the institute

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Farming Goes High Tech

IEEE

BRIEFINGS

This picture from the IEEE student branch at the Universidad Industrial de Santander, in Colombia, received first prize in the 2017 IEEE Day photo contest.

Celebrate IEEE Day on 2 October

MEMBERS AROUND the world are organizing events to mark IEEE Day on 2 October. The day commemorates the anniversary of the meeting in Philadelphia in 1884 when members of the American Institute of Electrical Engineers, one of IEEE's predecessor societies, gathered for the first time to share technical ideas.

Nearly 1,000 celebrations took place on last year's IEEE Day under the theme of leveraging technology for a better tomorrow. Included were technical talks, humanitarian projects, and field trips. Visit the IEEE Day website (http://www.ieeeday.org) to add your event to the world map and to see what other groups are planning.

Contests will be held for the best photos and videos taken at IEEE Day celebrations. To learn more about contest rules and prizes, visit the website.

As part of the celebration, IEEE is offering a US $30 discount on dues for new members who join between 30 September and 6 October. (The offer does not apply to student or graduate student memberships.) New members should visit http://www.ieee.org/membership/join and enter the promo code IEEEDAY18.

—Amanda Davis

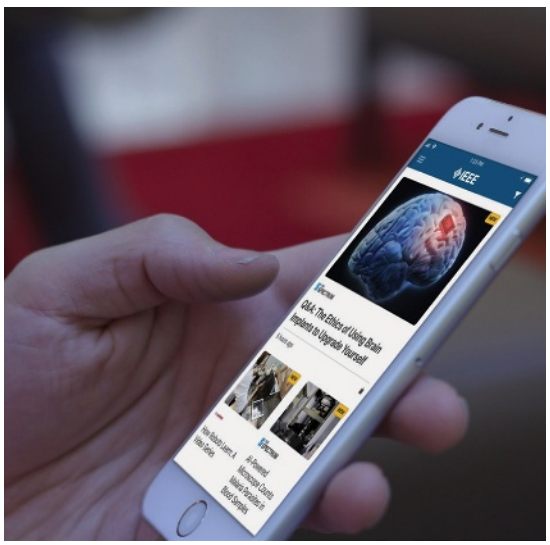
IEEE Launches Meetup App

HAVE YOU EVER BEEN out of town for an IEEE meeting, conference, or event and wanted an easy way to meet up with someone you know from IEEE? Now there's an app that can help you find colleagues near you and create an IEEE meetup event, any place at any time. The app—IEEE—is available for free from Apple iTunes and Google Play.

Users can locate and communicate with other members and schedule, manage, and join informal ad-hoc meetings. Members also can use the app to update their IEEE profile and preferences.

Aside from helping users network with other IEEE members, the new app also has a news feed with the latest articles from *The Institute, IEEE Spectrum,* and other IEEE sources.

The app was proposed by a group of IEEE staff and Young Professionals members led by the organization's chief information officer, Senior Member Cherif Amirat. It was developed by the IEEE Mobile Center of Excellence, which is creating apps for IEEE groups. The center is part of the organization's IT department, in Piscataway, N.J. *—A.D.*



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Calendar *of events*

SEPTEMBER

15–16
IEEE Women in Engineering International Leadership Summit, Toronto

20
IEEE Infrastructure Conference, San Francisco

22–23
World Maker Faire, New York City

OCTOBER

1
Last day that marked annual election ballots can be accepted by IEEE

20
IEEEXtreme online programming competition

20–21
IEEE Region 8 committee meeting, Belgrade, Serbia

25–27
IEEE Students and Young Professionals Meeting, Elblag, Poland

NOVEMBER

4–7
IEEE International Conference on Intelligent Transportation Systems, Maui, Hawaii

14–19
IEEE Meeting Series, Vancouver, B.C., Canada

27–29
IEEE Conference on Network Function Virtualization and Software Defined Networks, Verona, Italy

