 50 to 200 design iterations for the tooling," Lindner said.

Engineers can then evaluate the molds to determine the optimal design before creating a steel version for a final mold. Designing tooling with additive manufacturing from the very beginning removes multiple steps and untold costs compared with traditional tooling methods.

"And this can only be done with additive manufacturing," Lindner said. A prime example of shrinking the tooling process can be found in the 2011 Lamborghini Aventador, the sports car brand's flagship model. The $400,000 Aventador clocks in at 230 mph and owes many of its performance attributes to its carbon-fiber-reinforced composite monocoque, which makes up the core of the integrated body-chassis. It weighs 324.5 pounds, and the entire body and chassis weigh just 505 pounds.

A team used a Fortus 3D printer with a build envelope large enough to produce a complete one-sixth scale prototype of the body and chassis in one piece in just two months, including the time to print and assemble the parts.

Under traditional manufacturing processes, it would have taken an estimated four months and $40,000 to build the tooling for the scaled part. But with 3D printing, total build and processing time was 20 days, with a total cost of $3,000.

3. Fast Customization via 3D Printing

Customizing vehicles, especially when it comes to interiors, is a costly endeavor for automakers. Mass production of a particular automotive feature in low-volume vehicles often proves too expensive for OEMs to justify. But 3D printing offers an economical solution to carmakers looking to provide an array of trims and options for consumers.

For example, Stratasys worked with a German automaker to create a driver-friendly feature in the cabin of the car. This option was available on just 10,000 vehicles—too few units to justify the cost of tooling and injection molding. However, such a low-volume is well within reach of 3D printing technology, both in terms of costs and materials.

Customizing interiors, particularly for commercial customers, is another major need that's being addressed with 3D printing, Ferrulli said. That includes creating low-volume, specialized instrument panels that add features such as compartments for tools and instruments, as well as flexible dashboard features, such as GPS and satellite navigation systems.

And while electric vehicles still represent a low-volume segment, the market is growing rapidly, and 3D printing could play a more prominent role. These vehicles require lightweight, highly specialized components and parts that must be produced in lower quantities—a perfect place for FDM.

A carbon-fiber reinforced monocoque is key to the Lamborghini Aventador's light weight.

Lindner noted one recent project in which Stratasys worked with a producer of a small commercial electric vehicle (EV). The team produced the tools for thermoforming the roof of the vehicle. When the pieces of the roof were glued together and attached to the vehicle, the lighter roof helped achieve a nearly 5% overall weight reduction.

While this is an early-stage project, and some technical obstacles remain, it shows the potential for 3D printing in the growing EV sector.

4. Validation and Advanced Measurement on Demand

When it comes to measurement and parts assembly, Lindner also sees 3D printing playing an increased role on the factory floor. He provided the example of a supplier that worked with Stratasys engineers to develop a multi-functional tool that can measure several points on a headlight or taillight prior to final assembly.

"We came up with a triangle-shaped tool that marries three different processes into one tool, and it's printed with FDM technology," he said. The tool measures the edges, such as where the rubber connects to a taillight, to validate accuracy of the parts and fixtures.

It also replaces tools made with steel or aluminum that have less functionality, reducing costs by two-thirds at the same time. The FDM-produced tool is light and mobile and can be carried to any station, or anywhere along the assembly line.

"It can serve as an assistant in the zero-tolerance car process, to assure quality control," Lindner said. "And that's something no one considered before in the measuring process."

The tool will be produced by a supplier serving the plant, which produces several hundred thousand cars per year, Lindner said.

5. Rea-World Functional Testing: Discovering What Works

Nearly 10 years ago, experts at Stratasys showed Fiat how to create door and body panels with FDM technology. Ferrulli recalls that managers at the Italian automaker were impressed by how large, yet thin, the panels were, as well as how easily the parts fit together. SLA and SLS technologies cannot produce parts as large without warping. But FDM parts hold their shape over time, Ferrulli said.

Fortus 3D printers on a factory floor

"When Fiat saw the capability of FDM technology, they were surprised because they were finally able to do something with the technology they were not able to do before," he said. "They are able to build complex parts (for the engine compartment) that would withstand the functional tests … (for) resistance to chemicals and heat," Ferrulli said.

One of the most popular thermoplastics, ULTEM™ 9085 resin, a flame-retardant, high-performance thermoplastic, is the go-to material for complex parts that go in the test vehicles, including inside engine compartments. The weight-to-performance ratio is similar to some aluminum alloys used in these applications, and it is resistant to temperatures up to 186° C. Another popular material for automotive parts is ULTEM™ 1010 resin, which has higher resistance to temperature than ULTEM 9085 resin, as well as increased rigidity, and can withstand temperatures as high as 214° C.

But using FDM technology isn't just a way to confirm what designers believe will work; it can also reveal what isn't working well before a part or a whole assembly goes into production. For example, original and aftermarket equipment maker Hyundai Mobis relies on prototyping for design verification and functional testing, using a Fortus FDM system to help evaluate components such as instrument panels. Specifically, Hyundai Mobis produced a prototype instrument panel in ABS plastic for Kia's Spectra and precisely scanned it with a coordinate measuring machine to ensure accuracy to the original design. However, that original design, mounted as a prototype in a cockpit mockup and connected to sub-assemblies, contained 27 flaws that would have added cost and time delays, or could have hampered fit and finish.

The automotive sector has long been one of the most fast-paced and complex industries. But the industry arguably has never faced more challenges—or very promising opportunities—as it does today.

Hyundai Mobis 3D printed an instrument panel in ABS plastic to measure component fit.

A host of obstacles, from the demand for vehicle electrification, to diverse consumer preferences, to tighter environmental regulations, all have contributed to tightened vehicle production schedules and shortened vehicle life cycles. These pressures directly affect every OEM and every supplier throughout the value chain. They require creative approaches to speed up the design process, increase quality, and cut costs—all at the same time.

