

Biologically inspired membrane purges most greenhouse gases from coal-fired smoke

By Neal Singer

A biologically inspired membrane intended to cleanse carbon dioxide almost completely from the smoke of coal-fired power plants has been developed jointly by researchers at Sandia and the University of New Mexico.

The patented work, reported recently in "Nature Communications," has interested power and energy companies that would like to significantly reduce emissions of carbon dioxide, one of the most widespread greenhouse gases, and explore other possible uses of the invention.

Researchers term the membrane a "memzyme" because it acts like a filter and is near-saturated with an enzyme, carbonic anhydrase, developed by living cells over millions of years to help rid themselves of carbon dioxide efficiently and rapidly.

"To date, stripping carbon dioxide from smoke has been prohibitively expensive using the thick, solid, polymer membranes currently available," says Jeff Brinker, a Sandia fellow, University of New Mexico regents' professor and lead author of the paper.

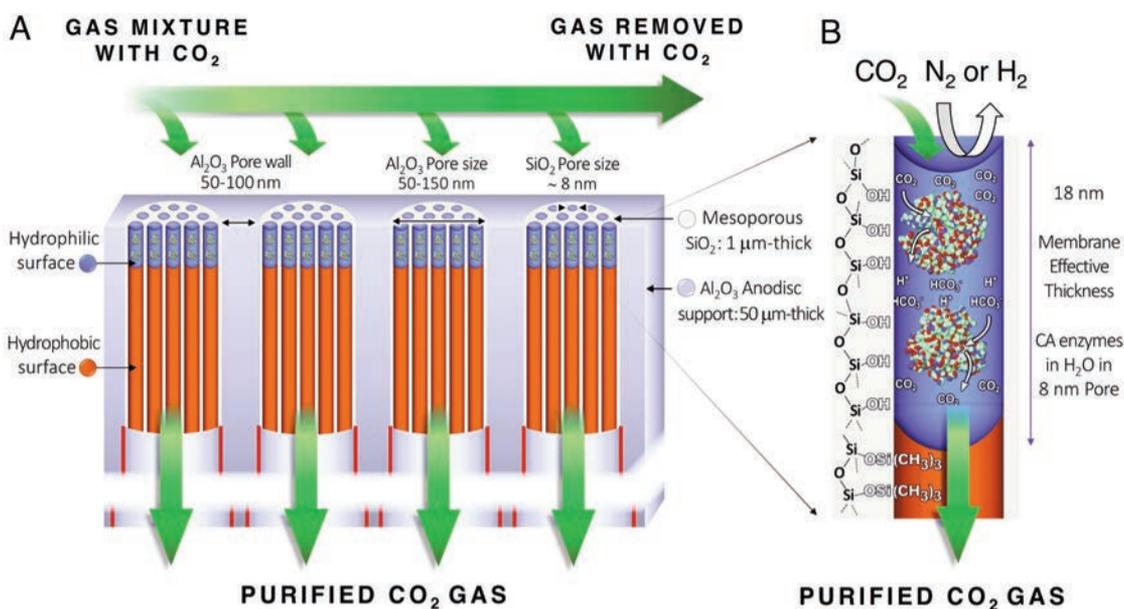
"Our inexpensive method follows nature's lead in our use of a water-based membrane only 18 nanometers thick that incorporates natural enzymes to capture 90 percent of carbon dioxide released. (A nanometer is about 1/700 of the diameter of a human hair.) This is almost 70 percent better than current commercial methods, and it's done at a fraction of the cost."

Coal power plants are one of the U.S.'s largest energy resources, but they face regulatory hurdles and criticism for sending more carbon dioxide into the atmosphere than any other form of electrical power generation. Still, coal burning in China, India and other countries means that U.S. abstinence alone is unlikely to solve the world's climate problems.

But, says Jeff, "maybe technology will."

The memzyme meets the Department of Energy's standards by capturing 90 percent of power plant carbon dioxide production at the relatively low cost of \$40

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ENZYMATIC LIQUID MEMBRANE DESIGN AND MECHANISM OF CARBON DIOXIDE CAPTURE AND SEPARATION: The Sandia/UNM membrane is fabricated by formation of 8-nanometer diameter cylindrical mesopores. Using atomic layer deposition and oxygen plasma processing, the silica mesopores are engineered to be hydrophobic except for an 18-nanometer-deep region at the pore surface which is hydrophilic. Through capillary condensation, carbonic anhydrase enzymes and water spontaneously fill the hydrophilic mesopores to form an array of stabilized enzymes with an effective concentration greater than 10 times of that achievable in solution. These catalyze the capture and dissolution of carbon dioxide at the upstream surface and regeneration of carbon dioxide at the downstream surface. The high enzyme concentration and short diffusion path maximizes capture efficiency and flux. (Image courtesy of Sandia)

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Using biomimicry to detect outbreaks faster

Sandia collaborating with UNM, CDC to improve biosurveillance

By Mollie Rappe

Our immune systems are made up of billions of white blood cells searching for signs of infections and foreign invaders, ready to raise the alarm.

Sandia computer scientists Pat Finley and Drew Levin have been working to improve the U.S. biosurveillance system that alerts authorities to disease outbreaks by mimicking the human immune system. They are working with researchers at the University of New Mexico and the Centers for Disease Control and Prevention.

The CDC coordinates the National Syndromic Surveillance Program. It collects anonymized data from most emergency departments around the nation and ana-



DISEASE DETECTIVES — Sandia computer scientists Pat Finley, left, and Drew Levin, center, and University of New Mexico Professor Melanie Moses have taken inspiration from the immune system to improve how the U.S. detects emerging outbreaks. Drew started on the project as a UNM graduate student and after he graduated he was hired by Sandia to continue working on the project. (Photo by Randy Montoya)

lyzes public health indicators to speed up the response to hazardous events and disease outbreaks.

