



S A N D I A

## LABNEWS

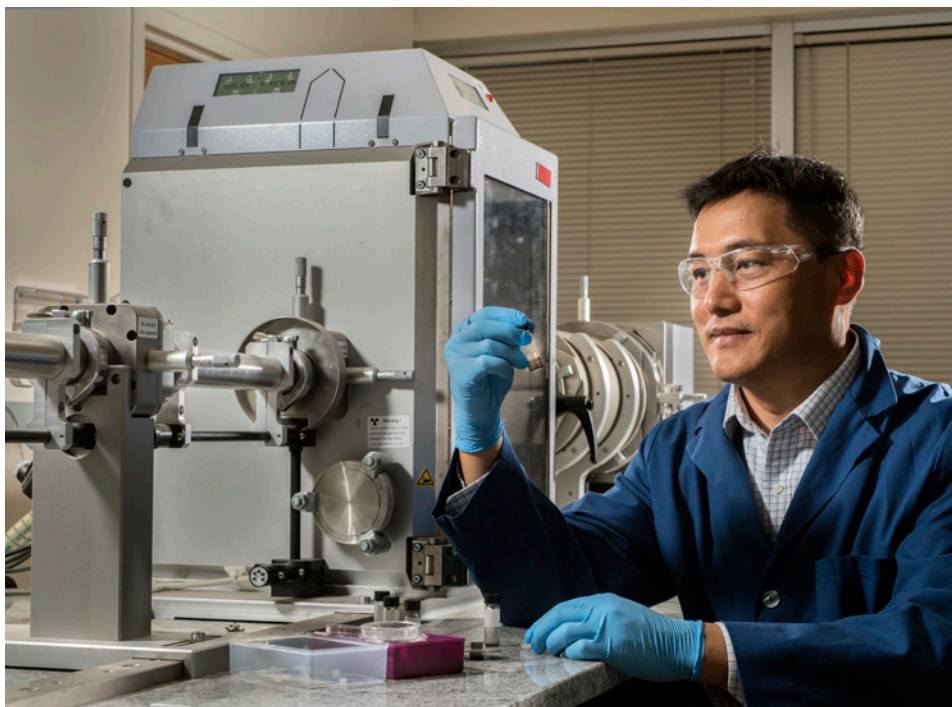
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prehistoric  
superhighways  
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## Sandia stands in solidarity with Asian staff, community



**SUPERCRYSTAL RESEARCH** — Sandia researcher Hongyou Fan claimed the Materials Research Society's 2018 Mid-Career Researcher Award. He is shown here with a small-angle X-ray scattering instrument he uses to characterize super crystals like those he holds. **Photo by Randy Montoya**

## Labs highlights AAPI contributions

By **Myles Copeland**

**E**ight people had been killed in a shooting spree at three Atlanta-area spas, six of them Asian women. It was the latest in a sinister trend that saw anti-Asian hate crimes rise by nearly 150% last year, according to a recent academic analysis.

Sandia engineer Cliff Ho recalled predicting this tragic wave a year earlier. He was put on alert by the rise in anti-Asian rhetoric that coincided with the rise of COVID-19 cases.

"I warned my family in March of last year," Cliff recounted. "I said, 'This is really dangerous.'"

Disturbed but sadly unsurprised by the violence, what struck Cliff following the

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# Simulating sneezes to show how COVID-19 spreads

*Sandia scientists publish studies of how spray droplets can spread disease*

By **Mollie Rappe, Michael J. Baker and Amy Treece**

**T**wo groups of researchers at Sandia have published papers on the droplets of liquid sprayed by coughs or sneezes and how far they can travel under different conditions.

Both teams used Sandia's decades of experience with advanced computer simulations studying how liquids and gases move for its nuclear stockpile stewardship mission.

Their findings reinforce the importance of wearing masks, maintaining social distancing, avoiding poorly ventilated indoor spaces and washing your hands frequently, especially with the emergence of new, more transmissible variants of SARS-CoV-2, the virus that causes COVID-19.