COVER: ISTOCKPHOTO. THIS PAGE, CLOCKWISE FROM TOP RIGHT: ISTOCKPHOTO (2); IEEE; MAURICIO BAUTISTA

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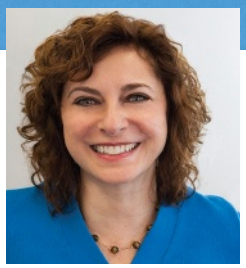

EDITOR'S NOTE

IF YOU'VE VISITED California and are a wine enthusiast like I am, you've probably taken a tasting tour of some of the state's many wineries. But did you know vintners in the Central and Napa valleys are facing a shortage of both water and workers?

I was relieved to learn that these problems might be eased by the Robot-Assisted Precision Irrigation Delivery system featured in our cover story [right]. RAPID uses inexpensive, adjustable, plastic water emitters attached to the holes in drip-irrigation lines. Instead of farm workers facing the tedious job of adjusting the hundreds of controls each vineyard needs, battery-operated robots will handle the task.

Meanwhile, cranberry growers are looking for a technological solution to their dilemma: how to accurately and efficiently estimate the size and quality of their crop. Assistant Editor Amanda Davis was surprised to learn the current method is to harvest the berries within 1 square foot (929 square centimeters) of a bog or marsh, count them by hand, and extrapolate from there. On page 6, she writes about how Ocean Spray, a leading producer of cranberry products, is working with researchers at the University of Wisconsin on a microwave scanning system to automate the process.

These are just some of the technologies the agriculture industry is beginning to employ. Such "agtech" innovations can help increase food production for a growing population, reduce farming's environmental impact, and yield data about crops that could be applied to increase profits.

The field is attracting venture capitalists. Last year US $2.6 billion was raised for developing new farm technology innovations.

If you have an idea for your own agtech venture, learn where to find opportunities and investors from my "Plenty of Money to Be Made in the Emerging AgTech Field" article on page 7. (Read about other projects in our online special report: http://theinstitute.ieee.org/agtech).

If you enjoy attending sports events but can't get great seats down front, you'll likely end up watching at least some of the action on the venue's giant-screen televisions. Mitsubishi Electric's Diamond Vision was the first really large-scale, video display system to allow the crowd to see the athletes up close. On page 8, you can learn the history of the groundbreaking 38-year-old technology, which was recently honored with an IEEE Milestone.

Also in this issue is a selection of responses to three blog entries that stirred many readers to voice their opinions. One post discusses the culture in academe of "publish or perish" and whether it's hurting research. In another, Associate Editor Monica Rozenfeld asked readers what they thought of companies using artificial intelligence programs in their hiring process. And to help those who score a job interview, I asked hiring managers what candidates should wear if they want to impress them.

—Kathy Pretz, editor in chief
@kathypretz

To comment on articles in this issue, visit http://theinstitute.ieee.org/september2018

RAPID: THOMAS THAYER; PRETZ: RANDI KLETT

ENJOYING THAT CHARDONNAY? THANK A ROBOT

Machines to help California grape growers conserve water

BY KATHY PRETZ

VINTNERS IN CALIFORNIA'S Central and Napa valleys are facing two shortages: of water and of workers. What's more, the state's recent drought has caused a financial strain for growers thanks to the cost of irrigating their thousands of hectares of vines. And stepped-up enforcement of immigration laws, competition from less strenuous higher-paying jobs, and an aging workforce have led to a labor shortage, according to *Wine Spectator* magazine.

When researchers from the University of California met with grape growers to discuss how technology could help them, the growers asked if their irrigation systems could be made more efficient and with less human intervention.

"I'm a roboticist, so whenever there's a problem, I study whether a robot could solve it," says IEEE Senior Member Stefano Carpin, a professor of electrical engineering and computer science at UC Merced.