"The national biosurveillance system serves essentially the same purpose as the human immune system, just on a larger scale," said Drew, who started working on the project as a UNM graduate student and was hired by Sandia to continue his work after he graduated. "The

immune system is made up of numerous T-cells that all operate independently. There's no centralized controller and yet we do pretty well not dying."

The CDC uses traditional statistical analyses to look for anomalies, such as a large or sudden increase in ER

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Lab News Notes

Editor's Note: As noted in the March 16 "That's That" column, Lab News editor and columnist Bill Murphy has retired. His voice was unique and will be missed. The Lab News team is looking for guest columnists and ideas for interesting columns on science and technology in the news and in contemporary life. If you have a column (500-750 words) or an idea you'd like to submit, please contact Jim Danneskiold, the acting editor. In the meantime, here's a guest column from Communications Senior Manager Val Smith.

People talk to me on planes. Maybe it's because I don't wear headphones, or maybe I'm unintentionally sending off some signal. My husband says I have a trusting face.

Whatever the reason, I've heard dozens of life stories from complete strangers. One of the scariest was when my earnest seat mate grabbed my hands during turbulence and began praying for my soul (prompting me to wonder if she knew something I didn't). One of the most touching was hearing about an estranged family brought back together at a funeral.

Rather than finding it a nuisance, I've learned to roll with it. I've also learned I can be a terrible first judge of people based on their appearance.

During some classes on unconscious bias I took recently at Sandia, one of those snap judgments came to mind.

I was seated by a window on a full flight, hoping for an empty center seat. The person who arrived was small. Her hair was enormous. With a thick West Texas accent, she immediately began to tell me about her ranching family and West Texas roots.

Aha, I told myself. I know this person. I've met her dozens of times and can describe her right down to the butter-soaked cornbread recipe she's going to share with me before this flight is over.

But as the young woman started talking, I realized I didn't know her at all. She was a D.C. staffer deeply versed in politics and current events. She was extremely interested in exploring new technologies to expand the use of renewable energy. And she never once shared her cornbread recipe.

That was a turning point for me because, until then, I really did think that I was immune to unconscious bias. I grew up one of the only Anglo kids in an all-Navajo school, so I felt I didn't see race. Clearly though, I saw big hair and jumped to a wrong conclusion.

Since then, I've been more cognizant of snap judgments and have looked for more data on what makes us think we know another person when we don't. One of the best books I've read on the subject is "Blink" by Malcolm Gladwell. What stayed with me from the book was the section on music auditions. When orchestral auditions had the musicians perform in front of the judges, white men wound up holding most of the chairs. Once musicians auditioned behind a screen with only a number to identify themselves, orchestras began hiring women.

It's likely the bias wasn't conscious. Perhaps conductors couldn't see a slight woman effectively playing a large instrument like a trombone, or even having the power of a man on a smaller instrument like a trumpet. If you were one of those affected, though, it certainly was harmful, whether intentional or not.

I've read where some companies are moving to the orchestra model for other types of hiring. For example, some information technology companies are using a software-based test to judge a candidate's programming capabilities, and weighting that blind performance heavily into their decisions.

I doubt there's a magic bullet that can eliminate unconscious bias from our lives, but from personal experience I know that self-awareness is an important first step. Sandia's classes help in that regard. Plus, they can give you interesting facts to discuss with a stranger on your next plane trip.

— Val Smith

Annual Labs Accomplishments Published



On the cover of the current issue of Labs Accomplishments, technologist Nicole Cofer inspects a target she fabricated for Sandia's Thor pulsed-power accelerator. (Cover Photo by Randy Montoya)

The annual Labs Accomplishments magazine is now available on the Lab News racks around the Laboratories or from the communications team at IPOC C2251.

The publication recognizes some of Sandia's best work during 2017, as submitted by center offices and selected by division offices. The magazine highlights critical milestones in key mission areas, scientific breakthroughs reached via Laboratory Directed Research and Development and valuable advances in mission support.

As Labs Director Steve Younger notes in his introduction, this year's Labs Accomplishments demonstrates the deep science and engineering foundations that give Sandia a cross-disciplinary advantage to solve some of the nation's toughest problems and make the world a safer place. Steve asks the Sandia community to "enjoy this look at significant work performed at the Labs over the past year. I promise it will be time well spent and make you, like me, proud to be a Sandian."

The publication in pdf format is also available online at <https://go.usa.gov/xQ27H>

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Sandia National Laboratories

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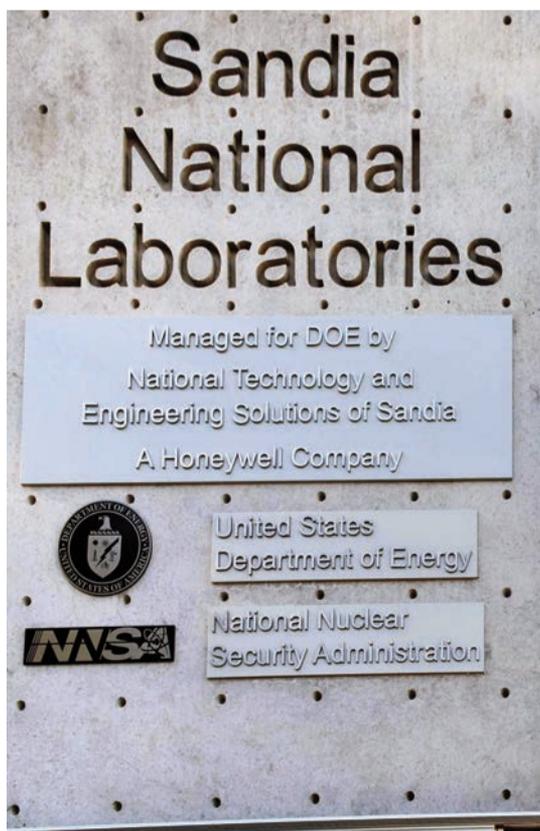
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Jim Danneskiold, Acting Editor 505/844-0587
Darrick Hurst, Managing Editor 505/844-8009
Michael Lanigan, Production 505/844-2297
Randy Montoya, Photographer 505/844-5605
Patti Koning, California site contact 925/294-4911