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# Recalling Sandia's rich history to mark Asian American and Pacific Islander Heritage Month

By **Rebecca Ullrich,**  
**Sandia Labs Historian**

Some important history needs to be part of the Lab News coverage of Asian American and Pacific Islander Heritage Month activities and outreach. I thought about the history of Asian Americans within Sandia — the significant individual achievements and their impact within the Labs and beyond. But in the context of the current round of violence directed at Asian Americans, I kept returning to the late 1990s and the last big outbreak in the country of open discrimination and hostility directed at Asian Americans.

The Asian Leadership Outreach Committee formed in October 1988, one in the suite of outreach groups that bloomed during the 1980s in the employee push for greater opportunities within

Sandia for underrepresented groups. Unlike some of the other groups, ALOC's work is not a history of struggle to hire or



**LEADER** — Dahwey Chu was chair of the Asian Leadership Outreach Committee in 1999, when he and the group's members took the lead in challenging leadership on racial profiling and discrimination. **Sandia Archives Photo**

to get people into the STEM fields because, as Pauline Ho, the first chair of ALOC noted, "Asian Americans are already well-represented in science and engineering." Instead, the group focused on issues of underrepresentation in management and cultural diversity, such as improving awareness, increasing opportunities for growth and ensuring retention.

In the late 1990s, a security investigation began into a possible leak of classified information from the nuclear weapons complex. It appeared China may have received information on U.S. nuclear weapons designs, specifically the W88, and might have used the information to advance its own weapon designs, or not. Then, in March 1999, the New York Times published a story about the investigation, asserting that a spy at Los Alamos National Laboratory had provided secrets to China. Two days later, a follow-up story identified the suspected spy as Wen Ho Lee, a LANL computer scientist who had just been fired.

Throughout Congress, DOE and the nuclear weapons complex, there were immediate efforts to address perceptions of lax security. Investigative reports from Congress and the President's Foreign Intelligence Advisory Board warned that staff in the national laboratories appeared arrogant and cynical regarding security.

Sandia Director C. Paul Robinson addressed security in his annual State of the Labs and other talks, reminding the workforce of its importance, but also

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## Standing in solidarity with Asian staff

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March 16 attack was the response from those around him.

“I saw (anti-Asian violence) coming,” said Cliff. “So, for me, how I felt when I saw the reaction of the community was positive. To see that kind of stand against Asian hate was uplifting for me.”

### Director listens to resource groups

Less than a week after the attacks, Labs Director James Peery convened a listening session attended virtually by members of Sandia’s Asian Leadership and Outreach Committee (ALOC) and Asian Pacific Leadership Committee (APLC), employee resource groups in Albuquerque and Livermore, respectively.

“I appreciated that James took his time to listen, understand and hear what we are going through — to make us feel equal,” said APAC Chair Brian Duong. “I think that’s very important right now. People feel hurt, feel vulnerable. We need a lot of support from others and, as a community, to not feel alone.”

Among the suggestions raised during that listening session were that the Lab News highlight contributions to Sandia’s research mission by Asian American and Pacific Islander staff.

“Sandia AAPI staff have demonstrated high achievement for a long time,” said Hongyou Fan, who suggested the article.