Carpin leads a team of researchers from UC Berkeley, UC Davis, and UC Merced who are building the Robot-Assisted Precision Irrigation Delivery (RAPID) system [left]. The system involves inexpensive, adjustable, plastic water emitters attached to the holes in drip irrigation lines. Each emitter would help regulate the amount of water discharged. And because there aren't enough workers to adjust the hundreds of emitters each vineyard is expected to need, the group is designing rugged, battery-operated robots to move around and handle the job.

The project, launched in 2016 and funded by a nearly US $1 million grant from the U.S. Department of Agriculture, is part of the National Science Foundation–led National Robotics Initiative.

"This robotic system would make fine-grain adjustments to deliver water on a per-plant level," Carpin says. "We would reduce water use while preserving the quality of the grapes."

GROWING BASICS

Growing grapes is a tricky business. Their quality depends in part on how much water is absorbed by the vines' roots. Current drip-irrigation systems consist of a rubber pipe pierced with holes laid down along a row of vines. Ideally, vineyards should apply localized stress irrigation, which customizes the amount of water delivered to each vine. But most drip-irrigation systems can't deliver water with precision. The drip pipes have emitters spaced from 300 millimeters to 900 mm apart—which can't be adjusted.

Water dripping through the holes wets the fields in uniform blocks, often of around 64 hectares. "There's a lot of variability in these blocks in terms of soil moisture, microclimate, and weather conditions, so delivering the same amount of water in a fixed flow to the whole block is not optimal," Carpin says. "Some grapes end up with too much, some with too little."

With RAPID, each watering pipe is, in effect, turned into a precision irrigation system.

The team is exploring a plastic emitter with a cap that can be turned by a robot to adjust the water flow. Each emitter would cost about 20 cents.

"It's a simple system," Carpin says. "Turn the cap clockwise to increase the flow and counterclockwise to decrease it." He says he can't estimate how much water the system might save until it has been tested.

ROBOT ADJUSTERS

To help determine when an adjustment is needed, RAPID will rely on data from field-monitoring systems such as drone and satellite imagery, weather satellites, and services including the California Irrigation Management Information System. CIMIS is a network of more than 145 automated weather stations to help irrigators manage their water.

Carpin is trying out the four-wheel Husky ground vehicle from Clearpath Robotics—basically an open-topped box that carries the elements of the robot. He expects his finished vehicle will be slightly larger than the Husky to accommodate batteries and an arm with a grasping hand. The robot also will have a GPS receiver to map its route and an RFID reader on board to direct the machine to the emitter, he says. The robot will position itself and with its grasping hand turn the cap to adjust water flow, he says, guided by readings from a monitoring system plugged into its flash drive.

By next year, Carpin says, he will have a prototype of his system, and an irrigation pipe pierced with holes will be retrofitted with the adjustable emitters. He expects the system to be tested on a farm, which has already been selected, by the summer of 2020.

Carpin estimates that initially each system will cost in the tens of thousands of dollars, depending on the size of the farm.

You can read about an earlier version of RAPID in "DATE: A Handheld Co-Robotic Device for Automated Tuning of Emitters to Enable Precision Irrigation," available in the IEEE Xplore Digital Library. ◆

The Robot-Assisted Precision Irrigation Delivery (RAPID) system is designed to turn the caps of drip irrigation lines to adjust water flow. The robot collects data from field monitoring systems, such as weather satellites and drones, to help determine how much water is needed on the fields.

RADAR TO THE RESCUE

The technology is automating the process of counting cranberries for Ocean Spray farmers

BY **AMANDA DAVIS**

IEEE FELLOW Susan Hagness and her research group at the University of Wisconsin in Madison have applied their expertise in electromagnetics to a number of areas including medical imaging and cancer therapies. Now her team is working on a device to help cranberry growers with the laborious task of counting their fruit.

The current method of estimating cranberry crop yield is to harvest the berries within 1 square foot (929 square centimeters) of a bog or marsh, count them by hand, and extrapolate from there. Because there might be hundreds of berries per square foot, the process can be time-consuming and labor-intensive. Also, the process is imprecise.

