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linking education to careers

OCTOBER 2018

## Tesla, Edison, and the AC/DC War

## Climbing Wind Turbines to the Middle Class

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**Vanessa Revelli** [vanessa@techdirections.com](mailto:vanessa@techdirections.com)



I found an interesting piece this week about a voucher program CompTIA is running in California. I thought I would share it with you, as it is a different approach to getting kids into the field.

As anyone who has worked in IT knows, certifications are key to a successful career. The earlier someone can obtain them, the better equipped they'll be to meet the demands of the cybersecurity workforce. However, certifications are expensive and the process to earn them is complicated. A new partnership between the California Cyberhub and the Computing Technology Industry Association (CompTIA) is already streamlining the process and opening up certifications to middle and high school students across California.

The vouchers allow students to obtain CompTIA IT Fundamentals certification by watching free video training on ITProTV and completing exercises on virtual machines through Practice Labs. The entire program is free to schools and other organizations that apply exam proctors through the California Cyberhub, thanks to funding from the California Community Colleges Information Communication Technologies and Digital Media sector.

The founder of the voucher program is Steve Linthicum. He has a strong relationship with CompTIA and negotiated a partnership with CompTIA, ITProTV, and Practice Labs while attending the CompTIA Academy Partner Program Summit last summer.

One of the voucher program's students is Christian Pinkston. He was nervous before an exam he took recently, but not in the way you might expect. Rather than studying for history or chemistry, he was preparing to take a CompTIA IT Fundamentals certification exam.

"It was a lot of focused studying in class, in groups, and long nights staying up so when the day came it was going to pay off," he said. "The test itself was very nerve-wracking and in some ways scary, but the feeling you get when you pass is amazing."

Pinkston came close to dropping out of high school before he found technology. His teacher, California Cyberhub Community Manager Donna Woods, witnessed the transformation as he discovered his future in IT.

"He had given up, but we found where his strengths were and worked with those abilities," Woods said. "He literally jumped out of his seat when he found out that he passed the exam."

Establishing the importance of certifications early on is essential for getting students to buy into the idea that they are important for success in IT and cybersecurity. In fact, certifications can lead to a high-paying job that does not require a college degree—especially when combined with apprenticeships and other professional experience.

"Entry-level positions do not require an associate or bachelor's degree. Students entering this career path can obtain additional higher-level certifications through courses offered by California's community colleges," Linthicum said.

*Vanessa Revelli*

## techdirections

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**Senior Editor** Susanne Peckham, [susanne@techdirections.com](mailto:susanne@techdirections.com)

**Art, Design, and Production Manager** Sharon K. Miller

**Advertising Sales Manager** Matt Knope, 800-530-9673 x302, [matt@techdirections.com](mailto:matt@techdirections.com)

**National Sales Consultant** Jim Negen, 320-281-7454, [jim@techdirections.com](mailto:jim@techdirections.com)

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By Sarah Garland  
An increasing number of wind turbines, and a new HS program, are bringing much-needed job opportunities to a small Texas town.

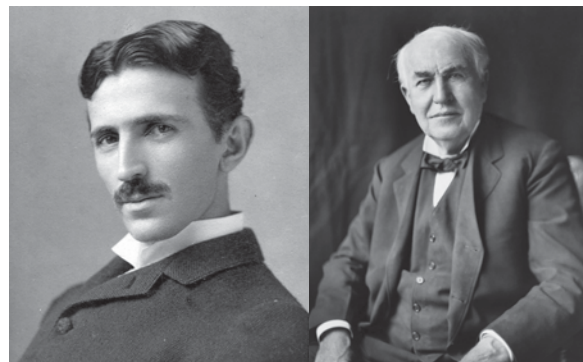
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# the news report

Vanessa Revelli  
vanessa@techdirections.com

## Register Now for the ExploraVision Competition

Toshiba and the National Science Teachers Association (NSTA) are kicking off the 27th annual Toshiba/NSTA ExploraVision competition, officially opening registration for entries. The ExploraVision program, sponsored by Toshiba and administered by NSTA, tasks students to use problem solving, critical thinking, and teamwork to imagine solutions to real-life issues. Participants will have a chance to win a number of prizes, including \$10,000 U.S. Series EE Savings Bonds (at maturity). Registration is now open until Feb. 8, 2019 at ExploraVision.org.

In the ExploraVision competition, teams of two to four students research scientific principles and current technologies to design innovations that could potentially come to life 20 years from now in response to a problem facing our world. Teams are aided by a teacher and an optional mentor as they simulate real scientific research and propose how they might execute their ideas. Semi-finalist teams then create mock websites and prototypes to bring their concepts to life. Last year's winning ideas ranged from projects on innovative disease prevention to innovations that provided artificial intelligence support for farmers.

Since the program launched in 1992, ExploraVision has helped nearly 400,000 students across the United States and Canada to cultivate a life-long passion for science, technology, engineering, and mathematics (STEM). The competition is also used by teachers to engage and excite students about the science and engineering practices found in the Next Generation Science Standards. By participating in ExploraVision, students must ask questions, plan and carry out investigations, and analyze and interpret data.

"Toshiba is proud to sponsor ExploraVision and to partner with NSTA to bring STEM education to students throughout North America," said Noriaki Hashimoto, Chairman & CEO, Toshiba America, Inc. "In its 27th year, we know that ExploraVision will continue to inspire creativity in its participants. We are thrilled to again provide the world's young STEM visionaries the opportunity to push themselves and develop the skills necessary to make their ideas a reality."

"Every year, the students who participate in the ExploraVision competition bring enthusiasm and inspiration to their schools and communities," said Dr. David Evans, Executive Director, NSTA. "Students not only explore the issues that affect our world, but are given a platform to develop solutions to tackle these issues. We have been impressed by the scope and impact of the projects completed over the past 27 years and the number of projects



that presaged actual innovations. We are looking forward to seeing what the next year of submissions will bring.”

All first- and second-place national winners will receive an expense-paid trip for themselves, their parents/guardians, teachers, and mentors to Washington, DC, for a gala awards weekend in June 2019.

For a brainstorming sheet to help students decide what problem their team will try to solve, visit <https://www.exploravision.org/sites/default/files/Brainstorming%20reference%20doc.pdf>.

Teachers looking to add project-based learning to their classrooms can visit <https://www.exploravision.org/lesson-plans-for-teachers> to receive free downloadable STEM lesson plans.

To register for the 2018/2019 competition, visit [www.exploravision.org](http://www.exploravision.org). Follow ExploraVision on Twitter at @ToshibaInnovate and Facebook at [www.Facebook.com/ToshibaInnovation](http://www.Facebook.com/ToshibaInnovation) for updates on the program.


## Krystal Foundation Opens School-Grant Window for 2018-2019 Academic Year

The Krystal Foundation is accepting applications for grants supporting local enrichment programs in science, technology, engineering, art, and mathematics (STEAM) as well as music, sports, and culinary arts. Sponsored by The Krystal Company, the Foundation has awarded over \$78,000 in grants to 37 schools across Krystal’s 11-state footprint in the southeast since its inception in 2016. The current grant window extends to October 1 with award recipients to be announced on October 22. “We’re committed to supporting students, families, and schools in Krystal communities,” said Sloane Perras, president of The Krystal Foundation and Krystal’s chief administrative and legal officer. “We want to give back to the teachers and schools that are making a meaningful difference for the children of our customers and employees. It’s part of our corporate DNA.”

In March, the Krystal Foundation provided Chattanooga-based Cleveland Middle School with grant

funding to help students combine virtual reality (VR) and augmented reality (AR) to create lifelike learning experiences that are both immersive and interactive. Previous grant award winners include Leroy Massey Elementary School in Summerville, Georgia, funding iPads and Sphero robots to assist students in applying hands-on coding skills, and Lanier Elementary School in Tampa, Florida, helping to create math, arts, music, culinary, science, gardening, and technology leadership clubs.

Krystal will open a second grant window from November 1-December 31, 2018 and will announce those award recipients in 2019. Teachers, principals, school faculty, PTO/PTA groups, and other K-12 school-affiliated organizations are all eligible to apply.

Those wishing to apply for a grant may do so by visiting [thekrystalfoundation.com](http://thekrystalfoundation.com). 