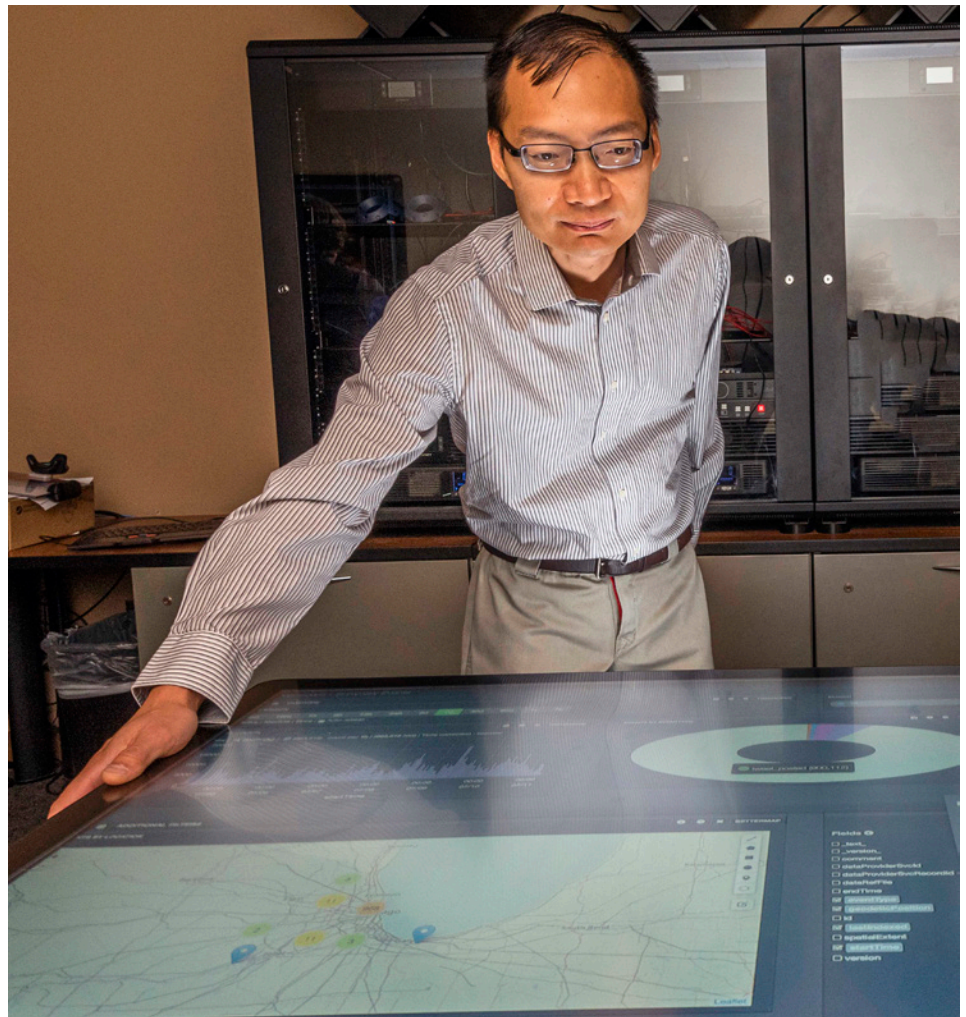
### Importance of recognizing contributions

“There are many different ethnicities in this wonderful country,” said ALOC chair Tian Ma, “and I believe it is important for us to recognize the contributions we all provide.”

To that end, Lab News is celebrating May’s AAPI Heritage Month by highlighting some of the work AAPI staff members have done to benefit Sandia, their country and their community.

APLC member Ninaad Desai expressed hope that bringing attention to these contributions might dispel misconceptions.

“In the current strenuous times,



**CURRENT CHAIR** — Chair of Sandia’s Asian Leadership and Outreach Committee, Tian Ma, won the Society of Asian Engineer’s 2020 Professional Achievement Award. **Photo by Randy Montoya**

highlighting contributions of Sandia’s AAPI staff will prove our solidarity,” said Ninaad. “The effort of working towards a common goal to protect our nation will show that the violence and mistreatment, germinating due to hatred, is based on misinformation.”

### Future city event promotes STEM nationally

Tian pointed to the way ALOC helps youth statewide through the annual New Mexico E-Discover Future City Competition. He helped cofound the local event for the national STEM learning program for middle schoolers in 2014, and ALOC continues to sponsor and supply many of the volunteers for the competition. [The event](#) continued virtually this year, even amid the pandemic.