"There can be numerous varieties of cranberries growing on any given farm, and not all varieties yield the same amount of fruit," Hagness says.

Growers have been looking for a technological solution to more accurately and efficiently estimate the size and quality of their crop, she says. Two years ago, Ben Tilberg, an Ocean Spray agricultural scientist in Wisconsin, contacted the university with an idea. (Ocean Spray, a cooperative of more than 700 farms, is a leading producer of cranberry products. It is headquartered in Lakeville, Mass.)

"He was generally familiar with the concept of microwave radar," Hagness says, "and wanted to see if microwaves could be used to remotely sense the number of berries in the canopy beneath the sensor."

To help Ocean Spray farmers count cranberries, researchers at the University of Wisconsin in Madison developed a prototype for a microwave sensing system that can scan a small part of a cranberry bog at a time. The system then estimates the number of berries—a task that now requires manual labor.

She worked with IEEE Fellow John Booske, a professor of electrical and computer engineering, and IEEE Graduate Student Member Alex Haufler, a Ph.D. candidate in electrical engineering, both at the University of Wisconsin, to turn Tilberg's idea into a working prototype [above]. They tested their device last year at two cranberry farms in central Wisconsin. Now they're working on a second-generation prototype, which they plan to try out this year.

HOW IT WORKS

A popular misconception is that cranberries are grown underwater, Hagness says. They actually grow on dry vines in beds that are layered with sand, peat, and gravel—known as "bogs." Typically farmers then flood the bogs. But long before a bog is flooded, farmers and growers, as well as cranberry researchers, want to know how many berries are on those vines.

The team's current microwave sensing system is composed of a metal waveguide mounted on a PVC support structure that positions it above the canopy. The waveguide sensor transmits electromagnetic waves toward the ground and receives the reflected signal. The device can scan about a square foot at a time.

"Before we set out to develop a first-generation prototype of the cranberry-sensing system, we asked Ben for a bunch of cranberries to study in the lab," Hagness says. "We sliced them open to measure the dielectric properties of the flesh of the fruit and confirmed that there was a significant dielectric contrast between the high-water-content fruit and the surrounding leaves and vines—about a 3-to-1 ratio."

The more berries in the canopy, the more water there is for the microwaves to interact with. The system converts the measured signals into an estimate of the number of berries within the sensor's 1-square-foot field of view.

The team is designing its second-generation prototype to be suspended from a boom and transported by truck to anywhere in the field that a grower wants to observe. Portability is important, Hagness notes, because the farmers want to estimate spatial variations in the berry counts across different growing areas to accurately determine the yield of berries that year.

GROWING POSSIBILITIES

The university's work stands to have a significant impact on the cranberry-growing industry in the state. The United States is the world's top producer, with an annual yield of more than 340,000 metric tons—and more than half of U.S. cranberries are grown in Wisconsin.

"To take our microwave-sensing expertise and apply it to something so relevant to Wisconsin has been really meaningful," Hagness says.

She says the group isn't aware of any prior work on cranberry crop assessment done by radar. One farmer in Florida has expressed interest in using the group's technology to count the fruit on citrus trees.

"Going forward we'll consider working with other growers," she says, "to see if our technology can be adapted for estimating yield for other crops." ◆

ALEX HAUFLER/UNIVERSITY OF WISCONSIN

ISTOCKPHOTO

Technologists are helping farmers increase yields, monitor soil health, and manage crop production.

Plenty of Money to Be Made in the Emerging AgTech Field

Venture capitalists are seeking innovations that help farmers improve food production and distribution BY KATHY PRETZ

THE NEED FOR tech innovation to help farmers become more efficient and address food waste, drought, labor shortages, and other problems has never been greater. And venture capitalists are ready to invest.

Agriculture food (agrifood) tech funding grew by nearly 30 percent over 2016, according to AgFunder, which invests in agtech companies. Last year US $2.6 billion was raised for farm technology businesses.