*Vanessa Revelli is managing editor of techdirections.*



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**Alan Pierce**

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## Converting Carbon Dioxide from Our Atmosphere into Synthetic Fuels

Scientists tell us that global warming is happening because of the ever-increasing amount of greenhouse gases that have been pumped into our atmosphere since the start of the industrial revolution. Greenhouses gases trap heat in our atmosphere in much the same way that the win-

dows of your car trap heat inside your vehicle on a sunny day.

Figure 1 shows the percentage of the different greenhouse gases that entered our atmosphere in the U.S. in 2016. To slow down global warming, it is important to reduce all greenhouse gases, as you can see from the

chart, especially carbon dioxide (CO<sub>2</sub>). To reverse global warming we need to physically start removing greenhouse gases, especially CO<sub>2</sub>, from our atmosphere.

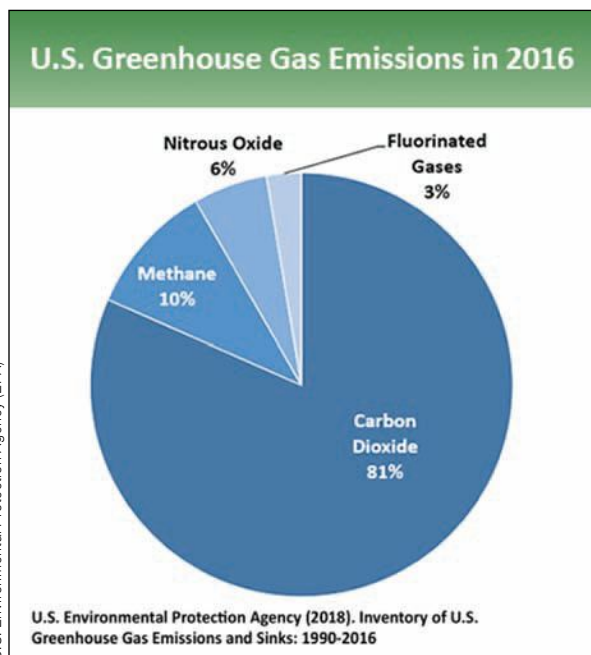
A new technology that can convert carbon dioxide from our atmosphere into synthetic fuels has been developed under the leadership of David Keith, a professor of applied physics at Harvard's School of

Engineering and Applied Sciences. The engineering systems that were developed are a combined effort of teams from Carnegie Mellon University and the University of Calgary in Alberta, Canada. Bill Gates is one of the private investors that has helped fund this entire project.

The company that David Keith and his colleagues founded to take this beyond a university laboratory proof of concept is named Carbon Engineering and they have built a fully functional test facility in Squamish, British Columbia, Canada (Photo 1.)

Carbon Engineering's test facility has proven it is possible to capture CO<sub>2</sub> from the air and turn it into a fuel that can replace fossil fuels. They are recycling carbon dioxide back into different fuels thereby reducing the amount of this greenhouse gas in our atmosphere. The test facility has proven that their process can create fuels in mega quantities from water and air using electricity that only comes from renewable sources.

This is the first time that CO<sub>2</sub> has been captured and recycled back into a fuel on an industrial scale. Carbon Engineering has created an industrial life cycle for carbon dioxide that parallels the natural world's life cycle where photosynthesis is used by green plants to convert CO<sub>2</sub> into carbohydrates and oxygen, which



**Fig. 1—Environmental Protection Agency graph shows that approximately 81% of the greenhouse gas in our atmosphere is carbon dioxide.**



**Photo 1—Carbon Engineering has built a fully functional pilot plant in Canada that is now converting CO<sub>2</sub> into synthetic fuels.**



**Photo 2—The giant fan in the center of the air contactor sucks in the air so other parts of the facility can separate out the CO<sub>2</sub> for processing into synthetic fuels.**



in turn is used by animals to sustain their metabolic needs and produce CO<sub>2</sub> which the plants need to continue running the cycle.

Carbon Engineering's process begins with Direct Air Capture (DAC).



Carbon Engineering

Here the company uses giant fans to pull in the air (Photo 2), and then a special chemical solution to pull the CO<sub>2</sub> out of the air that they have captured. Once most of the CO<sub>2</sub> is removed from the air, the air is released back into the atmosphere. In a two-step process the CO<sub>2</sub> that they collected is made ready for easy storage for later conversion into synthetic fuels (Photo 3.) The different liquids they use in all the different processes are part of a closed loop system and they are never released into the environment. They perfected their CO<sub>2</sub> capturing process in 2015.

The next step in their conversion process combines hydrogen, which they create by the electrolysis of water, with the CO<sub>2</sub> to produce their synthetic fuels. Their process can produce fuels that match the needs of cars, buses, and even airplanes. The pilot proof of concept that it was possible for the company to create the different types of fuels that could meet the needs of different types of engines was completed in 2017.

What is most significant about their 2017 achievements is they have

*Alan Pierce, Ed.D., CSIT, is a technology education consultant. Visit [www.technologytoday.us](http://www.technologytoday.us) for past columns and teacher resources.*

proven that their technology can pull a million tons of CO<sub>2</sub> out of the air a year and turn it into different fuels. Also, they can produce their synthetic fuels in the quantities needed to start weaning us off fossil fuels.

Photo 3—The reactor is one of the many machines that helps process and convert the CO<sub>2</sub> into a fuel.

For this to happen, this technology would need to be adopted and commercially deployed throughout the world. Their goal is to spend the next three years determining that the pilot facility can be scaled up into full-size production facilities. If they do reach all their targets, they hope to start building plants all over the world where each one can produce 2,000 barrels of fuel per day.

Exhaling or absorbing CO<sub>2</sub> is part of the life cycle of most living organisms that inhabit our planet. Carbon Engineering envisions a new life cycle for the carbon dioxide that our engines of industry release into our atmosphere, one where the CO<sub>2</sub> is captured and turned back into fuels. This Carbon Engineering YouTube video can further your understanding of their process. [www.youtube.com/watch?v=mG9FZ9zqOdo](http://www.youtube.com/watch?v=mG9FZ9zqOdo).

### Taking it a Step Further

1. What existing technologies are already in use that reduces the production of greenhouse gases?

2. Scientists and engineers are working on other methods to turn CO<sub>2</sub> into food (artificial leaf) or just scrub it from our atmosphere and sequester it somewhere safe. Working in teams, research the different possible solutions to global warming. 🌐

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## Maria Longworth Nichols Storer and Rookwood Pottery

Some popular television programs feature ordinary people bringing in antique items for evaluation.

They often include clocks, paintings, furniture, and Rookwood pottery. Rookwood vases are moderately sized containers with unusual glaze colorings. Maria Longworth Nichols Storer started the Cincinnati company in 1880. It was the first female-founded manufacturing company in America and became a world renowned business. Its vases, decorative tiles, and other products exhibit an elegant simplicity.

Maria Longworth was born in Cincinnati in 1849. She and three

siblings grew up in one of the city's wealthiest families and she had all the trappings of life that money could provide. Her father had a large collection of artwork, and private tutors encouraged Longworth's interest in painting and pottery.

She married George Nichols when she was 19



**Maria Longworth**

and soon after entered the Art Academy of Cincinnati. She and Nichols had two children. Longworth became

skilled at painting pottery before firing in the academy's kilns. Her earliest works were displayed at the Women's Pavilion of the 1876 American Centennial Exposition in Philadelphia.



**The Rookwood Pottery factory**

Longworth was particularly interested in glazes and in 1879 helped finance a specialty kiln at a local pottery shop. She had unfired pieces made to her specifications and painted

them with her experimental glazes.

The talented Longworth established Rookwood Pottery the following year in a renovated school building. Its name came from the 15-acre estate where she was raised. Her father had named it Rookwood because of the many crows (also called rooks) that roosted in its trees.

Longworth's pottery business began with just a few employees whom she encouraged to use new ideas to create fine art. Rookwood's products were sold locally and at upscale outlets in Boston, New York, and other cities. At the time, American pottery was considered unrefined and Longworth aimed to change that perspective.

She spent much of her time developing new glazes and techniques for applying them. Longworth received a patent in 1887 titled Manufacture of



**Above, an Aladdin vase**

**Right, a Black Iris vase, which sold for \$350,000 in 2004**



Pottery that dealt with her improved glazes. She and her artists used traditional brushes as well as an airbrush they called the "mouth atomizer." It gave each product a unique individual look.