3D printing technology is proving vital in the design studio and factory floor alike. As a cost-effective solution for improving measurement, functional testing, vehicle customization, optimized design, and rapid tooling, adopting and optimizing 3D printing is critical for engineers, plant workers, and designers of all kinds, wanting to stay ahead of the competitive field. And with new applications being discovered, tested, and implemented virtually every day, 3D printing technology's potential to impact the industry is just beginning. td

Helping Students Understand Automotive Electricity

By Rob Thompson

I DOUBT I'm alone in finding that automotive students often struggle the most when learning basic electricity. To address this issue, I created a series of articles with ideas for helping teach fundamental electrical concepts using some simple classroom lab activities. The first part of this series appeared in the March 2017 issue of **tech**directions (www.techdirections.com/past-issues.html), which starts with making sure students understand basic terms, such as volts, amps, and watts. We then talk about measurements, meters, and circuits.

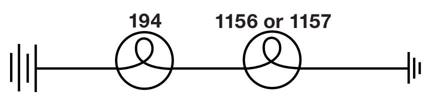
Previously, I mentioned having students use automotive bulbs to build and test basic circuits. Performing lab activities gives the students practice using a DMM, inspecting and testing bulbs, sockets, and wiring, and introduces troubleshooting procedures. And, because of my sadistic nature, I mix blown bulbs and faulty sockets into the selection of parts the students use to build and test these circuits.

One of my favorite circuits uses an 1157 and a 194 bulb in series, Fig. 1. The students are told the 1157 bulb represents the brake or turn signal light and it is supposed to illuminate. Of course the problem is the 1157 won't light up (Photo 1). This usually makes the students try reversing the order of the bulbs and then assuming the 1157 bulb is "bad." I give the students spare bulbs and sockets so they can replace the "bad" bulbs with little effect.

After some more testing, circuit resistance and current flow as shown in Photos 2 and 3, students can see that the circuit is complete and neither bulb is "bad." Checking the voltage drop of the 1157, shown in Photo 4, begins to show why the cir-

Rob Thompson is a high school automotive technology instructor, South-Western City Schools, Grove City, OH. He is the author of several automotive technology books. Reprinted from his newsletter, www.rob-thompson.net.

Fig. 1—Series circuit



Battery voltage ___________

Circuit resistance _________

Voltage drop 1 ____________ **Voltage drop 2** ____________

Ohm's Law predicted amperage _______ **Measured amperage** _______

Photo 1

Photo 2

Photo 3

Photo 4

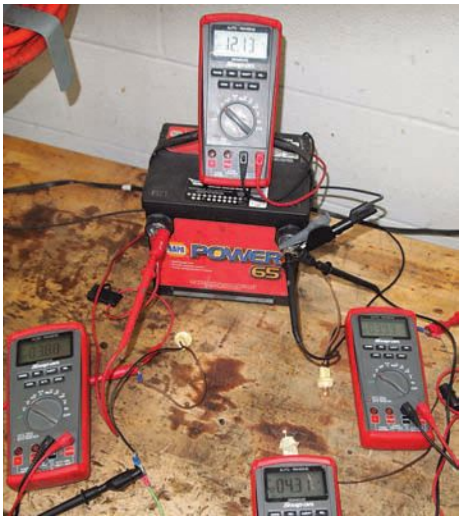


Photo 5

Photo 6

cuit acts the way is does. I find this circuit is particularly effective in helping to teach voltage drop and the effect of unwanted resistance on circuit operation.

Another way to reinforce how voltage drops affect a circuit is to have students set up a series circuit with DMMs connected, to show each voltage drop (Photos 5 and 6). Photo 5 shows the voltage drop of each bulb, and Photo 6 shows each referenced to the battery. Again, having students set up and measure voltage drop this way can really reinforce what is going on in the circuit, and creates a visual image in their heads about what voltage drop looks like.

Another benefit of using circuits and components such as those shown here is that as the connections and wires break, it automatically provides a supply of items that need repairing. This gives students practice cutting and stripping wire, installing terminals, and soldering pieces back together.

Continuing the theme, here are some more examples of using a scope to teach electricity. Figure 2 shows a three-bulb series circuit with a PICO scope connected to show each voltage drop and the current flow. While not earth-shattering, this set up does provide a good visual of how current remains constant in the circuit relative to the voltage drops.

Figure 3 shows a turn signal circuit using an old 552 flasher unit connected to an 1157 and a 194 bulb wired in an alternating-flash circuit found on many older GM products. In both Figs. 2 and 3, it is clearly visible that the bulbs require a small amount of time to heat up, which affects the current flow in the circuit.