"The world's population is increasing rapidly, so there's a great need to improve efficiencies in farming and provide farmers with a means of subsistence," says Theofanis "Fanis" Tsoulouhas. A professor of financial management at the University of California, Merced, he helped spearhead the school's agtech program.

Here's where to find opportunities and investors in the emerging field.

KNOW YOUR CUSTOMER

Engineers can contribute in many ways to the agtech field: software to better manage crop production, big data and predictive analytics to increase yield, smart sensors to monitor soil health, and data analysis for quality control.

Just like any business, you need to do your market research and understand your customers. That means meeting with farmers to get a better understanding about their operations and what challenges they face.

That's what IEEE Senior Member Stefano Carpin did. He's a professor of electrical engineering and computer science at UC Merced. Carpin and other researchers met with California grape growers to discuss how technology could help them. The growers asked if their irrigation systems could be made to reduce the amount of water they used, and with less human intervention. The researchers came up with the Robot-Assisted Precision Irrigation Delivery system [see p. 5].

RAPID involves inexpensive, adjustable, plastic water emitters attached to the holes in drip irrigation lines. Each emitter can help regulate the amount of water discharged. And because there aren't enough workers to adjust the hundreds of emitters each vineyard is expected to need, the group is designing rugged, battery-operated, mobile robots to handle the job.

Because most engineers have never set foot on a farm, UC Merced's agtech program ensures its students visit farmers in the nearby San Joaquin Valley, one of the most productive agricultural regions in the world. More than 200 crops are grown there. Students learn about food processing and efficient ways to organize agricultural production, especially on a large scale, Tsoulouhas says. They then go back to the lab to explore technologies that can meet farmers' needs.

Another way to get up to speed on how technologies can benefit farmers is to attend agtech-related conferences.

FOLLOW THE MONEY

Financial literacy is key to running any company, Tsoulouhas says. That includes understanding how to raise money for your venture on crowdfunding platforms and pitching to venture capitalists.

Tsoulouhas says initial coin offerings—a means of crowdfunding centered around cryptocurrency—are becoming one of the hottest vehicles for startups. According to CoinSchedule.com, there were more than 200 last year.

Senior Member Joseph Wei, cofounder of hardware incubator Lab360, who has invested in an agtech company, suggests checking out Royse AgTech. It supports companies focused on creating technologies for the agriculture and food industries. Royse connects promising startups with markets, financiers, and partners. For select startup companies, it hosts demo days and pitch sessions with farmers, companies, and investors.

Wei also recommends looking at microfunds and applying for grants and funding from government agencies that help small businesses. In the United States, he suggests the Small Business Innovation Research program.

Another place to seek funding is from IEEE's network of members, Wei notes.

"IEEE has a lot of luminary members who might be interested in investing in your startup," he says. "They understand what I call *deep technologies*, like chips, and can relate to what you are trying to accomplish."

He invested in IEEE Member Manu Pillai's startup, WaterBit. It's a precision irrigation company that uses wireless sensors to automate the amount of water needed based on weather conditions. Using WaterBit, farmers can monitor and manage irrigation with a mobile device.

Wei and Pillai met through the IEEE Santa Clara Valley Section, in California, which Wei chairs. Pillai approached Wei in 2014 about his startup after learning about Lab360.

"I explained that he had to be fully committed to his company before we would invest," Wei says. "After six months, he proved to me that he was." Pillai had recruited a cofounder. He also demonstrated that his idea was unique and that he had the technical skills to follow through. The company now employs 13 people and is led by executives who previously worked at Fujitsu and Cypress Semiconductor.

There's also the IEEE N3XT program, which seeks out ventures with engineering-driven innovation at their core, and ones that align with IEEE's mission to advance technology for humanity. The program aims to help founders take their venture to the next level by connecting them with technical experts, funding sources, strategic partners, and news media exposure.