One of Longworth's personally designed pieces was her 1882 Aladdin Vase. It was the largest underglaze decorated vase in America and its large 18" diameter made it technically difficult to produce. That same year, a grouping of her work won a top prize at the Tenth Cincinnati Industrial Exposition. Through

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





Interior image of the Rookwood Pottery factory

1883, the company had sold about 200 pieces.

Longworth won a gold medal at the 1889 Paris Exposition, her highest artistic achievement and a surprise to European potters. The award altered the way American ceramics were viewed and provided a major boost for Rookwood Pottery.

It was about this time that Longworth had a large factory built a few miles away and production expanded. Her husband had died in 1885 and she married Bellamy Storer the next year. He was elected to the U.S.

Congress in 1891 and Longworth found it necessary to reduce her efforts at the company. She eventually transferred ownership to others.

A 1900 Black Iris vase is the most valuable piece Rookwood Pottery ever produced. It sold in 2004 for over \$350,000.

The company began making decorative flat tiles in 1902 for household and public interiors.

Their tiles adorn walls at Grand Central Terminal in New York City, the Guardian Building in Detroit, and the Monroe Building in Chicago. Rookwood Pottery is still in business in Cincinnati.

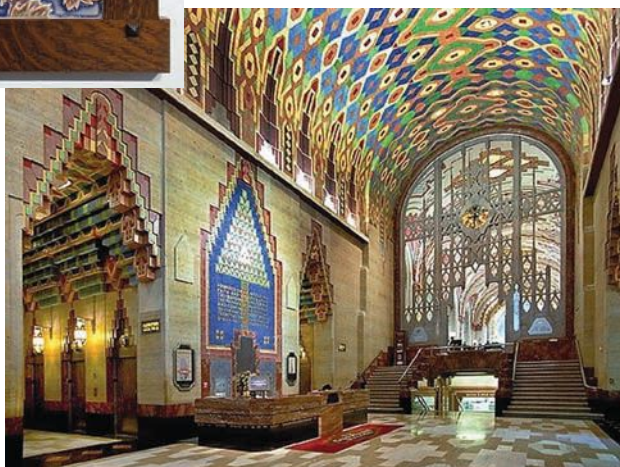
Longworth's second husband was appointed ambassador to Austria in 1902 by president Theodore Roosevelt, a family friend. She lacked political insight and persistently lobbied the president on behalf of certain individuals. Her husband lost his ambassadorship partly because of her activities. They relocated to France where Longworth died in 1932. ©

#### References

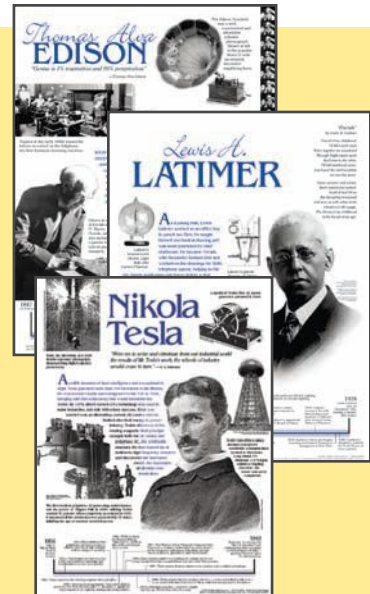
Boehle, Rose Angela. (1990). *Maria Longworth—A biography*. Landfall Press.  
*The Cincinnati region official Visitors Guide 2018*. (2018). Cincinnati Magazine.



Above, a Rookwood Pottery tile



Right, Rookwood tiles in Detroit's Guardian Building



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1.  $52 - x^2 + x = 10$  does not yield just the number 7. When you solve a quadratic equation, there are two solutions: -6 and 7.

2.  $3(\pi - .14)$  does not equal 9.  $\pi$  does not equal 3.14 but continues infinitely 3.14159....

### Let's Rock!

Paul plays the guitar, John plays the drums, and George plays the piano.

### A Glass Menagerie?

There are 22 birds and 14 beasts. Let A = number of birds and B = the number of beasts. Then  $A + B = 36$  and  $2A + 4B = 100$

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- |      |       |
|------|-------|
| 1. F | 6. A  |
| 2. J | 7. B  |
| 3. D | 8. E  |
| 4. C | 9. G  |
| 5. H | 10. I |

# Tesla, Edison, and the War of Currents

By Michael Parks

**T**HE latter part of the 19th century saw the first footsteps in a technological revolution that would dwarf all the advances made up to that point. Electrification profoundly changed every aspect of human life. Not only did electrification change existing technologies of the time (oil lighting to electric light bulbs), but it also created entirely new products previously undreamt of such as radio.

While we take our current electricity-based infrastructure and society for granted today, the path to this point was not as straightforward as we might like to remember. In the late 1880's there was a "format war" raging much like our modern-day VHS versus Betamax and Blu-Ray vs HD-DVD skirmishes. In those years Alternating Current (AC), whose figurehead was the Serbian-American eccentric genius Nikola Tesla, was battling Direct Current (DC) and it's brilliant but arguably more business savvy Thomas Edison. In the end compromises were struck and electrification of the world could jump from blueprint to reality.

## AC vs DC

At the heart of the argument, the utility of AC versus DC comes down

---

*Michael Parks, P.E. is the owner of Green Shoe Garage, a custom electronics design studio and technology consultancy in Southern Maryland. He produces the S.T.E.A.M. Power Podcast to help raise public awareness of technical and scientific matters. Reprinted with permission by Mouser Electronics, [www.mouser.com](http://www.mouser.com).*

to good old engineering tradeoffs. In the 1880's DC was less efficient to transport over long distances since line losses were significant compared to the DC voltage levels that could be generated. Thus, powering the world with DC would require a larger amount of power generating stations dotting the landscape. However, for 1880's machinery generating direct current was much simpler, giving it somewhat of a technological advantage.

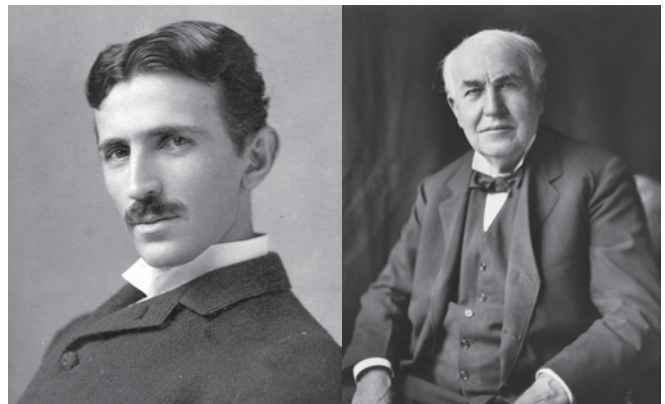
In contrast, alternating current required much more precise machinery to generate the oscillating electrons but AC transmission was far more efficient over large distances. These two solutions very much reflect the mindsets of their champions. Tesla tended to be more theoretical and able to invent in his mind's eye whereas Edison was the consummate hands-on maker of his day. Elegant yet delicate design versus utilitarian practicality. In the end when it came to pushing electrons from power plant to consumer, alternating current seized victory from direct current.

## AC Victory for Transmission

The key advantage that alternating current has is that the voltage level can be raised very easily with

relatively inexpensive transformers. Higher voltage allows the same amount of power to be transmitted with less current. This translates to very practical advantages. With a smaller line loss, the distance between the consumer and the power generating facility can be far greater. Having to build out a smaller infrastructure meant that it was more cost effective and practical to use AC for power transmission.