“ALOC is a place where Asians in the Labs can come together to give back to the community,” said Tian. “Through the



**TOP DOE SCIENTIST** — Jacqueline Chen was selected by the DOE’s Office of Science as a 2020 distinguished scientist fellow. **Photo courtesy of the Alameda County Women’s Hall of Fame**




Future City Competition, we are able to help the students in our city be challenged and motivated in the STEM area. We love to mentor and help these students have an opportunity to experience a national, science-based project.”

### Inclusive culture key to AAPI support

Others pointed to Sandia’s inclusive culture as a key source of support for the achievements of AAPI staff.

“I have found in my 28 years here that Sandia does a great job of promoting contributions of all employees,” said Cliff. “From a professional standpoint, I haven’t been treated any differently, and that has allowed me to thrive. I appreciate the leadership’s concern and support over Asian-hate issues. I think it’s been really helpful.”

“I immigrated to this country at the age of 11,” said Tian. “I truly believe no matter what your background or skin color is, we are all able to work together because we share a common goal: strive to give our best to the Labs.” 



**ANNUAL CELEBRATION** — Performers take part in the 2019 Asian American and Pacific Islander Heritage Festival at the National Museum of Nuclear Science and History.

Photos by Lonnie Anderson

## Asian-American, Pacific Islanders in Sandia News

By no means comprehensive, here is a sampling of less than five years of recent, significant research contributions and achievements from AAPI Sandia staff.

- [“Team led by Cliff Ho awarded \\$25M project to build a next-generation particle-based CSP plant”](#) (March 25 [YouTube](#); April 23 [Lab News](#))
- [Geoscientists Honkyu Yoon, Kyung Won Chang and colleagues used 3D-printed rocks and machine learning to detect unexpected earthquakes](#) (March 10, 2021)
- [Sandia mechanical engineer Bo Song was named Asian American Engineer of the Year](#) (Nov. 10, 2020)
- [Sandia was named 2020 Organization of the Year by the Society of Asian Engineers](#) (Oct. 29, 2020)
- [Jacqueline Chen was selected by the DOE’s Office of Science as a distinguished scientist fellow](#) (Sept. 10, 2020)
- [Alan Mar received a Professional Achievement Award from the Society of Asian Scientists and Engineers](#) (Dec. 23, 2019)
- [Computer scientist Tian Ma co-led a project wrangling big data from social media, cameras, sensors, and more into actionable intelligence](#) (Oct. 14, 2019)
- [Yifeng Wang was part of a team developing a new way to prevent spread of radioactive contamination during a catastrophic accident](#) (Sept. 30, 2019)
- [Stanley Chou was selected Most Promising Engineer of the Year at the 2019 Asian American Engineer of the Year Conference](#) (Sept. 24, 2019)
- [Nanomaterials researcher Hongyou Fan won the Materials Research Society’s Mid-Career Research award](#) (April 17, 2019)
- [Chung-Yan Koh was part of developing a device update that enables mobile testing for viruses, bacteria and active toxins](#) (Jan. 10, 2019)
- [Jeff Tsao and colleagues published an article suggesting Engineered light could improve health and food](#) (Jan. 9, 2019)
- [Chen Wang was named a Jill Hruby Fellow, earning a three-year postdoctoral fellowship](#) (Oct. 11, 2018)
- [Lynn Yang was part of a team that collaborated to deploy new capabilities for emergency planning](#) (Sept. 12, 2018)
- [Hongyou Fan led a project to encourage gold nanoparticles to self-assemble into unusually large supercrystals that could significantly improve explosives or drug detection](#) (Aug. 1, 2018)
- [Cliff Ho led a project that received 10.5 million from DOE to research and design a cheaper, more efficient solar energy system](#) (May 21, 2018)
- [Hongyou Fan and his team invented detergent-based technology that kick starts chemical reactions in solar cells](#) (May 30, 2018)
- [Fang Liu was part of an effort that tailored E. coli to convert plants into renewable chemicals](#) (May 17, 2018)
- [Thushara Gunda was the first author of a study that identified a community’s resilience to climate change can be increased through mutualism](#) (April 16, 2018)
- [Senior scientist Hy Tran named 2018 Asian American Engineer of the Year](#) (April 10, 2018)
- [Jacqueline Chen was elected to the National Academy of Engineering](#) (Feb. 28, 2018)
- [Jeff Tsao was one of two Sandia researchers elected fellows of the Optical Society](#) (Nov. 16, 2017)
- [Sandia engineer Cliff Ho was among those who developed new fractal-like concentrating solar power receivers that are better at absorbing sunlight](#) (Oct. 25, 2017)
- [Cliff Ho and Hy Tran were named fellows of the American Society of Mechanical Engineers](#) (June 8, 2017)
- [Hongyou Fan led an effort that fabricated nanoparticles into nanowire-array structures using pressure instead of chemicals](#) (April 18, 2017)
- [Electrical engineer Ireena Erteza was named 2017 Asian American Engineer of the Year](#) (Feb. 20, 2017)
- [Hongyou Fan elected Material Research Society Fellow](#) (March 29, 2016)
- [Tian Ma named 2016 Most Promising Asian Engineer of the Year](#) (March 9, 2016)