The agtech startup Solho was selected as an IEEE N3XT Star. Solho, a green energy company in Delft, the Netherlands, is working on a solar energy system that could support a greenhouse untethered from the electric grid. The founders are developing the Sprhout system, which is designed to harness heat from the sun and convert it to electricity to power greenhouses' heating, cooling, and irrigation. The system will use automation software that will allow remote control, the company says. ◆

Mitsubishi Electric's Diamond Vision was the first really large-scale, video dispay system. It was installed in Dodger Stadium in the summer of 1980. In this photo, a tribute is displayed to former Brooklyn Dodgers catcher Roy Campanella on 27 June 1993, before the Los Angeles Dodgers game against the Chicago Cubs.

DIAMOND VISION FOREVER CHANGED THE STADIUM EXPERIENCE

Mitsubishi's 1980 innovation receives IEEE Milestone

BY **AMANDA DAVIS**

IN THE SUMMER OF 1980, baseball fans in the upper deck at Dodger Stadium, in Los Angeles, no longer had to squint to see which player was taking the mound or stepping into the batter's box. Mitsubishi Electric, an electronics company in Tokyo, installed Diamond Vision, the first really large-scale, video display system, one that showed high-resolution television-like moving images in color.

The Diamond Vision screen hung above the left-field seats, giving fans a closer look at the action and showing instant replays (a new concept at the time). The US $3 million system was unveiled at Major League Baseball's 1980 All-Star Game, held in the stadium on 8 July. The screen initially measured 6 meters high and 8.5 meters wide. It was enlarged a year later by a meter in each direction.

In March, the technology was named an IEEE Milestone. Administered by the IEEE History Center and supported by donors, the Milestone program recognizes outstanding technical developments around the world.

IN LIVING COLOR

The Diamond Vision system was built in 1980 at Nagasaki Works, in Japan, and flown to Los Angeles that May for installation. Although large-scale outdoor electronic color displays existed before 1980, they often were used to display a single image such as an advertisement.

Mitsubishi developed the first screen that could show high-resolution videos in color. Close-ups of key plays as well as commercials, cartoons, and animated text could now be shown during the game.

According to an *Electronic Engineering Times* article, the screen incorporated tens of thousands of high-performance RGB (red, green, and blue) cathode-ray tubes (CRTs) as individual pixels arranged in a matrix controlled by a computer. *High performance* refers to the tubes' ability to change color quickly enough to reproduce fast-moving images. Each tube consumed 2 watts, about a 10th of the power of incandescent bulbs, the standard at the time.

The display was extremely bright—which was necessary to produce clear images that could be seen in broad daylight. Mitsubishi's display was 50 percent brighter than one with incandescent bulbs.

Mitsubishi's CRT matrix was the forerunner of today's superlarge LED displays, which show ultra-high-definition images and consume even less power.

According to Mitsubishi's website, the company has installed Diamond Vision screens in more than 950 locations worldwide, including NRG Stadium in Houston, the Tokyo Dome sporting arena, and New York City's Times Square. The screens are found in all manner of sports and entertainment venues.

MILESTONE CEREMONY

The first Diamond Vision system was honored on 8 March at Nagasaki Works. A plaque mounted inside the building reads:

> *Mitsubishi Electric developed the world's first large-scale emissive color video display system and installed it at Dodger Stadium, Los Angeles, California, in 1980. It achieved bright, efficient, high-quality moving images using matrix-addressed cathode-ray tubes (CRTs) as pixels. With increased dimensions and resolution, the system has entertained and informed millions of people in sports facilities and public spaces worldwide.* ◆

This article was written with assistance from the IEEE History Center, which is partially funded by donations to the IEEE Foundation. This article was part of our special issue on the future of television (http://theinstitute.ieee.org/static/special-report-the-future-of-television).