Contributors: Michelle Fleming (Ads, Milepost photos, 844-4902), Neal Singer (845-7078), Stephanie Holinka (284-9227), Michael Baker (284-1085), Troy Rummeler (284-1056), Valerie Larkin (284-7879), Lindsey Kibler (844-7988), Tim Deshler (844-2502), Mollie Rappe (844-8220), Kristen Meub (845-7215), Michael Padilla (925-294-2447), Julia Bernstein (925-294-3609), Jim Danneskiold, manager (844-0587)

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Retiree deaths

Robert Vokes (age 94)	December 18
Richard Vivian (93)	December 22
Billy Brock (68)	January 1
Jane Christy (99)	January 8
Larose Hailstorm (77)	January 12
Stanford Cain (93)	January 19
Eunice Simpson (96)	January 22
R. Norris Rose (84)	January 26
Sadie Knight (90)	January 27
Louis Ulibarri (94)	January 29
William Cocke (94)	January 31
William Rego (75)	February 4
Blynn Shafer (77)	February 4
Gertrude Finley (97)	February 7
Raymond Pattenon (70)	February 16
David Sanchez (90)	February 17
Francis Murar (92)	February 17
Norberto Garcia (70)	February 18
G. Hallowwa (97)	February 20
Alyce James (90)	February 21
James Pacini (85)	February 27
Bernard Stiefeld (87)	February 27
Jimmie Quick (80)	March 2
Lucille Sanchez (89)	March 5
Regina Kamp (93)	March 13



Secretary Perry and Sandia: A science alliance

By Jules Bernstein

Buried within U.S. Secretary of Energy Rick Perry's impressive biography is a little-known fact: he was once a yell leader for Texas A&M University. On a recent tour through California, Secretary Perry said he's now reprising that role, but this time it's in service of the national laboratories.

Kicking off his two-day tour through Livermore, the former Texas governor explained how this past year as Energy secretary has deeply affected him. "I have found this great new passion in my life, and that is to be a supporter and cheerleader, a proponent of these national jewels," he said, referring to the DOE laboratories.

This comment set the tone for his all-hands meeting at Lawrence Livermore National Lab hosted jointly by its director, Bill Goldstein, and Sandia Director Steve Younger. There, he touched on the challenges of recruiting and the need to develop multiple sources of energy to meet growing demand.

Competition for top talent

The secretary acknowledged the difficulty of recruiting in California, with its sky-high cost of living. Though he joked that Texas can't compete with the Golden State in terms of weather or wine, he stressed the necessity of legislative action to keep California competitive.

He also wondered aloud how to "make nuclear cool again," since weapons work was a popular choice for the bright students of his generation, but is less so today. That's why it was with surprise and delight he noticed the apparent youth of the engineers assembled for his visit to the W80-4 life extension suite.

Many of the engineers in the room appeared to be under 35, and the secretary complimented them for choosing a career with impacts that would continue for decades. He also expressed gratitude to everyone in the weapons program, particularly in the face of increased work that will be required of them due to the recent nuclear posture review.

Among DOE's recruitment solutions are its veteran training programs. Perry proudly noted that 40 percent of DOE employees are veterans, whom he said make great team members because they understand dedication to a mission.

Fueling the country's future

The secretary also made it clear at the all-hands that to meet projected future demands, the U.S. will require a healthy supply of all forms of energy, including renewables. He proudly noted that during his tenure as governor, Texas saw more growth in wind energy than any state in the nation.

He urged fans of renewable energy in the room not

to panic over proposed federal budget cuts, because budgets often are subject to intense negotiations and change. "The joke in Austin is that the governor's budget makes a really good doorstep," he said.

Later during the site tour, manager Paul Miles of Engine Combustion explained that Sandia is modifying its diesel research laboratories to study natural gas combustion in medium- and heavy-duty engines.

Paul said the challenge with natural gas is closing the efficiency gap with diesel. The secretary was enthusiastic about this work, relating Sandia's research to the extensive infrastructure for natural gas delivery that he helped develop in Texas.

Additional highlights of his tour included a demonstration of Twistact, a Sandia-designed device for wind

energy turbines that operates without the use of rare-earth magnets, by manager Amanda Dodd of Energy Innovation. Amanda also showed Perry the Sandia Cooler, a rotating cooling unit for electronics that is faster, smaller and quieter than current state-of-the-art electronics coolers.

Throughout it all, the secretary remained thoroughly upbeat about the labs, and reiterated his commitment to making sure the laboratories have the resources to continue their work for years to come.

"Hosting Secretary Perry today was truly a pleasure," said Associate Labs Director Dori Ellis. "He made clear that his commitment to the laboratories is unwavering, and that in him we have a strong, effective advocate for our mission of solving the nation's security and energy challenges."

CALIFORNIA STROLLING — DOE Secretary Rick Perry (left) tours Sandia's California campus, hosted by Associate Labs Director Dori Ellis (center) and Director Steve Younger (right).
(Photo by Randy Wong)



NO MAGNET NEEDED — Amanda Dodd, manager of Energy Innovation, explains Twistact, a spinning electrical-contact device designed by Sandia. It eliminates the need for rare-earth magnets in wind-turbine power generators. Secretary Perry holds a small, moving replica of the Twistact device.
(Photo by Randy Wong)

Membrane

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per ton.