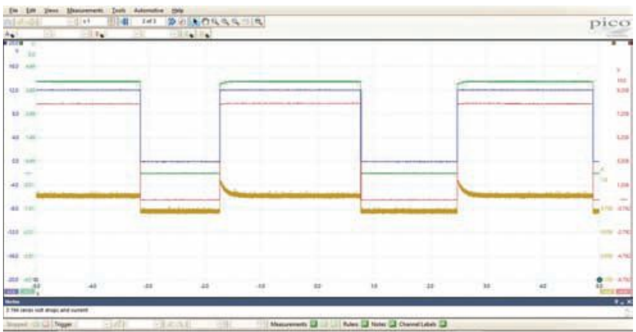


Fig. 2

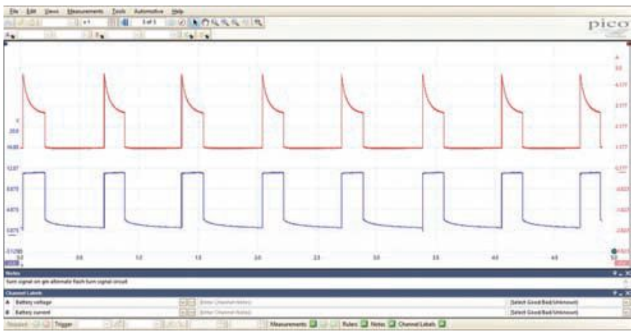


Fig. 3

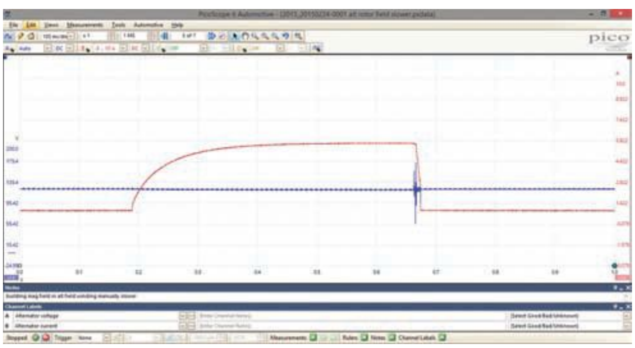


Fig. 4

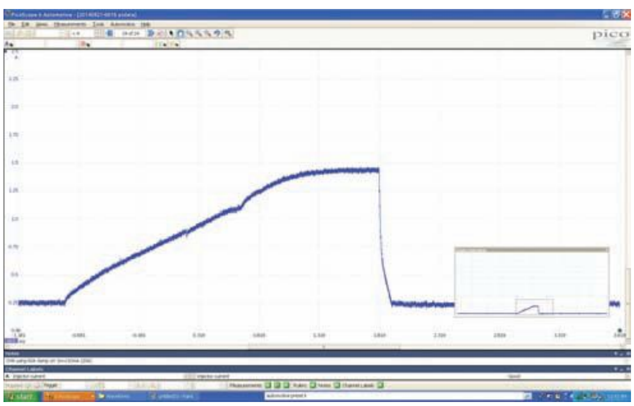


Fig. 5

Figures 4 and 5 show the current flow through two different types of windings. Figure 4 shows current flow through a generator field coil that has been removed from a generator. This type of demonstration is great when discussing electromagnetism and CEMF. Also, it's fun to toss small tools at a charged field coil to impress students with the strength of the magnetic field that is created.

Figure 5 shows current flow through a fuel injector. This type of image is nice because it shows how the movement of the core affects the magnetic field.

Figures 6 and 7 show two different power window circuits. Figure 6 is a passenger window, and Figure 7 is the driver's side window with the auto up and down feature.

Figure 8 shows battery voltage and current during cranking and starting on a known-good vehicle. With this one capture, you can show battery, cranking motor, and generator condition. Figure 9 shows the same vehicle during extended cranking to perform a relative compression test.

Once students have built and tested a variety of circuits, they take a pass/fail test. They have to build and test a series-parallel circuit of their own design, diagram the circuit, test resistance, current flow, and voltage drops correctly with me watching them work.

Once complete, they begin performing tests on school vehicles using lab worksheets (Figs. 10-12) to guide them. The main purpose of the circuit building is to get students used to using meters and taking measurements. A second

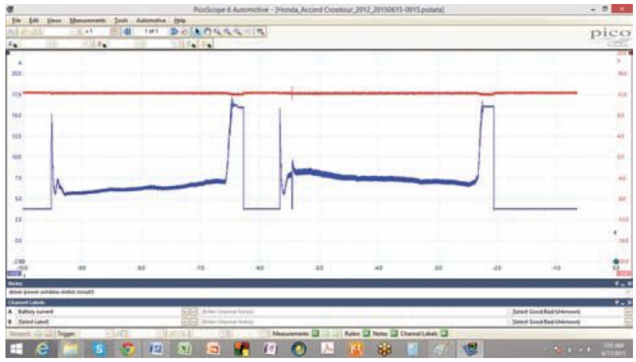


Fig. 6

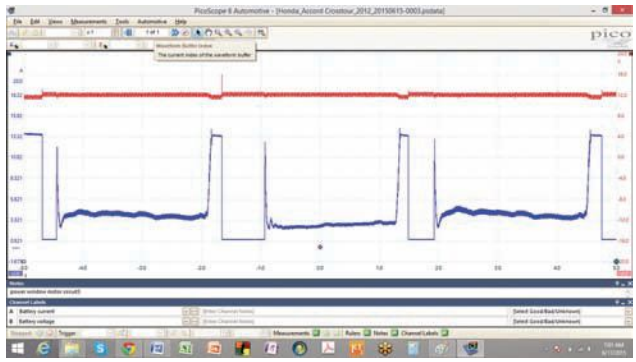


Fig. 7

Lab DMM worksheet

Perform the following measurements and record your readings.

Vehicle ____________________

1. Battery voltage at the battery __________
2. Battery voltage at underhood fuse ______ Difference ____
3. Battery voltage at an interior fuse _______ Difference ____
4. Battery voltage at headlight connector ___ Difference ____
5. Battery voltage at tail light connector ____ Difference ____

Vehicle ____________________

1. Battery voltage at the battery __________
2. Battery voltage at underhood fuse ______ Difference ____
3. Battery voltage at an interior fuse _______ Difference ____
4. Battery voltage at headlight connector ___ Difference ____
5. Battery voltage at tail light connector ____ Difference ____

Vehicle ____________________

1. Battery voltage at the battery __________
2. Battery voltage at underhood fuse ______ Difference ____
3. Battery voltage at an interior fuse _______ Difference ____
4. Battery voltage at headlight connector ___ Difference ____
5. Battery voltage at tail light connector ____ Difference ____