Of course, Edison would not go down without a fight. In the latter part of the 19th century Edison



Nikola Tesla (left) and Thomas Edison (right)

famously held demonstrations in which AC was used to electrocute animals in an attempt to persuade the masses of the dangers of alternating current. In addition, the first electric chair was built for New York State by two Edison employees. Unsurprisingly, alternating current was chosen to power the chair. While these demonstrations made for good showmanship, the reality is that

**Continued on page 21 ►**



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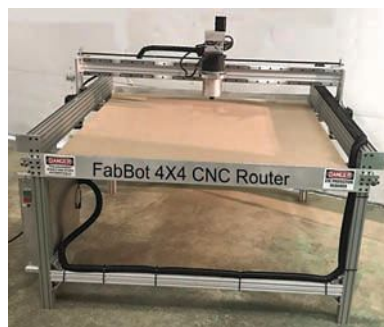
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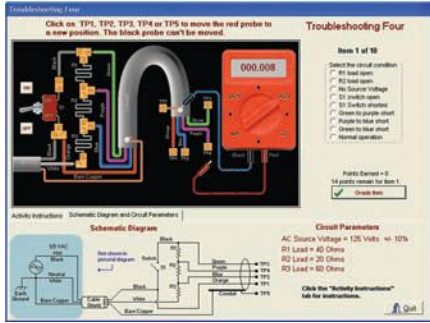
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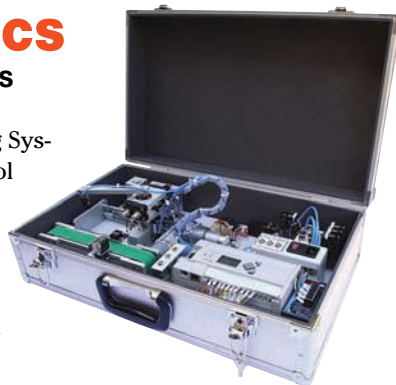
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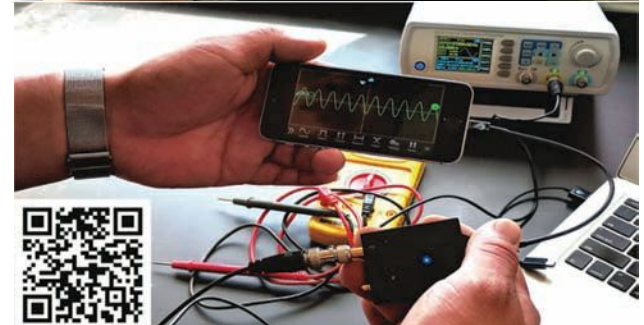
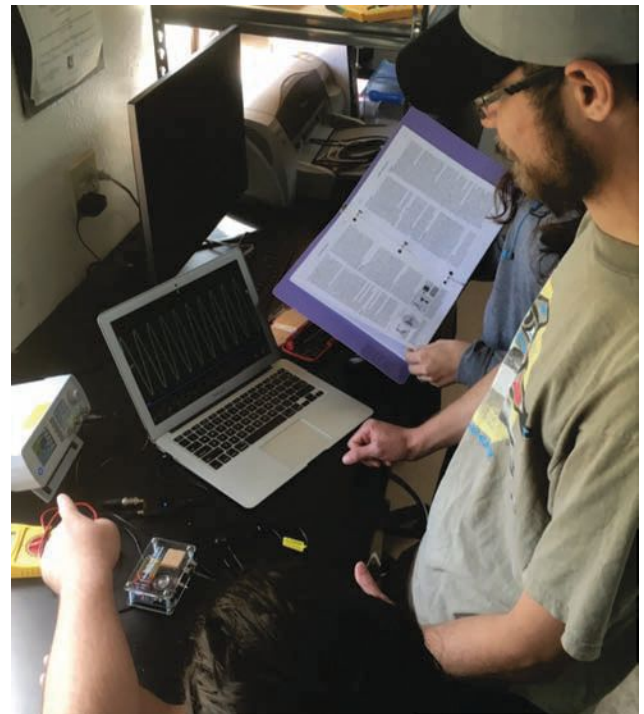
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## Continued from page 12.

both DC and AC can be dangerous if the current is sufficiently large. It only takes a few milliamperes of current in the right conditions to cause heart fibrillations that lead to death.

Over the years, refinements in technology have led to an improved performance in our electric grid. Electromagnetic Interference (EMI) caused by line noise upstream and loads connected downstream can

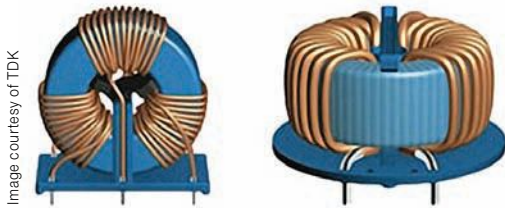


Image courtesy of TDK

### Chokes help to keep power lines clear of EMI.

“dirty” the power. Filters based on common mode chokes and capacitors from companies such as EPCOS/TDK help to reduce EMI which is critical as electronics devices increasingly require cleaner power to operate.

## DC and the Digital Revolution

While alternating current may have become the de facto standard for power transmission and distribution, direct current has maintained many crucial roles in modern life. DC motors dominate many low horsepower mechanical applications. Direct current also plays a crucial role in telecommunications devices and the automobile systems (battery and inverter to convert the alternators AC to DC).

Perhaps the biggest victory for DC coincided with the digital revolution that began in earnest in the 1970s after decades in laboratories around the world. Digital technology is absolutely dependent on DC power. The 1's and 0's that power the information age rely on the presence or absence of a direct current voltage. For digital devices that get their power from an AC wall outlet, the alternating current must first be transformed in direct current. Rectifier circuits

are used to perform this function in modern day devices.

For mobile digital technology that has cut the wires, batteries provide the direct current needed. Batteries rely on electrochemical reactions of its constituent components to generate a constant stream of electrons at a given voltage level. Battery life is a function of the mA-H rating of the battery and the current draw of the device. Switched DC-DC converters used in modern day mobile electronics allow for the fixed DC voltage level of battery to service multiple sub-circuits that may operate at different voltages levels. One negative side effect of switched mode DC-DC converters is the creation of RF noise that must be suppressed using special components such as RF chokes.

Today, aside from our larger appliances, the vast majority of the devices we bring into our home ultimately rely on direct current to perform their function.

## The Future

Much has changed in the almost 150 years in terms of quality and efficiency of the equipment that powers modern life. However, the fundamental concepts have remained by and large the same. Large power generation facilities rely on converting various energy sources into electricity which is then transmitted along an electrical grid. As the electricity nears the consumer is stepped down to lower and lower voltages until it is fed into your building through a final step-down transformer and circuit breaker panel, lastly arriving at the AC wall outlet. Our devices either consume the AC directly or transform it into a more useful DC voltage that brings our electronics to life.

One methodology that has garnered much attention (and perhaps even a cult-like following) is wireless power transfer. To clarify what is meant by wireless transfer we aren't talking products like inductive smartphone chargers. These devices do indeed wirelessly transmit power, though over very short distances and are driving relatively low power

devices. Rather, the notion in question is whether or not the world's entire electrical grid could be replaced with antennas that radiate electrical power much like one can “scoop” radio and broadcast television signals from the air. The altruistic-minded Nikola Tesla himself was enamored with just such a concept going so far as building the Wardencllyffe Tower on Long Island to experiment with the ideas of transmitting both information (voice and facsimiles) and power.

The fundamental problem with wireless power transmission is the math. The inverse-square law for an isotropic radiator (an antenna that radiates energy equally in all three dimensions) tells us the following:

$$\text{Energy Received (at distance } r) = \frac{\text{Energy Transmitted}}{4 \pi r^2}$$

According to the International Energy Agency, in 2012 the world consumed 20,900 TWh of electricity. Using a very rudimentary calculation based on the inverse-square formula, it would be necessary to generate  $5.1 \times 1,014$  times more energy than the 20,900 TWh to account for the transmission losses. In other words, the economics and physics demonstrate that wireless power transfer is completely impractical.

So, if wireless power transmission to every home, school, store and factory remains a pipedream; what



Image courtesy of Wikipedia

### Tesla's Wardencllyffe Tower

are the changes that might actually come to change our world? To look forward, sometimes we have to look backwards. ▶

At the same time as Edison and Tesla (and his champion George Westinghouse) were fighting the AC versus DC battles, other concepts were being explored. High Voltage DC (HVDC) technologies were being explored as early as the 1880s but

Image courtesy of Infineon



**Solid state devices such as IGBTs from Infineon help to make HVDC a practical reality.**

the technology of the time meant HVDC equipment was expensive to manufacture and maintain.

Flash forward a century later and technology began to catch up with the theory. The introduction of solid state technology (e.g. insulated-gate bipolar transistors and integrated gate-commutate thyristors from companies such as Infineon Technologies) beginning in the 1970s meant conversion of AC to high voltage DC (as high as 800 KV) became practical.