The device's creation begins with a drying process called evaporation-induced self-assembly, first developed at Sandia by Brinker 20 years ago and a field of study in its own right.

The procedure creates a close-packed array of silica nanopores designed to accommodate the carbonic anhydrase enzyme and keep it stable. This is done by treating the array, which may be 100 nanometers long, with a technique called atomic layer deposition to make the nanopore surface water-averse, or hydrophobic. An oxygen plasma treatment then makes the nanopores water-loving or hydrophilic, but only to a depth of 18 nanometers. A solution of the enzyme and water fill up and are stabilized within the water-loving nanopores. This creates a membrane of water 18 nanometers thick, with a carbonic anhydrase concentration 10 times greater than any aqueous solution made to date.

The solution, at home in its water-loving sleeve, is stable. But because the enzyme can rapidly and selectively dissolve carbon dioxide, the catalytic membrane has the capability to capture the overwhelming majority of carbon dioxide molecules that brush up against it from a rising cloud of coal smoke. The hooked molecules then pass rapidly through the membranes, driven solely by a naturally occurring pressure gradient caused by the large number of carbon dioxide molecules on one side of the membrane and their comparative absence on the other. The enzyme turns the gas briefly into carbonic acid and then bicarbonate before exiting immediately downstream as carbon dioxide gas.

The gas can be harvested with 99 percent purity — so pure that it could be used by oil companies for

resource extraction. Other molecules pass by the membrane's surface undisturbed. The enzyme is reusable and, because the water serves as a medium rather than an actor, does not need replacement.

"Energy companies and oil and gas utilities have expressed interest in optimizing the gas filters for specific conditions," says Susan Rempe, Sandia researcher and co-author, who suggested and developed the idea of inserting carbonic anhydrase into the water solution to improve the speed by which carbon dioxide could be taken up and released from the membrane. "The enzyme can catalyze the dissolution of a million carbon dioxide molecules per second, vastly improving the speed of the process. With optimization by industry, the memzyme could make electricity production cheap and green," she says.

The nanopores dry out over long periods of time due to evaporation. This will be checked by water vapor rising from lower water baths already installed in power plants to reduce sulfur emissions. And, enzymes damaged from use over time can easily be replaced.

Says Jeff, "The very high concentration of carbonic anhydrase, along with the thinness of the water chan-



Sandia fellow and University of New Mexico regents professor Jeff Brinker led work to develop the inexpensive memzyme capable of ridding coal smoke of carbon dioxide. (Photo by Randy Montoya)

nel, result in very high carbon dioxide flux through the membrane. The greater the carbonic anhydrase concentration, the greater the flux. The thinner the membrane, the greater the flux."

The membrane's arrangement in a generating station's flue would be like that of a catalytic converter in a car, suggests Jeff. The membranes would sit on the inner surface of a tube arranged like a honeycomb. The flue gas would flow through the membrane-embedded tube, with a carbon dioxide-free gas stream on the outside of the tubes. Varying the tube length and diameter would optimize the carbon dioxide extraction process.

The separation process could increase the amount of fuel obtained by enhanced oil recovery using carbon dioxide injected into existing reservoirs. A slightly different enzyme, used in the same process, can convert methane — an even more potent greenhouse gas — to the more soluble methanol for removal, Susan says.

Prior cleansing by industrial scrubbers means that the rising smoke will be clean enough not to significantly impair membrane efficiency, says University of New Mexico professor and paper co-author Ying-Bing Jiang, who originated and developed the idea of using watery membranes based on the human body's processes rather than solid manufactures, to separate out carbon dioxide. The membranes have operated efficiently in laboratory settings for months.

The procedure also could sequester carbon dioxide on a spacecraft, because the membranes operate at ambient temperatures and are driven solely by chemical gradients, say the authors.

The work was initially supported by Sandia Laboratory Directed Research and Development, with additional funding from the Department of Energy Office of Science and the Air Force Office of Scientific Research. The work was performed, in part, at the Center for Integrated Nanotechnologies, an Office of Science User Facility operated by Sandia and Los Alamos national labs.

Biomimicry

(Continued from page 1)

visits and determine the likelihood of an outbreak. These algorithms are based on reliable, decades-old math but usually only look at one variable at a time, said Drew.

The faster an emerging outbreak is detected, the more lives are saved; however, flagging non-outbreaks can waste resources.

Pat said the biosurveillance system has the dual challenge of detecting new outbreaks of old diseases, such as seasonal influenza, as well as outbreaks of new diseases, such as the next Zika virus, a very tough problem. However, it is a problem the immune system has been working on for millions of years.

Synthetic T-cells monitor multiple variables for nuanced alerts

T-cells are a type of white blood cell that recognize and kill virus-infected cells and other foreign pathogens. They are "trained" to focus on these invaders through a process where every T-cell that attacks normal body cells is destroyed. Other than this initial negative-selection "training," there's no central "brain" telling the T-cells where to go or what to look for.

Pat thought that mimicking how T-cells work might speed up outbreak detection. In 2015, he began collaborating with immune system modeling experts at UNM as part of Sandia's Academic Alliance program. The Academic Alliance is a partnership Sandia has built with five universities to promote collaborative research on tough problems and attract top talent to work on these challenges.

"The adaptive immune system in vertebrates is one of the most complex systems in biology with trillions of cells, dozens of cell types and signaling molecules," said Melanie Moses, a UNM professor of computer science and biology involved in the project. "Through computer modeling and simulation, we understand how the immune system works which, in the long term, can lead to improved immuno-therapies, allergy treatments and vaccines. It also provides inspiration for the design of other decentralized systems for surveillance and protection."

Working together, they created synthetic, mathematical "T-cells" that look at multiple different variables at the same time, such as number of clinic visits, day of the year and intake temperature. Then, mimicking the T-cell negative selection process, Drew ran the synthetic T-cell algorithms against past data collected by the CDC and New Mexico Department of Health. He compared the algorithms and selected the most accurate.