Fig. 10

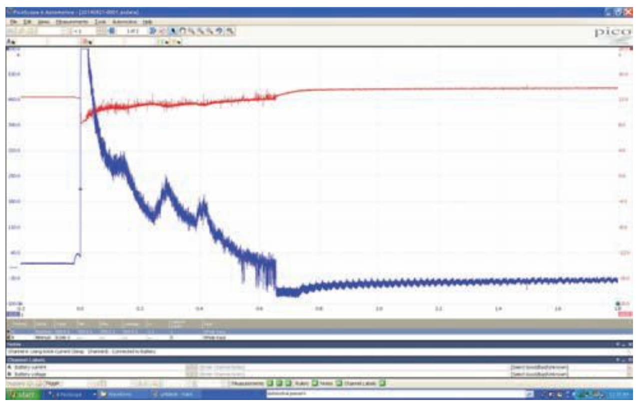


Fig. 8

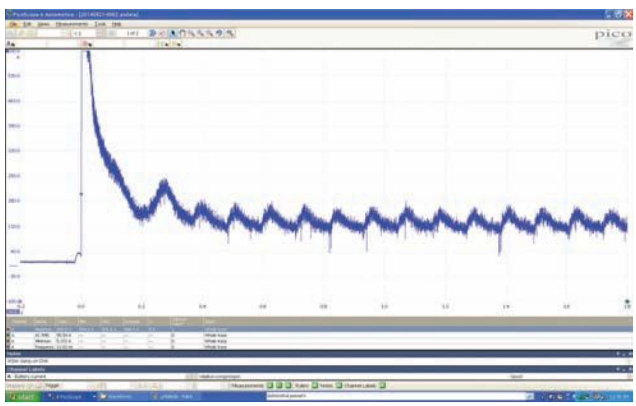


Fig. 9

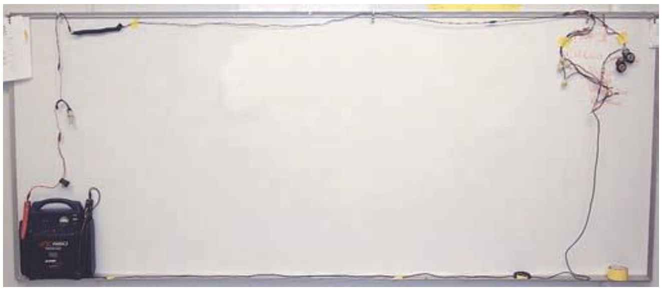


Photo 7

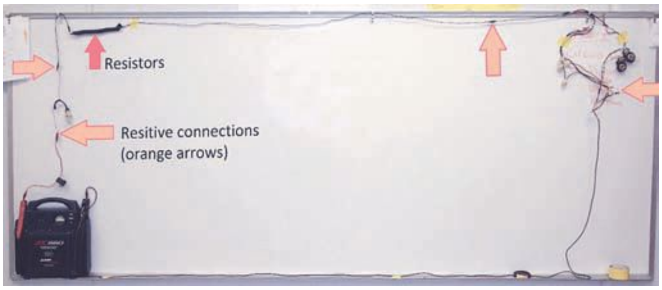


Photo 8

benefit is they can see how series, parallel, and series parallel circuits operate.

Transitioning to working on a vehicle is often where a stumbling block occurs. Students who have little experience with using a DMM usually do not transition easily to making measurements on vehicles and still confuse taking a voltage reading with measuring voltage drop. Additionally, students still may not have a good grasp of how voltage drops affect circuits on the car.

To help visualize an actual circuit, I put together a brake light circuit that approximates how it would be on the vehicle. In Photo 7, the brake light circuit initially is wired up to work normally. As a class, we go through each part of the circuit, discuss the functions and operation of the components, and use a meter to make measurements.

Once familiar with how the circuit works, I introduce several "bugs." Included in the bugs are damaged wires at the switch, two resistors wired in after the switch, and several poor connections at various points (Photo 8).

With the circuit taped to the board, students can easily visualize the circuit and then perform tests at various points to try out diagnosing and fixing various concerns. This usually starts some of the students on developing diagnostic techniques and thinking about how to find and repair electrical problems.

I've found that providing a circuit like this, and one that is removed from the car, allows students to get a much better idea of how a circuit is constructed, how it operates, and how to perform tests before being expected to tackle real problems on vehicles. ⓣⓓ

Voltage Drop Testing

Measure the voltage drop of the following components in operation.

Vehicle ____________________

1. Battery voltage at the battery _________
2. Voltage drop of headlight ___________ Difference ____
3. Voltage drop of parking light __________ Difference ____
4. Voltage drop of brake light switch ______ Difference ____
5. Voltage drop of battery ground cable ____ Difference ____

Vehicle ____________________

1. Battery voltage at the battery _________
2. Voltage drop of headlight ___________ Difference ____
3. Voltage drop of parking light __________ Difference ____
4. Voltage drop of brake light switch ______ Difference ____
5. Voltage drop of battery ground cable ____ Difference ____

Vehicle ____________________

1. Battery voltage at the battery _________
2. Voltage drop of headlight ___________ Difference ____
3. Voltage drop of parking light __________ Difference ____
4. Voltage drop of brake light switch ______ Difference ____
5. Voltage drop of battery ground cable ____ Difference ____

Fig. 11

Resistance Tests

Measure the resistance of the following components.

Vehicle ____________________

1. Headlight bulb ____________________
2. Tail light bulb ____________________
3. Brake light switch open ______ closed _______
4. Negative battery cable (disconnected from battery) ______
5. Speaker ________________________

Vehicle ____________________

1. Headlight bulb ____________________
2. Tail light bulb ____________________
3. Brake light switch open ______ closed _______
4. Negative battery cable (disconnected from battery) ______
5. Speaker ________________________

Vehicle ____________________

1. Headlight bulb ____________________
2. Tail light bulb ____________________
3. Brake light switch open ______ closed _______
4. Negative battery cable (disconnected from battery) ______
5. Speaker ________________________

Fig. 12

Continued from page 12.

Transforming the shop and learning the equipment was a challenge for the school, at first. The transformation was a huge commitment, but overall, was a necessity for the school to further their knowledge and better their classes. MHS now has grades 8-12 students flowing through the shop for all nine periods of the day.

Another eager-to-learn student who just successfully completed his final project on the class CNC router

"We are still learning how to integrate the new equipment into our teaching curriculum. It is a work in progress, but very much worth it. We also spend more time on designing and learning the Aspire, AutoCAD, and Inventor CAD/CAM programs. As a result, the types of projects have changed tremendously. Before, we used a lot of hard and soft woods, and now, we are using more plywood.

"We are getting the students to solve more real-world problems such as seating, flat pack furniture, and space organizers." Sommer stated that, "The biggest challenge to adding CNC into our program was that we were given two high-end CNC machines and high-end computer design programs all at once. This was overwhelming in the beginning, especially since we had little to no experience with these types of machines and software.

"Thanks to the training and exceptional tech support from Techno CNC Systems, we were able to get through the first few months and begin to develop a curriculum for our students. Now, our students are able to use the software and run the machines with no problems. The possibilities are endless."

MHS recently created an entire robotics team. Smith states, "The CNC equipment has been tremendously beneficial for our new robotics team, as well. We are able to manufacture our own parts, and we can customize any of our parts. It has also helped us with our alliances with other robotics clubs. We are now able to help other schools manufacture their own robotics parts."

Not only is the Fab Lab used for classes and manufacturing robotic team parts, but it is also used for many other activities that the entire town requires. Sommer explained how the CNC equipment has completely transformed the theater clubs in the elementary, middle, and high schools of Mineola. "Once word got out that we could manufacture pretty much anything, we were getting requests from everyone asking if we could create their designs."

Metal cutting project in the works on the classroom's Techno CNC plasma cutter

Paul Sommer and Andrew Woolsey, technology teachers at MHS, were also asked to help with theater design. They were given the project to create stage lighting from the bottom. They were able to route out an entire stage lighting template. "If we had to do these by hand, it would have taken months. We had to create six of these and I was able to program it all within minutes, letting the router do the rest," said Woolsey.