## Recalling AAPI history

CONTINUED FROM PAGE 2

pushing back on the stereotype being drawn of the staff. By that point there were clear indications of racial profiling in security briefings and ill treatment of Asian Americans within the complex.

Paul called this out as unacceptable. He spoke of a meeting with Asian American Sandians at Sandia/California, and was quoted in the July 2nd, 1999, *Lab News* saying “that the previous worst espionage cases — and the worst traitors in our history — were Aldrich Ames, the CIA fellow, and the Walker family father-and-son espionage team. All of those were Anglos.” Paul was underlining the absurdity of attributing espionage to anyone based on ethnicity alone.

On June 16, 1999, DOE Secretary Bill Richardson directed a work standdown and security immersion activity throughout DOE. Sandians spent June 21-22 in a program focused on security awareness and training. Two days later, Secretary Richardson visited Sandia/NM, praising the workforce for its attention. In the same presentation, he noted reports that Asian Americans within the national labs were experiencing discrimination. He asked anyone experiencing such treatment to report it to him, as he had formed a task force to look into discrimination and racial profiling. Asian American staff at Sandia successfully spoke out to improve their treatment.

On December 10, 1999, Wen Ho Lee was arrested and indicted on 59 felony counts of mishandling classified information.

After a series of hearings on security within the nuclear weapons complex and the complexity of DOE’s bureaucracy, Congress created the National Nuclear Security Administration. NNSA was born in early 2000 as an autonomous agency within DOE.

In January 2000, with the report from his discrimination task force completed, Secretary Richardson announced there would be a DOE-wide diversity standdown. On April 5, 2000, everyone within the DOE universe spent a day focusing on diversity. DOE provided content and each site also developed its own material. Paul Robinson was particularly lauded for the passion and commitment expressed in his presentation.

Most impressive and probably useful were the testimonials by individual Sandians on their experiences with discrimination in Building Bridges videos tailored to the NM and CA sites. While the standdown was generally considered a positive step, it was also seen as and proved incomplete on its own.


To summarize: The tight coupling of security concerns with the singular focus on Wen Ho Lee as a suspect in China’s potential nuclear weapons espionage allowed existing prejudices and stereotypes full expression. Although leadership at the national and Labs level spoke out against racism, much of the initial language on espionage and security from higher levels reinforced prejudicial fears. Annual security briefings provided to DOE sites by headquarters included clear anti-Asian statements and, while they were subsequently halted and scrubbed, they reinforced existing prejudices. It became difficult to overcome statements of distrust and to ensure that Asian Americans were treated with respect within the DOE community generally and Sandia specifically.