While the AC-to-DC conversion technology at either end of an HVDC transmission system is expensive, the cost of the DC transmission hardware in between becomes much more economical at distances over 400 miles as you do not need to run cabling for three phases or account for skin effect. An HVDC system could also be used to interconnect unsynchronized AC transmission networks, adding some capacity handling capability lacking in current disconnected grids.

However, system reliability for HVDC systems is not quite yet on par with their AC counterparts. Coupled with the fact that HVDC technology is still advancing quickly, operating an HVDC network requires maintaining a significant spares inventory that may or may not be interoperable with various HVDC systems.

It's also possible that the future

of power transmission is no transmission hardware at all. Renewable energy sources are being increasingly harvested closer and closer to the energy consumer. It is no surprise that photovoltaic panels are popping up on the roofs of houses all across the world. As efficiency increases and breakthroughs in energy storage emerge, it is not unfathomable that living "off the grid" will become more common than not.

But here is where it gets very interesting. Photovoltaics produce DC voltage. Therefore, to tie it into your home it must first be converted to AC. Significant losses are incurred at each conversion from AC to DC and vice versa. There is work being done through industry alliance, such as the EM Alliance, to advocate for local DC distribution. In short, the wall outlet of tomorrow might just be a USB port and not the three prong AC outlet that is the standard today. In the end, it's possible that Tesla won the most battles, but Edison will win the war.

## The War That Never Was, Perhaps

The world of today has been undoubtedly shaped by the pioneering work of both Nikola Tesla and Thomas Edison. Modern life was made possible thanks to our ability to harness the power of the electron. Both AC and DC have found their respective use cases in our high-tech world. We have learned how to exploit the technological and economic advantages and disadvantages of both technologies to our benefit.

Fortunately for engineers and technology companies we are on the threshold of a second electrical revolution. As the world begins to seriously look at harnessing renewable sources to become better environmental stewards and energy independent, we will have to integrate solar, wind, geothermal, and tidal-based electricity-generating technology into the grid. Understanding the advantages and disadvantages of AC and DC transmission with respect to how these sources generate electrons will be key to our future success. It would seem both Tesla and Edison would be justly proud of the contributions that AC and DC offer to building a better tomorrow. ☺

### For More Information

#### High-Current Common Mode Chokes

<https://www.mouser.com/new/EPCOS/epcos-current-compensated-ring-core-chokes/>

#### Film Capacitors

<https://www.mouser.com/new/EPCOS/epcos-mmkp-b32641b-b32642b/>

#### DC/DC Converters

[https://www.mouser.com/search/refine.aspx?Ntk=P\\_MarCom&Ntt=189985796](https://www.mouser.com/search/refine.aspx?Ntk=P_MarCom&Ntt=189985796)

#### RF Chokes

<https://www.mouser.com/new/EPCOS/epcos-tdk-b781x8e/>

#### High Voltage DC (HVDC)

<https://www.mouser.com/applications/high-voltage/>

#### Insulated Gate Bipolar Transistor

<https://www.mouser.com/new/Infineon-Technologies/infineon-trenchstop5/>

#### Infineon Technologies

<https://www.mouser.com/new/Infineon-Technologies/>

#### Photovoltaic Panels

<https://www.mouser.com/applications/solar-power-technology/>

#### USB Technology

<https://www.mouser.com/applications/usb-technology/>



# Workers Are Climbing Wind Turbines to the Middle Class

Community colleges—and at least one high school—are starting programs to train students for these in-demand occupations

By Sarah Garland

**T**HE town of Bruni in southwest Texas is just a speck on the map in an area surrounded by miles of mesquite trees, cows, and not much else. Since the oil wells slowed down, the biggest economic engines in this no-stoplight town are the county school district, which serves about 300 kids, and a row of makeshift casinos run out of dilapidated houses lining the highway.

And the wind. It barrels across the plains to power glistening white turbines dotting the horizon whichever way you look. More turbines are being built next year—and when they come, the schools here will be ready for them.

The Webb Consolidated Independent School District, which serves Bruni and a handful of other tiny towns, is launching what might

*Sarah Garland is the executive editor of The Hechinger Report. This article was originally published on The Hechinger Report website, [www.hechingerreport.org](http://www.hechingerreport.org). The Hechinger Report is a nonprofit, independent news website focused on inequality and innovation in education.*

be the nation's first wind turbine technician program for high school students. Starting next year, students

road. The students can even earn a certificate through the classes and go straight to work on the turbines.

**Wind is becoming one of the biggest job producers in west Texas, where the oil industry has lagged.**



Sarah Garland/The Hechinger Report



**Wind energy could revive rural areas like west Texas, where the oil industry has lagged and there aren't many other employment opportunities.**

at Bruni High School will be able to take coursework that will give them a jump start on an associate's degree in wind, which they can finish at Texas State Technical College in Harlingen, 2-1/2 hours down the

Locals hope the program will make this little school district a national model. "We have very poor children who come from poor families," said Robert Marshall, Webb's school board president and a ranch-

er who owns a construction business that services the oil fields. For many students, he said, “none of the family have ever gone to college.”

**Ninety-nine percent of wind projects are in rural areas; over 70% of the installed capacity is installed in low-income counties.**

“We’re giving them opportunities,” he said.

Politicians may hotly debate climate change and what to do about it, but the economy has come down clearly on one side. Jobs in clean energy are growing faster than any jobs in the United States. At the top of the list is solar panel installer, a position that typically requires just a high school diploma and pays close to \$40,000 a year. Wind turbine service technician, with a solidly middle-class salary of \$52,000 on average, comes in second. The position requires technical school training.

Industry experts say wind technicians often earn a lot more. In the Webb school district, for instance, Marshall has made tax abatement deals with local wind companies that set aside a certain number of jobs for local residents, with a minimum entry-level salary requirement of \$46,000. With overtime, workers can earn as much as \$70,000, even \$90,000 after a couple of years, Marshall said. The median salary in Bruni is about \$50,000, but about 30% of the town’s 281 residents—and more than half of its children—live below the poverty line.

Perhaps the best part about wind jobs, industry experts say, is that they’re inherently rural, meaning they provide stable middle-class jobs in places that often have few other industries. Lower living costs in rural areas mean these salaries can stretch further, said Hannah Hunt, a senior analyst at the American Wind Energy Association, a trade association for the wind industry.

“Ninety-nine percent of wind

projects are in rural areas,” she said, “and over 70% of the installed capacity is installed in low-income counties.”

Many of the nation’s wind installations are appearing in places that have lost manufacturing jobs. Harlingen in the Rio Grande Valley is a case in point. In the 1990s, the region lost a host of factories as companies moved across the river to Mexico for the cheaper labor. Some manufacturing and oil jobs remain, but nearly a third of residents live below the poverty line and the unemployment rate is 6%, higher than the national average.



Sarah Garland/The Hechinger Report

**Gardiell Martinez, 25 (left), and Desirae Cabrera, 23 (center), are betting that a wind turbine technician certificate will launch them into a middle class career with a stable future.**

Wind energy could revive rural areas like west Texas, where the oil industry has lagged and there aren’t many other employment opportunities.

Now, students from the Rio Grande Valley are flocking to a pro-

**“The college is trying to beat the curve. We’re trying to train students before the demand is out there at 100%.”**

*David Sanchez, the lead instructor for the wind, telecommunications, and biomedical program at Texas State Technical College*

gram that trains them to climb and fix 40’ high wind turbines sprinkled across the region’s ranchland and coast. Texas State Technical College (TSTC) students can earn a certifi-

cate as a wind energy technician in a year for about \$6,000, or they can stay for two years to earn an associate’s degree in wind energy technology for about \$10,000. The jobs can pay a lot better than many manufacturing jobs, and all graduates get hired, said David Sanchez, the lead instructor for the college’s wind, telecommunications, and biomedical program.

“The college is trying to beat the curve,” said Sanchez. “We’re trying to train students before the demand is out there at 100%.”

Sanchez said wind jobs require fewer years of training than well-pay-

ing healthcare jobs like nursing, also a ballooning industry here, and often pay better than jobs that require a four-year degree, like teaching. Desirae Cabrera, 23, who will earn her wind technician certification from TSTC this summer, initially trained to be a medical assistant but decided to change fields. “It was not for me,” she said. She’s good at math and was attracted to the idea of working outside like her grandfather, a maintenance worker for a school district, but for a much bigger paycheck.