The tech teachers were also able to design and route perfect (and huge) theater props for the play.

"The students are taught the software, but are given freedom to think out of the box, challenging their young minds," says Sommer. He uses online tools available to him and the students for learning and finding quick solutions to immediate challenges. Sommer believes this is a great tool for students to use at home or in the shop, as a secondary way to master Aspire and AutoCAD software.

The program at MHS has completely transformed the learning process from conventional hand tools to now being able to design, program, and route whatever they imagine, as well as cut metals with their new CNC plasma metal cutting machine. "We had trouble cutting thick material so I had wanted to research a

Tech student, Sareem, works closely with Business Ownership and Marketing student, Tara, to design these wooden plaques to sell at their school store.

plasma cutter. It has changed the welding class by allowing us to cut thick plate steel accurately. In the past, we used a torch or hand-held plasma," said Sommer.

The students have developed a passion for CNCs, and are even considering manufacturing as a future. "As a high school, it is our job to prepare our students for the real world. We want our students to leave high school with an idea and direction, and with the possibility of getting a job that they love after school. We are really focused on getting kids to pursue a pathway for their future here at MHS and we concentrate on having electives that pave that pathway.

"We are using this CNC equipment not only in tech classes but in our business classes, as well. The CNC equipment has allowed us to create a school store where students can actually showcase and sell their projects. Not only has the CNC equipment benefited the tech students, but it has also made it possible for business students to practice marketing, design, and advertising, while having an idea come to life," said Smith.

The lab is designed to let the kids design whatever they want. "Basically, if you can draw it, you can route it," Sommer explained. The students are taught to create, design, program, and route, and have their visions come to life.

The Business Ownership & Marketing class at MHS works closely with the students from the Tech class to design and create a finished product. The Business Ownership & Marketing class students are responsible for designing the product to hopefully be sold in their new school store. The students then bring their ideas to the Tech students who bring their concepts to life.

"I first started to think of a product that I could sell at local events, like our musical events, or at our school store. I came up with a pic-

Continued on page 29.

Physics/Engineering Mash-Up Piques Student Interest

By Douglas Ripka
dlr11@scasd.org

STEM is a widely used term, not only in education but in the news media whenever jobs of the future are discussed. While we all know what the letters of STEM stand for, there are as many ways to implement it as there are people trying to do so.

After many years involved in STEM learning, I have come to believe that the classes that best represent what STEM can be contain three elements:

1. Interdisciplinary—since STEM has science, technology, engineering, and math in the name, any course must incorporate at least two to live up to the name.

2. Project based—students must be challenged with assignments that are not canned or have a predictable outcome. The struggle builds confidence in their ability to solve problems without relying on the teacher or other authority for validation

3. Team oriented—students working in teams learn to trade ideas, negotiate outcomes, and trust others while meeting their goals. While some projects can be individual, even those do not occur in a vacuum-students can see what other students are doing around them and learn, and improve on the ideas of others.

The nested Physics/Engineering Technology course was first taught in the 2009-2010 school year at State College Area High School, State College, PA. As a comprehensive high school with a full Career and Technical Center, as well as a Technology Education Department, there were plenty of opportunities for collaboration in the past, so a pairing of a science course with a technology class made sense.

After talking to faculty and administration, we decided to take two existing courses, Physics 1 and Advanced Engineering Technology and "nest" or pair them together. A student signing up for one would have to register for the other class as well. Only one section of Physics 1 was treated this way. Using existing courses allowed us to fast track the process. Otherwise, we would have had to wait a year to implement new classes as the proposals worked their way through the system. We were able to use the curriculum for the existing courses with minimal changes. The student received two separate grades, one for each class.

In the first year, we had a cohort of students enrolled for both classes. The standard Physics 1 curriculum already in use in the school was used, with a few additions of topics such as torque that future engineers might see in later engineering studies. The physics curriculum is algebra based. I was paired with a physics teacher who has an undergraduate degree in engineering science. Our duty for the last several years has been to assist in the other's class.

In the first year, the curriculum centered on VEX robotics (culminating in a regional Sumo-Robot competition), CAD/CAM, and designing and building a Rube Goldberg machine. For that, students had to present their designs to a panel of engineers for a design review.

Like all good teaching vehicles, we

Photo 1—Ben Rudnik and Nathan Schweitzer test and video record their golf ball launching machine. Another machine in the foreground clearly shows the photogates and LabQuest unit.

Douglas Ripka is an engineering technology teacher in the State College (PA) Area High School Career and Technical Center.

Photo 2—Daniel Briscoe and Jeanette Felmlee-Gartner working on taping their boat

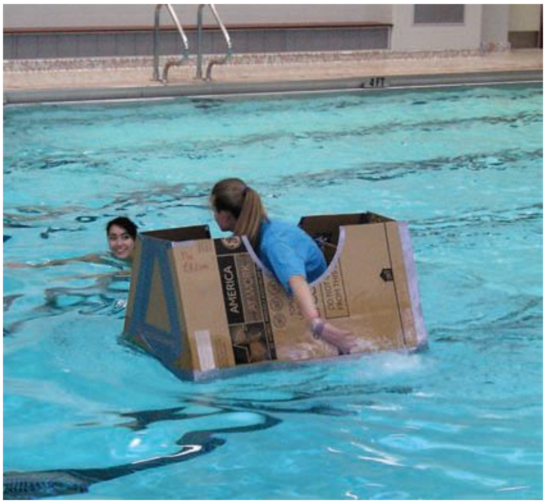


Photo 3—Chloe Melnick paddling her team's boat to the finish line

have evolved the curriculum to present new challenges to students. The Engineering Technology class had a weighted grade associated with it, so after two years, a weighted grade physics curriculum was created to put both classes on an equal footing. The enhanced curriculum includes engineering-related topics of torque, simple machines, thermodynamics, and rotational motion, while covering other topics such as kinematics to greater depth.