In 2016, initial tests on a pilot-scale biosurveillance system showed that Drew's synthetic T-cells performed better than the traditional statistical methods, said Pat. Also, because they track multiple variables intrinsically, they could provide more nuanced alerts, such as separating an outbreak of a new disease from seasonal influenza, he said.

Brain-inspired machine learning improves chief complaint deciphering

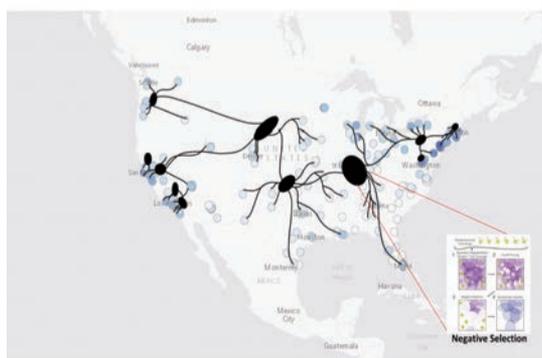
The first piece of data the CDC receives from each emergency room visit is called the chief complaint. This is a concise statement describing why a patient has gone to the emergency room or clinic, before they've seen a doctor and have been diagnosed. Chief complaints range from "chest pain" and "fever three days" to specialized abbreviations.

Biosurveillance Topology

Current Biosurveillance Topology



Lymph-Node Biosurveillance Topology



These terse statements are full of medical jargon and even misspelled words, making them difficult to decipher by simple keyword searches or by the inexperienced. Also, many words describe the same symptoms, such as fever, hot, temperature and chills.

Technology companies have been using deep learning for similar natural-language processing problems. Deep learning is brain-inspired machine learning that excels at finding patterns without being explicitly programmed on what to look for. One such algorithm, called Word2vec, converts the context of words into mathematical vectors.

When Drew ran the Word2vec algorithm on anonymized chief complaint data collected by the New Mexico Department of Health, it out-performed a standard keyword search, as well as other state-of-the-art machine learning algorithms. However, it still had troubles with misspelled words and abbreviations.

To work around this, Drew tried two related neural network algorithms: one that converts letters into vectors and another that converts words into random vectors. The algorithm that converted words into random, or untrained, vectors was most accurate. The Word2vec algorithm was trained on standard, non-medical prose, and makes antonyms such as hot and cold too similar mathematically speaking, which could be why it didn't produce the best results, said Drew.

Though more optimization is needed, the team's deep-learning algorithm for deciphering chief complaints could be particularly useful for the opioid epidemic, said Pat. He added, "New terms for street drugs tend to appear much more quickly than the public health community realizes. If we find that a weird word is popping up a lot in an area, it could be a new variety of fentanyl."

Future of distributed biosurveillance centers

Lymph nodes are distributed throughout the body and act as immune system hubs, chock full of T-cells and the B-cells that produce antibodies to fight off infections.

Pat and his team are just beginning to explore how mimicking lymph nodes might improve the biosurveillance system. Pat believes it would be particularly helpful in detecting outbreaks of regional diseases like Lyme disease, plague and Hantavirus. Also, distributed detection algorithms could be more efficient by bypassing the physical and power consumption limits that Moore's Law computers are now running up against, added Drew.

"We are working closely with the CDC to test a number of our deep learning approaches on a subset of the national data flow," said Pat.

His goal is to have his bio-inspired system set up by October to allow side-by-side comparisons with the traditional statistical methods at the national scale. He believes the different approaches will have different strengths, and combining them will improve the speed and accuracy of outbreak detection.

This research was funded by Sandia's Laboratory Directed Research and Development program. Sandia computer scientists Walt Beyeler and Michael Mitchell and UNM postdoctoral fellow Tatiana Flanagan also worked on the project, focusing on the lymph system-mimicking distributed detection algorithm.

"This project with Sandia has provided us with an opportunity to test the practical application of the concepts we've learned from our models," said Melanie. "Ultimately, this project will lead to a more complete understanding of the immune system, as well as a practical way to quickly identify and respond to disease outbreaks and other biological threats."

The future is now

By Nancy Salem

Labs Director Steve Younger says there are two ways to approach the future — either shape it or let it happen to you. “I tend to prefer the former,” he said at an All Hands March 21 titled “Creating Our Future.” “The pace of world events is outpacing our ability to simply respond — we must seek to understand our future environment and plan accordingly. “Sandia’s role is to enhance national security,” Steve said. “Creating our future is our job and always has been our job.” Steve said the workforce didn’t miss a beat during the transition nearly a year ago to new management by National Technology and Engineering Solutions of Sandia. “You met every milestone,” he said. “Astonishing work by astonishing people.” He called former Labs Director Jill Hruby and her team “true patriots and true Sandians,” and credited them with leaving Sandia in great shape and overseeing a smooth transition. Sandia’s future looks bright in terms of budgets and staffing. Performing work safely and securely should remain a top priority. Steve outlined aggressive threats to the United States from Russia, China, North Korea, terrorists and cyberattacks. “Sandia has an important role in



LABS DIRECTOR STEVE YOUNGER urges Sandia to plan for future challenges. Shown with Steve in this photo is sign-language interpreter Alex Luce. (Photo by Randy Montoya)

assuring that we are ready to meet these and other challenges,” he said. “The national security environment is more complex than ever. What kind of institution will thrive in that kind of environment? Let’s think about what we want to be. Our roles are to anticipate,

help the government understand what is possible, develop technology, integrate systems and be a rapid responder. Creating our future will take imagination, innovation and integration through transformational people, technology and processes. We are up to the task.”

The arrival of Spring

Trees blossoming in front of Building 800 greet members of the workforce and visitors as they enter Sandia.