Still, the work isn’t easy.

On a recent morning at 8 a.m., several burly young men in hoodies, one toting a motorcycle helmet, were studying their textbooks before instructor Braulio Gonzalez’s AC/DC class in electronics. (Cabrera is one of only a handful of women in the program.) “Do you think we need to know the angles?” one wondered. “I hope not,” the others muttered.

Yes, it turned out, they needed to know the angles. For an hour, Gonza-



lez drew equations and diagrams on the board, explaining how using the Pythagorean theorem and trigonometry to convert angles from a rectangular coordinate system to a phasor coordinate system would help them check their work in the field.

“I was thinking it was going to be a lot easier. I had to slap myself in the face,” said Crescencio Cruz, 36, a former Marine who did two tours in Iraq.

The program is a mix of adults switching careers and young people, a few years out of high school, getting serious about their studies. Cruz worked in the oil fields for GE Oil & Gas until the overtime hours started drying up. “We were getting paid good money,” he said. “But a lot of people were getting laid off and I worried I’d be next.”

Cruz said some of the wind turbine work is similar to servicing pump units for the oil company. But a solid grip of college algebra and trigonometry is essential to understand the turbine machinery. Cruz along with several of his peers have made use of the college’s tutors to keep up.

During the second half of class,

**“That’s the end goal, at least what my parents drilled into me. To do better than whatever they’re doing now.”**

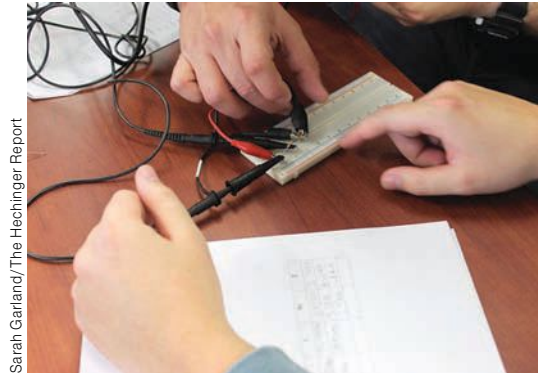
*Gardiel Martinez, student,  
Texas State Technical College*

students moved to the back of the room and gathered in small groups around several oscilloscopes, which display oscillations in electrical current. Gardiel Martinez, 25, and Cabrera tried to get the waves on their screen to look like those Gonzalez had drawn on the board. Before coming to the college, Martinez served in the Navy, then as a corrections officer at a maximum-security prison three hours from his home. But with two preschool-age daughters, he said, he didn’t want to be stuck “just being in the Valley and getting a mini-

mum wage job and not really moving forward.”

After several friends graduated from Texas State’s wind program and went on to get well-paying jobs,

only one slice of a growing industry, however. The nation’s more than 52,000 wind turbines in 41 states and territories have helped generate a total of 102,500 jobs so far, according



Sarah Garland/The Hechinger Report

**Students try to get their oscilloscopes to work in a course on electronics at Texas State Technical College.**

**Instructor Braulio Gonzalez leads a demonstration of torquing and tensioning for students in the wind energy program at Texas State Technical College.**



Sarah Garland/The Hechinger Report

he signed up, and plans, literally, to climb his way up a wind turbine to the middle class.

His mother has a certificate and works in accounting, and his father is a hydraulics mechanic. “That’s the end goal, at least what my parents drilled into me,” said Martinez, who is the first in his family to go to college. “To do better than whatever they’re doing now.”

The program doesn’t just test students’ math skills, it also tests their physical and psychological fitness for the job. They can’t be afraid of heights, for one. And while more wind turbines are being outfitted with elevators, climbing daily on the vast majority of turbines that still lack them is hard on the knees—even with motorized climbing assists taking some of the weight off as workers ascend the ladders.

Industry experts say that physically demanding technician jobs are

to a 2017 industry report.

Projects need engineers, construction workers, control room operators, site supervisors, and environmental assessors, among other positions. Analysts like Hunt say that even in places where there aren’t any turbines, most notably in sultry Deep South states, factories are cropping up to manufacture parts for the industry. And some older factories have diversified “because they believe it’s a smart investment,” said Hunt.

Remy Pangle, associate director for the Center for Wind Energy at James Madison University, said wind is also generating white-collar jobs, including work as meteorologists and project developers, that require a bachelor’s degree. The work is less “sexy,” but also less physically taxing and even better paying. “It’s policy and communications and business where we’re finding land, acquiring

**Superintendent Beto Gonzalez talks to students about their futures in the tiny town of Bruni, Texas. Gonzalez is helping set up what may be the nation's first wind technician certification program for high schoolers.**



Sarah Garland/The Hechinger Report

That's what Webb superintendent Beto Gonzalez in Bruni is banking on. Wind companies, including NextEra, have helped the district set up three immaculate classrooms alongside the pigpens in the district's agricultural science building.

NextEra's Garner was impressed by the district's eagerness to transform. "To see a high school have this sort of program I think is very forward-looking, and especially in a rural community makes a lot of sense," he said.

The classrooms, redecorated with posters showing wind turbine components, are awaiting a set of model equipment for students to practice on. The district is also hiring a new teacher.

The industry is so new, there are few instructors with experience in both wind and teaching, but Gonzalez has asked the state to waive the teaching certification requirement so he can find an expert with hands-on experience to share with students. The district's budget will have to stretch to draw someone with the right resume, he said, but it's worth it.

"We have really good kids," he said. "We're doing this for them." ☺

land. We're financing projects, we're siting projects," she said.

At NextEra Energy, a renewable energy company, communications manager Bryan Garner said it's common for wind technicians to move up into site and project management positions. While these jobs typically

look to hire locally first. We also bring in wind techs that would move to that community."

Oklahoma is famous for its gusting winds, yet the industry is still nascent there. But interest is growing, according to Kathy Jackson, founder of SpiritWind, an educational organization in Oklahoma City. She travels the state talking about wind to students and teachers at schools where local career options are "either farming or farming."

"This changes the ballgame," Jackson, who also still works as an oil landman, said of the wind industry. "It makes a more level playing field for kids in those rural communities."

**Perhaps the best part about wind jobs, industry experts say, is that they're inherently rural, meaning they're providing stable middle-class jobs in places that often have few other industries.**

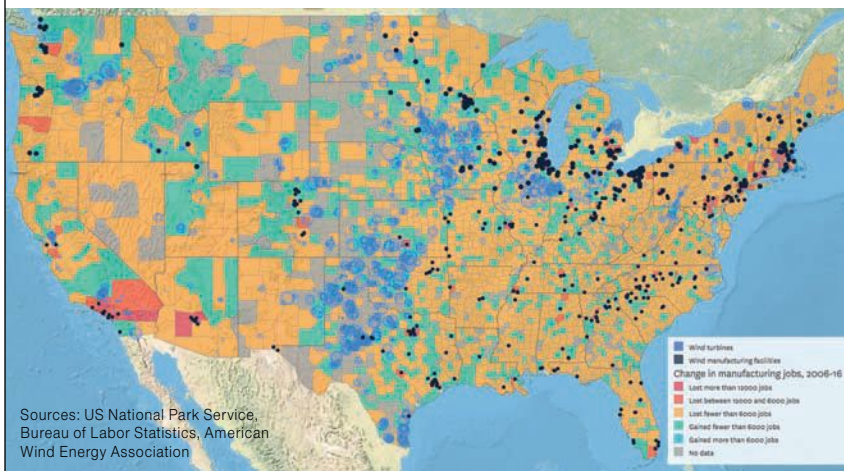
require a bachelor's degree, he said the company often helps its employees with tuition. "There have been some great success stories," he said.

In Harlingen, David Sanchez said he hasn't had to put much effort into recruiting students—the wind turbines themselves are the perfect billboard—although he sometimes takes a flatbed truck mounted with a model turbine out to high school career fairs. But elsewhere in the country, educators are trying to entice high school students to start thinking about wind (and studying their trig) before they get their diploma, especially in rural areas where entering the middle class so often means leaving home.

"It can be a challenge to find the kind of talent that you need in rural communities," Garner said. "We do

### Wind Power

In 2000, there were just a handful of utility-scale turbines. Today, more than 52,000 generate about 6% of the nation's electricity and wind turbine technician is one of America's fastest-growing occupations. Check out the map below to see where wind turbines and wind manufacturing facilities have popped up.