In the current year, the curriculum for the Advanced Engineering Technology course is as follows: (related physics concepts in parentheses)

- Safety, hand and power tool use
- CAD/CAM including laser, CNC, and 3D printing
- Golf ball launcher (2D kinematics)
- Cardboard boats (buoyancy and center of mass)
- Rube Goldberg machines with design review (work, energy, force, momentum, circular motion, kinematics)
- Complex machines (simple machines)
- Electrical project-creating a voltmeter or ammeter- (Circuit theory and Ohm's Law)
- Musical instrument project (sound and waves, vibrations in air and matter)
- Final Exam—use NSPE Code of Ethics to identify possible conflicts between the code and actual actions taken during engineering accidents in the last 50 to 60 years.

Students interested in taking the nested classes can apply to take the class during their junior or senior year. They must have passed our College Prep Algebra 2 and completed two science credits. About half of the students are returning engineering students, but there is no pre-requisite engineering course they must take. While the rest may have not taken engineering courses before, they may have taken courses that provide related skills and knowledge such as architecture, building construction, materials processing (formerly wood shop), and computer graphics courses. With such a diverse population, it is inevitable that some differentiated instruction occurs, for example in the CAD unit. Some students have never touched CAD before, some have never used Inventor before, and some have used SolidWorks or Inventor. Each student is challenged to learn new, or add to existing, skills.

We are piloting a STEM lab this year, in preparation for moving to a new/renovated high school. Students can go to the STEM lab to work on building all, or parts, of their engineering projects for which we don't have equipment. Students must be certified by the STEM lab teachers as passing safety tests and demonstrations before they can work in the lab. Currently, we are using the Materials Engineering Processing lab.

The golf ball launcher project is new this year, and we used the STEM lab to help create all or part of the machines. Each team was tasked to design a golf ball launcher, powered by heavy rubber bands. The angle of launch had to be adjustable between 30° and 60° inclusive, and students had to incorporate photogates to measure time of passage of the golf ball, and calculate velocity. They also had to measure the distance the ball traveled and account for the launch height (Photo 1).

Using the STEM lab allowed the students to access a wider array of hand and power tools than those found in the engineering lab. Many teams did part of their work in the STEM lab, then completed construction in the engineering lab, where we were better set up to mill slots in PVC pipe and do final assembly and test.

The next building project for the students is the cardboard boat project (Photos 2 and 3). Students learn about buoyancy and center of mass with this project; they also practice brainstorming, modeling, CAD, and building skills. After a team has done a rough sketch of their design, they calculate the displacement of the boat with the pilot/navigator/power source on board, along with checking the center of mass for their design.

After these calculations have been checked, the students draw up the design in CAD and add final dimensions to guide them during the building process. Then a scale model is made at 2" equal to 1' out of thin cardboard such as cereal boxes, which is tested in a tub for stability and tolerance to off-center loads. With this hurdle is crossed, students can proceed to create a full-size version of their boat. The completed boat is placed in the school swimming pool and timed as it goes across. If it survives the crossing, it is pulled out and put back in to see how long before it sinks, So, boats have to be designed for two tasks, speed and endurance.

The highlight for many students is the Rube Goldberg machine challenge (Photo 4). Put simply, a Rube Goldberg machine does a simple task in a complex way. Before students can start building, they have to prepare a set of documents that will be presented at a design review in front of a group of engineers from the local community. The presentation must address cost and schedule as well as the "tricks" or steps of the Rube Goldberg machine. Students gain insight into how real-world engineers go about designing something, as well as learn some soft skills such as making a good impression, communicating clearly, and meeting goals.

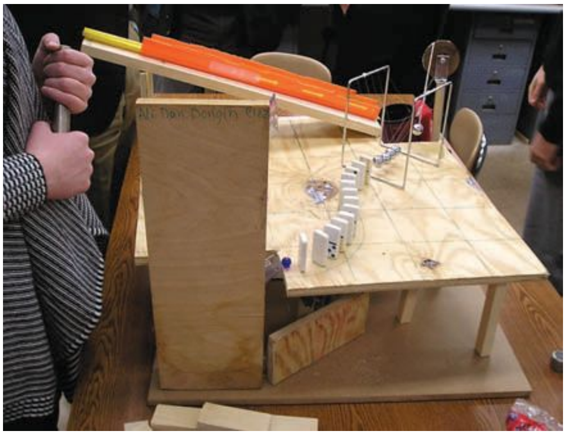


Photo 4—Part of one Rube Goldberg machine showing dominoes and a Newton's Cradle

Photo 5—One of the many musical instruments made in class

When we first proposed creating the nested course, one piece of feedback we received was that we were going to create an elite class, which would discourage some from participating. This has not turned out to be so. While many students who have a strong interest in engineering as a career have taken the classes, others who were unsure have taken the class and found their passion. Others have indicated that they have no intention of pursuing a career in engineering, but have gone on to college in majors as diverse as stage management, English, and business, or directly into the military.

Since we started the nested Physics/Engineering class, over 250 students have taken the class. Many have benefited from the close coordination of curriculum between the two classes. By regularly looking at curriculum outcomes and standards, we have been able to keep the class new and interesting to the students as well as relevant to their postsecondary careers. ⓣⓓ

Continued from page 26.
ture frame that has an adjustable picture frame in the center, where you can easily take the photo in and out of the heart shape. We came up with our ideas based on what people would be most inclined to purchase," said Tara, 17-year-old student at MHS.

Tara then brought her idea to Sareem Jabar, intern and student at MHS, who was able to bring her idea to life. The two worked together to make a design into a tangible product. "The business class pretty much feeds me the ideas. My job is to then put it on paper. Once I am able to do that, I program it into the machine. Just like that, I am able to cut out all of the products for the shop. I am so impressed with how precise everything is. The text is sharp and the corners are crisp, and everything fits together perfectly," says Jabar.

The students at MHS were excited to speak about their projects and new passions for CNC. Amazed at all the machines can do, the students bragged about being able to learn using such advanced equipment at a high school level. Most importantly, the students could explain and teach other students what they did, how they programmed it, and what tools they used to complete the project.

The students' energy is contagious, making more and more students want to enroll in the tech classes offered at MHS. "We have always had good enrollment. But we are definitely getting more students coming in who were intimidated by the traditional machinery in the past. Once they see that they can pretty much rapid prototype anything that they can draw and design on the computer, they immediately want to take the class," says Sommer. He ended with saying, "CNC is absolutely a necessity for any high school, and we are so happy and proud to have invested in such quality equipment for our students to learn and prosper." ⓣⓓ

The Time is Ripe for Tech Apprenticeships

By Eric Larson

THE U.S. Bureau of Labor Statistics predicts by 2024 there will be more than 1.2 million open jobs in information technology due to a combination of industry growth and Baby Boomer retirements. This trend has troubling implications for the entire U.S. economy, because employer demand for tech talent already routinely outstrips the available supply. Analysts estimate at least half a million open IT positions already go unfilled in the U.S. during any given calendar quarter.