(Photo by Randy Montoya)



Women recount leadership journeys at SWAN panel



Leadership • Empowerment • Mentoring • Collaboration

By Lindsey Kibler

On March 21, Sandia Women's Action Network (SWAN) hosted its fourth annual leadership panel, "Lead From Where You Are". This year, the panel consisted of accomplished women from various levels of leadership who discussed their leadership journeys and important mentors, how leadership characteristics align with the Sandia Behaviors and how they balanced work with their lives outside the Labs.

When asked what characteristics are important for leaders to possess, the women echoed the importance of teamwork while sharing anecdotes about why other qualities — such as empathy, trust, active listening and self-awareness — are equally valuable.

"I think there are too many important things to count, but one of the most important is to, first, deal with your own issues," said panelist and Associate Laboratories Director Susan Seestrom. "Everybody has issues in life, whether it comes from their family or at work, and, if you don't address them, they pop up and influence your interactions in ways you don't control." By understanding and managing them, Susan said, your interactions with your colleagues will be much more productive.

If you missed the panel, you can view the archived video online at <http://tiny.sandia.gov/qco0w>.



WOMEN'S LEADERSHIP PANEL — Panelists (left to right) Renee Holland, Susan Seestrom, Dori Ellis, Jericah Townsend, Tina Hernandez, Rosalie Multari and SWAN co-chair and panel moderator Blythe Clark. (Photo by Randy Montoya)



Associate Laboratories Directors Susan Seestrom, left, and Dori Ellis, served as panelists for the 2018 SWAN Women's Leadership Panel. Both women discussed their paths to leadership, with Dori jokingly referring to it as "more of a random walk" than a set path, and offered their advice for women looking to pursue roles as leaders within their organizations. (Photo by Randy Montoya)



INTERNATIONAL DAY OF HAPPINESS

INTERNATIONAL DAY OF HAPPINESS — Several teams at the Labs participated in the recent celebration of the United Nations International Day of Happiness. Susan Shelton coordinated Sandia's participation with employees from Employee Health Services and SERP. Volunteers placed happiness walls in several locations Labs-wide including the Sandia Medical Clinic, SERP and buildings 870, 905 and 894, where employees posted examples of what makes them happy or what they do to make others happy. (Photo by Randy Montoya)



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DINING TABLE, 68"L x 44"W, w/6 chairs, cover, 2 extra 18-in. leaves, solid oak frame, table excellent condition, chairs lightly soiled, 1 needs new fabric, \$675. Cordwell, 505-299-5026.

AMI BLACKSHEAR'S RAINBOW BABIES 'POOKIE', in original box, \$75. Gollan, 505-323-5317, leave number.

HOLOGRAPHY EQUIPMENT, for 'sandbox' laser, optics, plateholders, some old plates, photos on Craigslist: 'holography.' Hansche, 505-281-6623.

CHAISE LOUNGER, lift, sit, recline, \$300 OBO. Koester, 890-2730.

FAX MACHINE, Brother model 1270, \$25. de la Fe, 505-459-4685.

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KNEE SCOOTER, deluxe, steerable, KneeRover, excellent condition, \$135. Schear, 505-865-6457.

ROLL-TOP COMPUTER DESK, oak, multiple drawers, bins, lockable, 57" x 36" x 52", great condition, looks amazing in any room, \$200. Barney, 505-301-1583.

TABLE, maple, 42-in. pedestal, w/3 leaves, mechanism patented 1869, 4 oak chairs, photo available, \$200. Walkington, 831-6974.

LANDSCAPING ROCK, clean, 1-2 in., ~ 3 yds., free. Graham, 505-293-7302.

GAS GRILL, Jenn-Air, stainless steel, 3 burners, w/infrared side burner, you pick up, \$150 OBO. Parks, 505-400-4408.

LAWN TRACTOR, Craftsman, 54-in. mower, w/3 grass, weed catcher, Briggs & Stratton Intertec engine. Riley, 869-2119.

TRAMPOLINE, Sportspower, w/removable handle, rarely used, very easy to set up, excellent condition, photos available, \$50. Mares, 505-980-5438.

'10 UTILITY TRAILER, 5' x 10', wood deck, 4-ft. mesh gate, spare tire, trailer dolly, \$750. Gehrke, 505-263-7327.

PLASMA 3D TV, Panasonic, 55-in., model TCP55UT50-55, 600 Mhz, great for sports, excellent condition, \$275. Schwartz, 220-6301, ask for Barry.

SOFA & LOVESEAT, Anasazi leather, white, excellent condition; dining table, glass top, w/4 chairs, excellent. Blackburn, 505-280-6130.

FULL BED, honey maple, dresser w/hutch & nightstand, \$250/set; buffet, large, cherry wood, \$350. Valdez, 550-1993.

WOMEN'S COWGIRL BOOTS, Ariat, size 8.5, 3 pair, like new, good condition, photos available, \$40 ea. or \$100/all. Armijo, 505-550-0954.

TIRES, 4, Sears Hercules G2000T, 155/80R, 12-in. on Geo rims w/caps, <500 miles, \$100. Greer, 331-2726.

PARLOR TABLE, antique, oak, ball and claw foot, \$325. Stubblefield, 263-3468.

TRANSPORTATION

'99 SUBARU OUTBACK, 5-spd. manual, fresh tires, interior fair, engine good, no leaks, 189K miles, \$2,000. Wolfgang, 505-414-1483.

'98 BMW M-ROADSTER, red, 21K miles, clean CarFax, manuals, all keys, all records, excellent condition, \$21,900. Scott, 505-269-3285.

How to submit classified ads

DEADLINE: Friday noon before week of publication unless changed by holiday.