To see an interactive version of the map, visit <http://hechingerreport.org/static/manufacturing/>.





Photos courtesy visitsanantonio.com

# Get Inspired at CareerTech Vision

**T**HE Association for Career and Technical Education (ACTE) will hold its annual convention November 28 - December 1 in San Antonio, TX. As always, this year's CareerTech VISION promises much value to CTE educators. Here's what ACTE has for those who attend:

- Renowned keynote speakers exploring new directions in CTE.
- 300+ concurrent sessions covering every aspect of secondary and postsecondary CTE.
- CareerTech Expo and interactive exhibitor workshops.
- Career Pavilion providing essential resources on several CTE career pathways.
- Wednesday workshops and tours offering insights into focused topics and CTE programming.
- STEM is CTE Symposium addressing access to STEM-related career paths through CTE programming for all students and especially for young women.

The annual convention draws career and technical educators and administrators from across the United States and around the world.

## General Sessions

On Thursday, November 29, Jenna Hagar gets things started as speaker at the Opening General Session. Passionate about literacy and education, Hager has seen firsthand how a small

change can make a large difference in a single life. As chair of UNICEF's Next Generation and a former teacher in Baltimore, Maryland, Hager shows how lives can be transformed with compassion, community support, and educational opportunities. Author of *The New York Times* best-seller *Ana's Story: A Journey of Hope*, Hager is the daughter of former U.S. President George W. Bush and First Lady Laura Bush.

Saturday, Patrice Banks, founder of Girls Auto Clinic, will speak at the general session. Passionate about innovation, technology, and STEM education, Banks provides the perfect blend of energy, credibility, humor, and a refreshing realness to motivate audiences to action, beckoning them to break down barriers, find their purpose, and achieve greatness.

Expanded Secondary and Postsecondary CTE Programming—VISION provides the postsecondary community with a venue for exploring multiple pathways to college and career readiness, networking with postsecondary CTE professionals and leveraging business and industry partnerships to enhance your CTE programs. Fifty sessions on the most current issues in postsecondary CTE will cover:

- Business, industry, and education partnerships and needs.
- Designing successful CTE teacher education programs.

- Effective teaching strategies for adult learners.
- Re-skilling the middle-aged workforce.
- Promoting and attracting CTE student diversity.
- College and career readiness models.
- Teacher recruitment and retention.

**Career Clusters**—ACTE and Advance CTE are pleased to offer sessions focused on career clusters and programs of study, a comprehensive framework for organizing high-quality CTE programs, and cultivating collaboration between secondary and postsecondary CTE.

## Pre-Convention Workshops

ACTE has scheduled several informative workshops for Wednesday, Nov. 28. They include:

■ **Admin 101: A Bootcamp for New Administrators**—This half day session is especially designed to help new administrators at all levels more clearly understand what CTE is and why it is such a successful program for student success, and how CTE programs can improve your organization.

■ **CTE Administrators**—Just as there is a growing national need for CTE teachers, there is also a national shortage of CTE administrative leaders. Many states addressed the issue by enabling those with a variety of

administrative certifications to be eligible to administer specialized CTE programs and/or CTE schools. On the surface, this seems like a logical decision. After all, a school is a school, right? ACTE and NOCTI are pleased to announce the first installment of a series that is focused on CTE administrative leadership, including key information on the fundamental skills needed for a CTE administrator to be successful. It is targeted to those individuals who have accepted responsibility for leadership of a school focused on preparing students for technically demanding careers.

■ **Developing a College and Career Pathways (NC3T)**— This workshop, facilitated by Hans Meeder of the National Center for College and Career Transitions, provides an excellent opportunity for education and community leaders interested in creating an integrated approach to college and career pathways in their schools. This session focuses on implementing K-12 career development strategies, creating meaningful

programs of study, engaging business and community partners, and developing an actionable phase-by-phase plan for implementation. Attendees receive a free copy of Mr. Meeder's book *The Power and Promise of Pathways*.

■ **Empowering Students to Pursue Their Career Goals—Tools and Resources for School Counselors and Guidance Development and Career Professionals**—This workshop will provide school counselors and career counseling professionals with information, tools, and resources they need to connect their students with their career passions. Participants will emerge with an enhanced knowledge of the full range of education and career options to empower students to pursue their career goals and expand their existing strategies for effective career advisement. At the conclusion of this training, attendees will be able to:

- Identify and discuss the various components and benefits of a high-quality CTE program of study, including work-based learning, industry-

recognized credentials, and dual/concurrent credit.

- Discuss the range of options available in CTE and know how to locate and access information on programs in their specific state and local CTE delivery systems.

- Explain the value of CTE to students and parents.

- Assist students with career exploration and development in K-12 and identify potential strategies to implement in their community.

- Develop an individual action plan with specific strategies to reach students, parents, administrators, other counselors, and/or other stakeholders two months following the workshop to communicate the value of CTE

■ **Maximize Enrollment, Retention, and Performance by Mastering the New CTE Narrative**—Join dynamic education expert Mark C. Perna for an immersive dive into the innovative strategies that are transforming the CTE narrative nationwide. Discover the power of the Three Pillars that CTE professionals



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**Fort Sam Houston Quadrangle**

dialogue, demolish CTE stigmas, and tell a fresh story of value for students, parents, legislators, and stakeholders.

**Tours**

Tours organized for this year's CareerTech VISION include:

● **Construction Careers Academy**—The Construction Careers Academy (CCA) was founded in 2009, and shares the campus of Earl Warren High School with an academic focus on construction-related skills. It is a “school within a school” that provides an advanced and rigorous curriculum for construction technology, construction management, architectural design, applied engineering, and real-world experiences. The CCA also offers electrical, HVAC, plumbing, and welding classes, and curricula for its students.

● **East Central High School CTE Program Tour**—East Central High School is a large 6A campus located in southeast San Antonio. It uniquely boasts a mix of urban, suburban, and rural student populations. The campus is home to approximately 3,600 high school students. ECHS provides CTE programming opportunities for students in 11 of the nationally recognized Career Clusters and has part-

nered with local colleges to offer collegiate level programming in an additional four career clusters through the Alamo Academies program. East Central Independent School District strives to create productive citizens of society who are prepared for all postsecondary opportunities. Educators will have an opportunity to see how ECHS has implemented numerous industry-validated certification programs into the CTE curriculum, as well as viewing students in action.

● **Fort Sam Houston Tour**—Tour will include a motorized tour around the grounds of the base as well as time to visit the Fort Sam Houston museum located in the historic quadrangle.

● **Marvels of Modern Medicine, Fort Sam Houston**—Fort Sam Houston, founded in 1845, includes some of the oldest structures on any Army installation plus serves as the “Home of Army Medicine”. Army investigators collaborate with scientists in industry and academia to attain common research goals that provide world-class medical technologies to protect and sustain America’s service men and women. The visit includes a museum visit and historical tour, briefing on medical innovations, and lunch with the troops.

**Career Pavilion**

Bigger and better than ever, VISION’s Career Pavilion will feature CTE career pathways with representatives showcasing career opportunities and resources to help you get your students excited about their future career path.

**STEM is CTE Symposium Saturday, December 1, 12:15-5:15 pm**

Back by popular demand, this event addresses crucial diversity, equity, and access issues to STEM fields via CTE programs, which encourage students and especially women to explore high-paying, high-demand STEM careers. CTE classrooms offer hands-on learning environments that bring STEM to life, apply core academics to real-world situations, and provide creative problem-solving skills to address our nation’s most pressing issues. Together, STEM

and CTE expand opportunities for youth to engage in some of the most exciting realms of discovery and technological innovation.

This year’s STEM is CTE Symposium begins immediately following the closing VISION general session and includes an opening general session, lunch, information-rich breakout sessions, and a closing networking reception. Join education and business leaders from across the nation to address diversity issues related to STEM career paths through CTE and why it’s important for all students, especially for women who are still underrepresented in STEM fields. ☺

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## Does Anybody Really Know What Time It Is?

Below is a picture of the clock that one of Mr. P's daughters gave him as a gift. Can you find two errors?