SIMON BARNETT/GETTY IMAGES

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OPINIONS

Sparking Conversation

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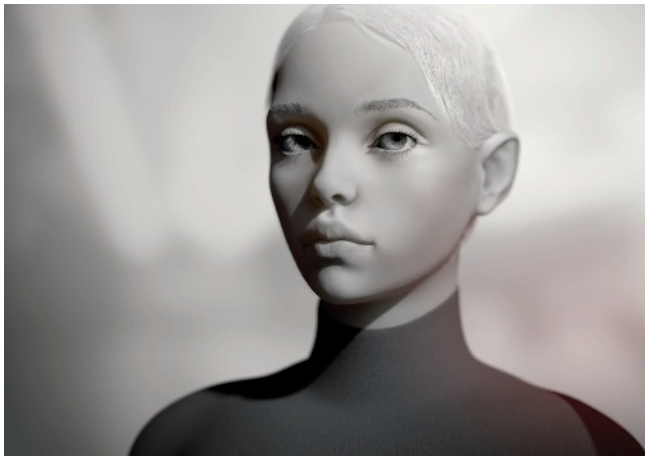

FROM TOP: STRAFORY; ISTOCKPHOTO

Should AI Be In Charge of Hiring?

VERA, AN ARTIFICIAL-INTELLIGENCE program designed by Russian startup Stafory, is helping hundreds of companies fill open positions. In minutes, the program sorts through résumés from five job websites to find candidates who meet the employer's requirements, and then calls them with details of the position.

The avatar [above], which appears relatively lifelike on the screen, conducts video and phone interviews to further narrow prospective workers down to what it considers to be the top 10 percent. From there, the employer makes the final hiring decision.

More than 300 clients, primarily those with offices in Russia and the Middle East, are using Vera. Pilot programs are running in China, Europe, and the United States. Large employers include Ikea, L'Oréal, and PepsiCo.

I would have to be truly desperate to take a job with any company that would expect me to interview with an AI avatar. And if I ever were that desperate, I would keep looking for a better job. Any company so disrespectful of the people it's trying to recruit clearly doesn't have its employees' best interest in mind.

—Barry Moss

I would be curious to see if there are any biases entailed by the use of Vera. This kind of tool should be unpacked for its selection mechanisms, especially biases against people with disabilities or criminal records, or of various racial and ethnic groups, and so on.

—Daniel Schiff

I have four issues with this process. If you want an actor who can speak to a camera, include that it in the list of qualifications. At the very least, it is discriminatory against people of a certain age who have not grown up in front of a computer screen and taking selfies. What about privacy? What happens to this material after the interview? And lastly, it is called "human" resources for a reason.

—Kevin in Calgary

It is automated algorithmic filtering that prevents the best candidates—the ones who don't fit the algorithm's criteria—from being seen by hiring managers. Automation overlooking exceptional talent is good news for the few employers who know better. But it is not good for the industry as a whole.

—Tiok

If they are going to interview me with an avatar, I can just have their avatar talk to my avatar.

—Jim Klessing

'Publish or Perish' Is Hurting Research

EEE FELLOW CHAI K. TOH wrote about his concerns over researchers' "paper cranking" to increase their citation number. He says one should not publish for the sake of publishing, but to make an impact on society.

One problem with measuring productivity,

he noted, is that industry researchers do not publish as much as university students and professors—which means the work of those in industry is not considered as impactful. Industries are focused on research outcomes that can significantly improve a product or create new ones. Innovators including Steve Jobs and Elon Musk arguably have a greater impact on people's lives than, say, a university researcher with several thousand citations.

"The way I believe we should define impact is based on criteria far beyond citations," Toh wrote. "The criteria should include: Did the researcher write the paper on his or her own, or with the help of others? Did the research uncover new knowledge? Did it help start a new discipline? Did it invent a new industry and, as a result, create new types of jobs? Does the research help improve the national economy in any way? Is it changing the lives of millions of people? Those are examples of the type of impact our engineering giants have made."

A small step in the right direction would be to make the review process double-blind, which means the reviewers are anonymous to the authors and the authors are anonymous to the reviewers. In this way, the papers have a greater chance of being judged on merit rather than on the author's reputation (or lack of it). Biased reviewing does enable paper cranking. A (very small) number of IEEE publications are already implementing this system, and I commend them for their stance. But wide adoption is far away.