Submit by one of these methods:

- EMAIL: Michelle Fleming (classads@sandia.gov)
- FAX: 844-0645
- MAIL: MS 1468 (Dept. 3651)
- INTERNAL WEB: From Techweb search for 'NewsCenter', at the bottom of that page choose to submit an ad under, 'Submit an article'. If you have questions, call Michelle at 844-4902. Because of space constraints, ads will be printed on a first-come basis.

Ad rules

1. Limit 18 words, including last name and home phone (if you include a web or e-mail address, it will count as two or three words, depending on length of the address.)
2. Include organization and full name with the ad submission.
3. Submit ad in writing. No phone-ins.
4. Type or print ad legibly; use accepted abbreviations.
5. One ad per issue.
6. We will not run the same ad more than twice.
7. No "for rent" ads except for employees on temporary assignment.
8. No commercial ads.
9. For active Sandia members of the workforce, retired Sandians, and DOE employees.
10. Housing listed for sale is available without regard to race, creed, color, or national origin.
11. Work Wanted ads limited to student-aged children of employees.
12. We reserve the right not to publish any ad that may be considered offensive or in bad taste.

'04 NISSAN ALTIMA, 4-dr., call for details, \$2,500. Marquez, 340-1556, ask for Brandon.

'96 CHEVY CAPRICE, 1 owner, garaged, 97K miles, good gas mileage, \$2,500. Furnish, 884-6626.

'10 TOYOTA COROLLA S, 5-spd. manual, 1 owner, 32-mpg, 83K miles, well maintained, excellent condition, \$7,800. Potts, 505-235-4903.

'06 GMC 1500 PICKUP, extended cab, 5.3, clean, 87.5K miles, \$9,000. Weaver, 505-235-4407.

'11 TOYOTA VENZA, AWD, V6, white, light grey interior, 36K miles, very clean, well maintained, \$16,000 OBO. Fricks, 238-9583.

'08 ACURA MDX, AWD, 4-dr., 3.7L, V6, leather, 1 owner, 109K miles, \$10,000 OBO. Sweet, 505-980-3196.

'16 HONDA ODYSSEY EXL, dark grey, leather, moonroof, backup/blind spot cameras, more, 29.8K miles, excellent condition, \$26,500. New, 505-414-0901.

'17 CADILLAC ATS, 6-cyl., larger engine, uses regular gas, enhanced exhaust (rumble), 3,542 miles, \$33,000. Risvold, 280-3496.

'08 SCION XD, 4-dr. hatchback, dark gray, black interior, 110K miles, \$5,000 OBO. Cross, 505-891-0964.

RECREATION

'12 JAYCO GREYHAWK, Class C, F450, 31 FS model, leather, new tires, 2 slide outs, 10,834 miles, \$65,000. Esquibel, 505-235-2343.

'93 HARLEY-DAVIDSON SPORTSTER, XLH1200, w/windshield, 5-spd., sapphire blue, 31K miles, \$3,100. Smith, 505-362-0664.

'13 iGO TRAVEL TRAILER, 27-ft., garage storage, AC, shower, outdoor kitchen, queen bed, like new, \$15,000. Hindman, 505-281-7710.

'16 FOREST RIVER CAMPER, 2403S, sleeps 4, w/Eaz Lift hitch, excellent condition, \$19,900. King, 775-843-9311, call or text Andy.

'16 LANCE 2285 TRAILER, every option, solar, dual batteries, lifted, slide out, hitch, extras, 6,000 GVWR, \$25,000. Shaw, 505-980-7491.

FISHING BOAT, 14-ft., aluminum, on trailer, w/9.8 hp Mercury motor, excellent condition, \$950. Green, 505-228-7015.

REAL ESTATE

4-BDR. HOME, 3 baths, 2,724-sq. ft., w/loft, Cabezon/Rio Rancho, near park and bike path, \$270,000. Ramos, 972-951-0290.

2-BDR. HOME, 2 baths, 2,200-sq. ft., den, dining room, living room, all hardwood floors, updated, large patio, parking, 1 AC, Corrales view, \$419,000. Hardin, 702-630-4468.

2-BDR. CONDO, 2 baths, 1-car garage, Oso Park gated community, completely updated, \$158,000. Walker, 863-441-3861.

4-BDR. HOME, 1,992-sq. ft., Holiday Park, updated ranch, quite and safe neighborhood, easy base access, \$270,000. Kim, 484-362-8328.

2-BDR. TOWNHOUSE, 2 baths, 1,215-sq. ft., 2-car garage, w/appliances, quiet, convenient, NE Heights neighborhood, \$150,000. Linker, 505-681-3352.

3-BDR. HOME, 2 baths, 2,060-sq. ft., 2-car garage, w/appliances, Volterra, 12123 Aqueduct Rd. SW, \$289,900. Lai, 505-681-7361.

WANTED

FLY TYING TOOLS, and materials, used or old. Menicucci, 505-235-8501.

BASS DRUMMERS, for HDPD pipebands, practices held Thursday evenings, some travel. Appel, 505-750-8410.

WORK WANTED

DOG SITTING, pet sitting, house sitting, in Albuquerque/Rio Rancho area, reliable UNM student. Twyeffort, 554-9287.

Mileposts



New Mexico photos by Michelle Fleming
California photos by Randy Wong



Ireena Erteza 25



David Heckart 25

Recent Retirees



New Mexico photos by Michelle Fleming
California photos by Randy Wong



Ken Black 35



Sandra (Tanny) Mays 35



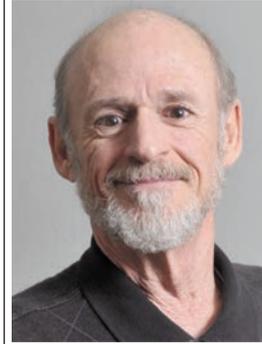
Bertha Montoya 20



Jill Suo-Anttila 20



Anita Andrews 15



Terry Ernest 33



Jeff Mason 30



Tim O'Hern 30



Donna Baldonado 15



Arthur Gariety 15



Jae Lee 15



Ro Malcomb 28



Carolyn Ugarte 15



Bianca Thayer 7

The power of community boosts acequia resilience

By Kristen Meub

“During our research, a community’s ability to withstand natural and social pressures was routinely pinpointed to the fact that the people who live there feel like they are a community,” Thushara Gunda, a Sandia environmental engineer said. “The social fabric of the community, the mutualism, or sense of cohesion, is a really important factor that contributes to its resilience.”