Puzzle devised by David Pleacher, [www.pleacher.com/mp/mpframe.html](http://www.pleacher.com/mp/mpframe.html)



## Let's Rock!

Paul, John, and George are three rock stars.

One plays guitar, one plays the drums, and one plays the piano, but not necessarily in that order.

The drummer tried to hire the guitarist for a recording session, but was told that he was out of town doing shows with the pianist.

The drummer admires the work of both musicians.

The pianist earns more money than the drummer.

Paul earns less than John.

George has never heard of John.

What instrument does each of the rock stars play?

Puzzle devised by David Pleacher, [www.pleacher.com/mp/mpframe.html](http://www.pleacher.com/mp/mpframe.html)

## A Glass Menagerie?

In a menagerie, there are birds and beasts. Determine the number of each given the fact that the lot has 36 heads and 100 feet.

Puzzle devised by David Pleacher, [www.pleacher.com/mp/mpframe.html](http://www.pleacher.com/mp/mpframe.html)

## Transportation Technology Inventors

Each of the inventors listed below made a great contribution to the field of transportation. See if you can match up the inventor with his invention.



- |                              |  |
|------------------------------|--|
| 1. August Fruehauf           | A. Pioneered piloted powered flight  |
| 2. Ole Evinrude              | B. Made the first operational steamboat  |
| 3. Donald Douglas            | C. Built the first trainer to provide ground instruction for new pilots                        |
| 4. Edwin Link                | D. Invented the first airplane that could lift a load that exceeded its own weight             |
| 5. Igor Sikorsky             | E. Invented an automatic lubrication system for locomotive steam engines and factory machinery |
| 6. Orville and Wilbur Wright | F. Developed and built the first semitrailer   |
| 7. John Fitch                | G. Prototype of the modern gas engine  |
| 8. Elijah McCoy              | H. Built the first practical helicopter  |
| 9. Gottlieb Daimler          | I. Patented the first successful car air bag   |
| 10. Allen Breed              | J. Invented the first practical outboard motor   |

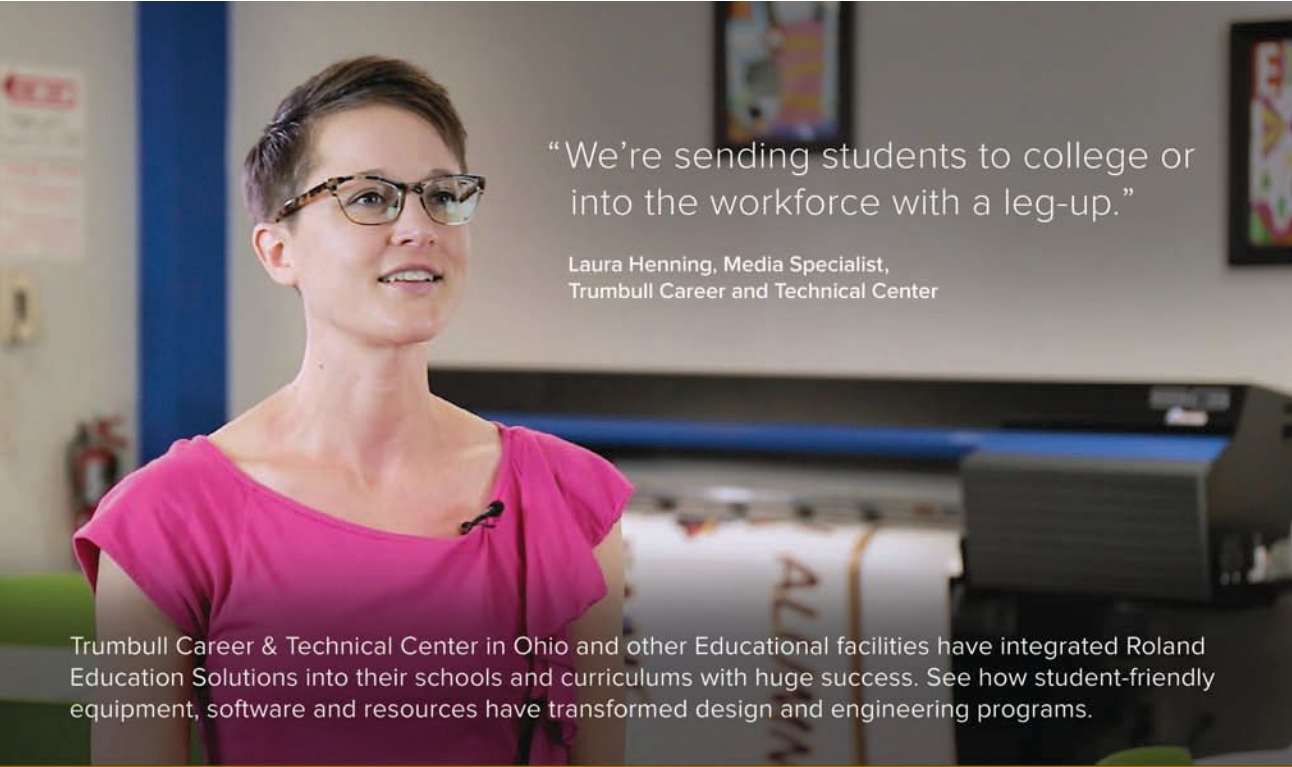


"So I'm reading this article in Tech Directions about building a giant wooden horse, and this idea hits me . . ."

See answers on page 11.

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](mailto:vanessa@techdirections.com) or mail to "More Than Fun," PO Box 8623, Ann Arbor, MI 48107-8623.





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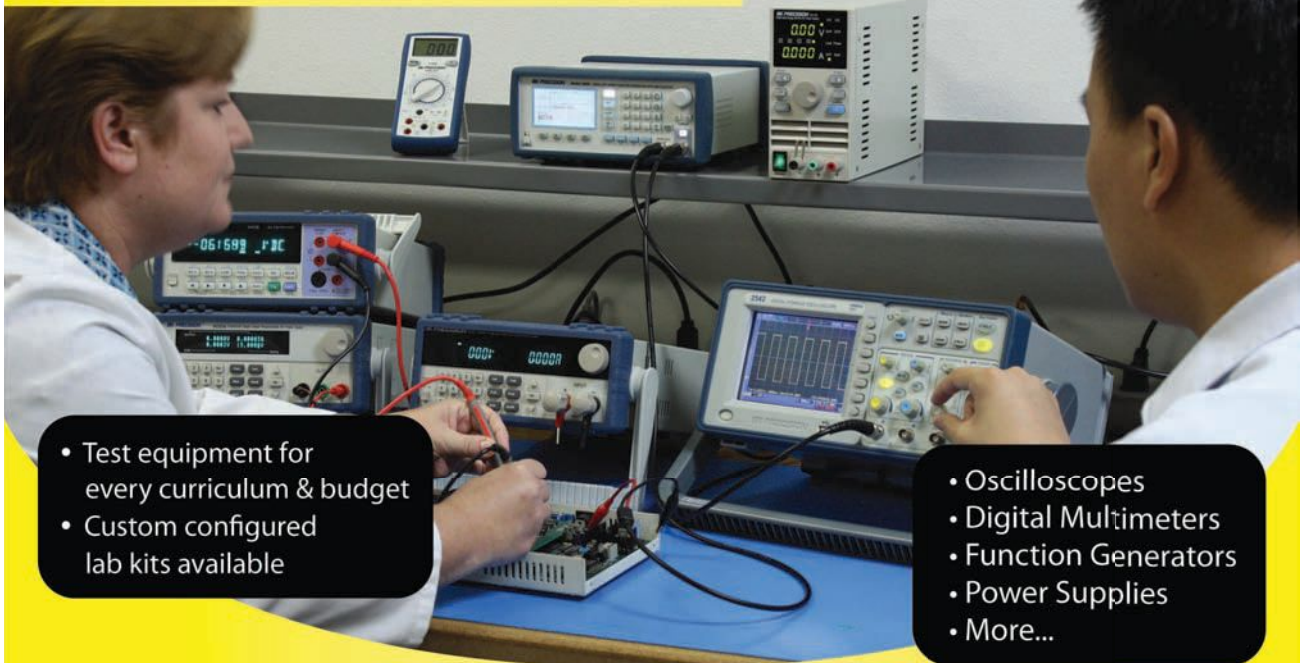
Laura Henning, Media Specialist,  
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