—Alex Ciubotaru

Universities that require specific numbers of articles for graduation further fuel the explosion in publishing. Rather than a single complete article, readers are subjected to a deluge of partial papers that may, in combination, have been an exceptional one.

—Andre

I appreciate your comments about sole author papers and assessing whether the researcher wrote the paper on his or her own or with the help of others. There is far too much gaming of the system, in which authors have had no significant role in the research yet are named on papers, artificially boosting their citation numbers. I wonder if there is a better metric that can take this into account, such as putting more weight on sole or primary author contributions.

—Barry Hayes

Quantitative measurements are simpler, but they rarely encompass all the complexities and subtleties of the work. Citations are a clear case in point. Simple to measure and compare, they are only a weak reflection of the value of work, and they are open to manipulation. We need something more nuanced, which will be harder to derive but be more aligned with the goals of leading academic and research work.

—William Webb

What's the Dress Code for Job Interviews These Days?

THERE'S A LOT of confusion about what job candidates should wear for interviews at today's tech companies and startups. Are suits and skirts too formal? Are jeans and sneakers too casual? Does anyone even care how you dress as long as you can do the job?

Member Anurag Garg, cofounder of Dattus, an industrial Internet of Things company, says to dress for the job you're interviewing for, while also being considerate of the company's and industry's culture. "There is no 'one size fits all' approach to interviewing at startups," Garg says, adding he personally prefers an outside salesperson be dressed well but wouldn't mind a developer candidate interviewing in a T-shirt and shorts.

A post on the recruiting website Ivy Exec says candidates need to show they'll fit in with the company culture.

When I interview candidates for a tech job, I consider whether they are dressed in a neat, clean, and professional manner, but also would they be ready to crawl around a server room floor? In other words, somewhere in between stiff corporate wear and going to the pub.

—Julian Berdych

I suggest taking time to peruse the organization's website to find workplace photos that might give you some clues about how employees dress. I once had a very important interview at a company where I went so far as to cut my hair chin-length to look more professional, only to find that all the women who worked there had long hair. My attire was misplaced. They were very casual, with managers in polo shirts. I still got the job offer, but I cringe at my decision. It took me years to grow my hair back.

—Rebecca Mercuri

Before you interview, you should know not just about the company's products and competitors but also its internal culture.

I suggest dressing one level above the business attire expected at that company. But always be neat and clean.

—Peter Salerno

Depends on the department. Show up dressed like the company brochures and you won't get a job in the R&D section. You'll be viewed as a climber and not a worker.

—JC Kirk

I'm an old software guy. I stopped wearing suits to interviews 20 years ago. My interviewees wear T-shirts, shorts, and sneakers. My buddy, a data scientist, is interviewing people in Hawaiian shirts, and not tucked in of course. They also arrive by Lyft or electric scooter.

—itellu3times

Your prospective employer will never expect to see you any better dressed than you are at the interview. Don't worry about looking like a penguin. You're still sending the right message.

—verntigo

People working in the tech sector pride themselves for being smart and open-minded, but to evaluate "culture fit" means everyone has to be the same to the point they're all dressed the same way. That's shockingly narrow-minded. People who evaluate candidates on culture fit should be ashamed of themselves. If it's that important, employees should wear uniforms.

—sonjav

This applies equally well to interviewers. Show some respect for the applicant. It doesn't help to start off a new relationship with an "I don't care what you think" attitude, even if that's how you feel.

—benrolfe

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These discussions are ongoing. To weigh in, visit http://theinstitute.ieee.org/sept18responses.

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PRESIDENT'S COLUMN

DAVID SUTPHIN

Stepping Ahead, Envisioning the Future

The role of technical professional associations in society

JIM JEFFERIES IEEE PRESIDENT AND CEO

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Please share your thoughts with me at president@ieee.org.

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