This looming IT skills gap is forcing many organizations to rethink approaches to recruiting, training and talent management.

For example, for CompTIA's latest IT research brief—"Employer Perceptions of IT Apprenticeships"—we asked more than 550 U.S. hiring managers about issues they face. More than two thirds (67%) expect filling openings with the right candidate to be challenging during the next two years. Moreover, nearly all (99%) note at least one specific challenge they currently endure, such as finding candidates with the right level of experience, finding candidates with the right "hard" technical skills and identifying candidates with the right "soft" business skills.

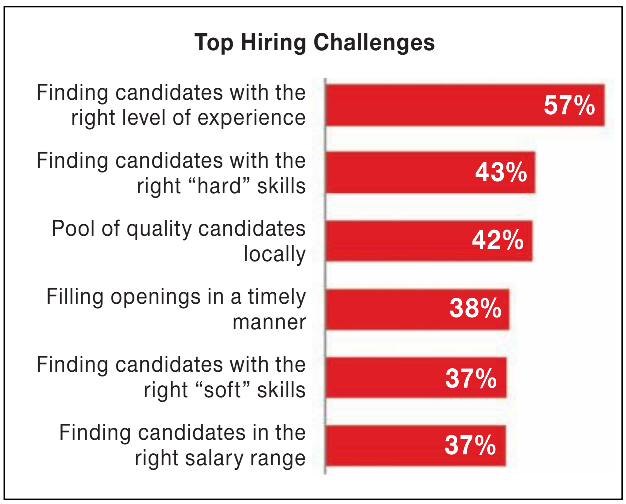
Our recent study revealed that six in 10 hiring managers have a generally positive view of apprenticeships, with most of the remaining respondents holding a neutral perception (38%) and a minute group expressing negative opinions (2%). Regarding IT

apprenticeships, eight in 10 managers polled believe the concept has merit. Furthermore, a large group (83 %) could envision their company exploring a formal IT apprenticeship program.

As advocates for the IT industry, we find this new openness to the classical apprenticeship model refreshing and encouraging. Why? Because apprenticeship is a time-tested technique for rapid skills development which can begin closing the tech talent gap in comparatively short order. Specifically, apprenticeships enable employers to tap three potential sources of IT talent:

• **Skilled workers in other fields**—Consider the field of cybersecurity as a case study. A 2017 study shared by the Wall Street Journal showed about 87 % of professionals now working in cybersecurity did not start there. Nearly a third (30 %) came to their positions from fields outside technology, such as marketing, finance, and the military. Fully a third of chief information security officers and other upper levels in cybersecurity today started with roles outside IT departments, researchers reported. These findings suggest many companies need look no farther than their own ranks to find viable cybersecurity talent, so long as they are willing to look beyond the IT department.

• **Groups currently underrepresented in IT**—Our organization's pre-apprenticeship training program, IT-Ready, offers eight weeks of intensive, classroom-based education and training free of charge. We



Eric Larson is senior director of Creating IT Futures' signature initiative, IT Futures Labs, which discovers and develops research, projects, programs, and best practices for charting new pathways to tech careers.

Top Apprenticeship Program Benefits Organizations Could Realize or Have Realized

1. Opportunity to train workers to suit needs (63%)
2. Opportunity to address skills gaps early in a worker's career (50%)
3. Opportunity to engage with local schools, community colleges & other feeders (44%)
4. Opportunity to hire an employee loyal to the company (43%)
5. Opportunity to hire a worker ready to contribute from day one (43%)
6. Opportunity to attract a more diverse pool of candidates (41%)

seek participants from groups currently under-represented in the IT industry, including: unemployed, under-employed and displaced workers, women, ethnic minorities, and veterans and their spouses.

IT-Ready students learn skills that include building a computer from parts, installing software, troubleshooting problems, and setting up and managing networks. We also instill softer professional skills, such as effective communication, customer service, and job interviewing. At the end of the eight-week program, IT-Ready students take our A+ certification exam and are encouraged to pursue other CompTIA credentials, such as Security+, free of charge after graduating.

We connect the graduate to local companies with whom we have close relationships. The students are ready for paid work, be it a full-time tech support role or an apprenticeship that leads to a specialization such as cyber-security. Our experience over the past five years has convinced us that non-traditional students can be viable candidates for IT apprenticeships.

• **Students under-trained in college**—In one of our other studies, "Assessing the IT Skills Gap," 87 % of the 600 U.S. IT and business executives surveyed across a variety industries agreed with the statement "Colleges are not sufficiently preparing students for today's jobs" including cybersecurity, which ranked among our poll's top five IT skills gap areas.

Companies can apply the apprenticeship solution to this channel, too, by creating what we call "sustained internship" programs. In short, college students (and sometimes qualified high school candidates) work as interns for the same organization summer after summer with the promise of a full-time position upon graduation. This approach lends a real-world immediacy to cybersecurity awareness and other technology training often lacking in classroom settings.

In Chicago, our home market, we collaborate on this approach with Accenture, Cisco, and IBM. To add greater weight to our argument, yet another of our recent studies—"Youth Opinions of Careers in Information Technology"—indicates apprenticeships are a viable means of interesting teenagers in IT jobs. About four in 10 teens we canvassed recognized apprenticeships as a credible source of career guidance. We believe that today's college students—not to mention tomorrow's high school graduates—are open to apprenticeships as their entry into tech careers.

So, whether focusing on talent inside or outside an organization, apprenticeships can supply companies with a more predictable, sustainable pipeline of applicants, while providing new technology workers with necessary experience, education, and mentorship. Through apprenticeships, businesses can overcome the current scarcity of tech professionals and prepare their workforce for today's—and tomorrow's—IT challenges, such as cybersecurity.

There's no shortage of evidence: Today's workforce and employers say they are ready for apprenticeships. The question remains: Will companies bite the bullet and deploy this powerful model to bridge the IT skill gap? The economy is waiting for an answer. td

Teacher Training Opportunities

Continuing education options that provide a great way for career-technical and STEM educators to catch up with current technology, upgrade skills, and further their graduate education.