With changes in rainfall amounts, rising temperatures and population growth putting pressure on water resources around the globe, a Sandia study adds to the understanding and predictability of how communities and water systems worldwide will fare during times of environmental or social change.

In fact, the research showed the mechanisms that strengthen community cohesion helped reinforce individual connections with the community, which softened the impacts of climate change.

The work, part of Sandia’s energy-water nexus program to help safeguard resilient and sustainable energy-water systems in the interest of national and global security, was recently published in a special socio-hydrology issue of “Water Resources Research”. The research paired a dynamic systems model of an acequia community and its water system with a hydrology model of an upland water source to study how the community responds to changes in water availability and flow.

The study builds from a larger six-year collaborative project funded by the National Science Foundation that studies the relationships between traditional water management systems, communities and landscapes. In addition to Sandia, project research partners include New Mexico State University, the University of New Mexico and others.

Studying the resilience of acequias

The researchers used a model based on the northern New Mexico town of Valdez, which is the farthest upriver of 11 acequia systems along the Rio Hondo. An acequia is a ditch that diverts water for farming and agricultural use from upland streams by using gravity



(Photo by Randy Montoya)



STUDYING THE ACEQUIAS – Thushara Gunda and Vince Tidwell studied how shared fates and experiences help acequias withstand changes in water availability due to climate change. (Photo by Randy Montoya)

and head gates. Acequia also refers to the community that uses and governs the ditch. There are about 800 acequias in northern New Mexico and southern Colorado. Some were originally built by Spanish colonists more than three centuries ago.

“These acequias have gone through multiple changes in government, from colonial times to modern day, and survived throughout all those social changes,” Thushara said. “Now they are facing natural changes from climate change and increasing demands from downstream users.”

Benjamin Turner, a professor at Texas A&M University and co-author of the paper, built the community model based on research conducted by an interdisciplinary team of cultural anthropologists, economists, political scientists, geographers, sociologists and hydrologists who worked with Valdez to capture the dynamics of its acequia system and community through months of workshops, phone calls and meetings.

The Sandia team then developed a hydrological model of an upland water source to pair with the community model to study how decreases in water availability affected the community. The upland model incorporates temperature and precipitation projections that decrease the amount of water available and changes the arrival of peak water flow for the year.

“We wanted to see how the community would respond when the streamflow changed based on how we think it will likely be affected by climate change in the future,” Thushara said. “With climate change, especially in the Southwest, we are expecting to see a reduction in the total stream flow, but also a shift in when the peak stream flow occurs.”

The research team used the two models to simulate three different conditions. The three scenarios compare 30-year historical stream outputs from 1969 to 1998 to 30-year periods in the near future (2019 to 2048) and the far future (2069 to 2098).

In the first scenario, the acequia experiences decreased water levels and an earlier peak flow — the month when the acequia receives the greatest amount of water. The community diverts water the same amount of time as before, and closes its gate to let water continue downstream about 25 percent of the time. An acequia will close its gate to ensure downstream communities have sufficient access to the water based on standing agreements.

In the second and third scenarios, the acequia still experiences decreased water levels and earlier peak flows, but also faces increased gate closures throughout the year, amounting to 50 percent of the year in the second scenario, and 75 percent of the year in the third scenario. This is based on the likely increased pressure from downstream users asking their upstream neighbors to divert less water.

Mutualism increases resilience to climate change

“The results of the study were surprising, in the sense that agricultural profitability actually increased during the first scenario,” Thushara said. “With the shift in peak stream flows to earlier in the season due to climate change, the acequia members were able to use that earlier water more productively, and it created this feedback cycle where because they had more access to that water, they were able to grow more crops, including more profitable crops, and that incentivized them to invest in agriculture, and that time spent in agriculture strengthened the community.”

In the second and third scenarios, Thushara says agricultural profitability tanked, but the size of the community grew, because landowners were more likely to sell pieces of their parcels so new members could enter the community.

“We can look at the history of acequias and see that they are not very sensitive to shock, otherwise they wouldn’t have the capacity to stay together for as long as they have,” Thushara said. “When newcomers enter the community and engage in agricultural work and help maintain the acequia, that reinforces the bonds of the community. It gives them the buffer to be able to stay together long enough to adapt to the new conditions.”

The findings show the mechanisms that strengthen community cohesion in acequias — time spent doing agricultural work and maintaining the ditch together — helped reinforce individual connections with the community, which softened the impacts of climate change and helped the acequia stay together.

“By taking this sociological look at the system, it helped us see some behaviors and how these social systems might mitigate factors that would otherwise pose challenges that could cause these systems to disappear,” said Vince Tidwell, Sandia engineer and co-author of the paper.

While the study focused on acequias because of their historical resilience, Thushara said the findings have broader implications for communally-managed water systems worldwide.

“In Sri Lanka, community cohesion is focused on kinship and passing down parcels of the land to your children, which perpetuates the connection of families to the land,” Thushara said. “In Bali, the cohesion is focused around water temples and religious figures. All these different modes of community cohesion exist, and our modeling work shows that we really need to understand how these mechanisms for community cohesion can lend themselves to increased resilience in times of pressure. We need to understand the social structure as well as the physical environment.”