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two	number
couple	two
plane	undefined term in geometry
half	fraction
sum	addition
bit	binary digit
cent	hundred
dot	dot-product
rule	a ruler or algorithm
slant	slant height of solids in geometry
fair	in game theory or statistics (dice)
fairly	in game theory
unfairly	in game theory? This word uses ALL 8 buttons!!!!
flow	as in flow chart?
plot	on a coordinate system
loci	plural of locus (location)
foci	plural of focus
trial	in statistics
flip	in probability (coin tossing)
nu	Greek letter used in statistics
box	box plots in statistics

If your students find any others, please let us know!

Time for Change

15 Sickles and 14 Knuts.

Yes, I know that Harry shouldn't have given the three Knuts because he got them right back in change but he didn't really understand the monetary system, so he just gave all the change that he had in his pocket.

School's Out!

They were dismissed from school at 2:30 P.M. and walked 2 miles. Sally got home at 3:30 PM.

To solve this problem, let x = the number of hours for Dick to walk home. Then Dick traveled $4x$ miles home.

Jane must have traveled for x + 1/6 hours, so she walked $3x + 1/2$ miles home. Since they lived at the same house, set $4x = 3x + 1/2$ and solve for x.

$x = 1/2$ hour.

Since Dick arrived home at 3:00 PM, he must have been dismissed at 2:30 PM. So, the distance from home to school is 2 miles. (it checks in both expressions above).

Since Sally walked at 2 mph for 2 miles, it took her 1 hour to walk home. Therefore she got home at 3:30 PM.

Social Security BeneFits!

The answer is 78 years, 0 months.At that age, the total of all the reduced monthly benefits will equal the total of all the full monthly benefits.

To solve, let x = Full monthly benefit.

Let n = number of months from age 66 until the two totals are equal.

Then the reduced monthly benefit is .75x.

There are 4 years or 48 months between age 62 and age 66, and if he retired at age 62, he would be getting the reduced rate for that many months.

So, $48(.75x) + n(.75x) = nx$

Solving this equation, x will divide out, and you obtain n = 144 months.

So, the two totals will be equal in 144 months from age 66.

Since 144 months = 12 years, the age that Mr. P is looking for is 78 years 0 months.

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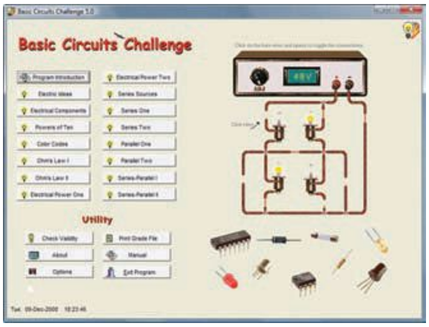

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You may use a button only once in each word, and words must be two to eight letters in length. Abbreviations do not count.

Time for Change

In *Harry Potter and the Sorcerer's Stone* by J.K. Rowling, Hagrid explains the monetary system of the wizards to Harry:

The gold coins are Galleons

17 Silver Sickles = 1 Galleon

29 Knuts = 1 Sickle.

How much change should Harry get if he buys a broomstick that costs 1 Galleon, 5 Sickles, and 18 Knuts? He gives the cashier all the money that he has in his pocket: 2 Galleons, 4 Sickles, and 3 Knuts.

School's out!

Dick, Jane, and Sally, all siblings who live together, left school at the same time and walked home.

Dick walked at 4 mph, Jane walked at 3 mph, and Sally walked at 2 mph. Dick got home at 3 p.m. and Jane got home at 3:10 p.m.

What time were they dismissed from school, how far did they walk, and when did Sally get home?

Social Security Benefits!

Mr. P was born between 1943 and 1954, so his full retirement age for social security monthly payments is age 66.

However, he can begin receiving a reduced monthly benefit at age 62. The monthly retirement benefit is reduced by 25% and he would continue to receive that reduced amount for the rest of his life.

Mr. P wants to know what age he would be (year and month) when the total amount of the reduced monthly benefits from age 62 to this age would equal the total of all the full monthly benefits from age 66 to this age.

Please give your answer in years and months (for example, 67 years 2 months).

All puzzles on this page devised by David Pleacher, www.pleacher.com/mp/mpframe.html

See answers on page 32.

"No, I didn't give him my cell phone to play with. I gave it to him to program.

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.

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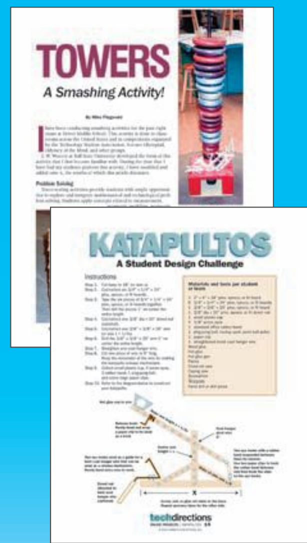

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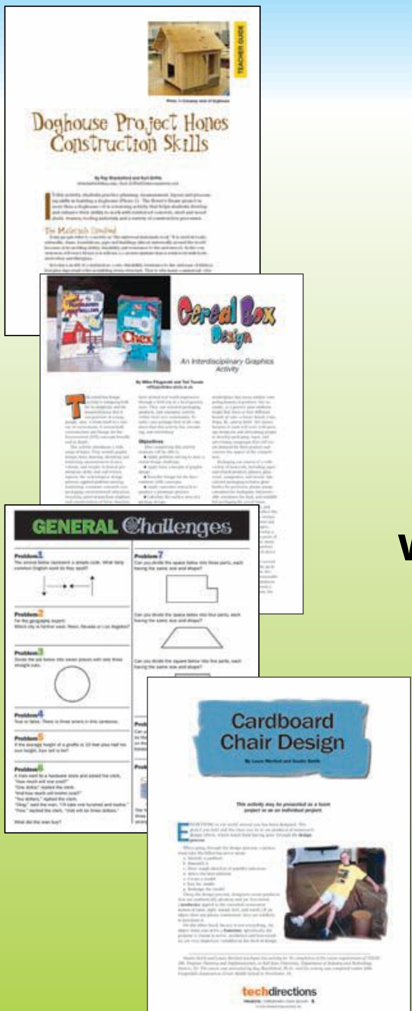

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