The Wen Ho Lee case ended in September 2000 when he pleaded guilty to one felony count of mishandling data and accepted the judge’s apology for how he was treated. There were subsequent security incidents within the complex and another major security standdown in 2003.

Later, in the wake of all this unprecedented national attention on security at the national labs, my husband was serving as a consultant in Sandia’s Advanced Concepts Group.

Tim was born in New Jersey of Chinese descent. He loved working in the ACG. But he came home quite frustrated at the way he was treated by people in meetings. He frequently was asked whether he spoke English and if he was a U.S. citizen. I mentioned this to a manager in my line and he said, “That is as it should be. It’s just prudent.” I was glad to have Paul Robinson’s comments about U.S. spies usually being white males to hand, so that I could note that only asking members of one ethnic group if they are citizens leaves a large gap in your potential spy catching.

The story hasn’t ended, because, here we are. The immediate Sandia context is much different this time, because the resource

groups, the Inclusion, Diversity, EEO and AA organization and Labs management were already offering speakers and panels and open discussions of how we can move toward inclusion when anti-Asian American Pacific Islander violence erupted. There have been excellent speakers and panel discussions on the matter. I hope it will have a greater effect this time. 

## Sandians honored as top Asian American Engineer of the Year

As AAPI Heritage Month celebrates the contributions to the United States and the world of Americans of Asian Pacific Islander descent, we cannot doubt their contributions to Sandia. As a sample of some of those making an impact in science and engineering, here are the many Sandians honored as [Asian American Engineer of the Year](#) winners.

**Raymond Ng (2002)**

**Shawn Lin (2002)**

**Er-Ping Chen (2004)**

**Tze-Yao Chu (2004)**

**Eliot Fang (2006)**

**Wen Hsu (2007)**

**Jackie Chen (2009)**

**Cliff Ho (2010)**

**Pin Yang (2011)**

**Hongyou Fan (2012)**

**Rekha Rao (2012)**

**Ming Lau (2012)**

**Jeffrey Tsao (2013)**

**Yifeng Wang (2014)**

**Somuri V. Prasad (2015)**

**Patrick Feng (2015—Most Promising Engineer of the Year award)**


**Tian Ma (2016—Most Promising Engineer of the Year award)**

**Ireena Erteza (2017)**

**Hy Tran (2018)**

**Stan Chou (2019—Most Promising Engineer of the Year award)**

**Bo Song (2020)**

The Asian American Engineer of the Year awards began in 2002 in the wake of fallout from the Wen Ho Lee case. Their purpose is “to recognize and honor outstanding Asian American professionals in Science and Engineering for their technical achievements, leadership and public services.” 

## How COVID-19 spreads

CONTINUED FROM PAGE 1

One study used Sandia-developed high-performance computer simulation tools to model coughing with and without a breeze and with and without protective barriers. [This work was recently published](#) in the scientific journal *Atomization and Sprays*.

Stefan Domino, the lead computer scientist on the paper, said his team found that while protective barriers, such as plexiglass partitions in grocery stores, offer protection from larger droplets, very tiny particles can persist in the air for an extended time and travel some distance depending on the environmental conditions.

Separate computer modeling research at Sandia looked at what happens to the smaller aerosol droplets under different conditions, including when a person is wearing a face covering. That study showed that face masks and shields keep even the small droplets from a cough from dispersing great distances, said researcher Cliff Ho, who is leading that effort. [This work was published](#) in the journal *Applied Mathematical Modelling* on Feb. 24.

### Simulating coughs shows persistent particles

In simulations run by Stefan's team through Sandia's high-performance

computers, larger droplets from a cough with no crosswind and no face coverings fell at most approximately three meters, or roughly nine feet away. They also found that the dry "droplet nuclei," or aerosols, left over after the liquid evaporates from a droplet traveled about the same distance but stuck around in the air for the two minutes they modeled.

Add a plexiglass partition into the mix, and their computer simulations showed that larger droplets cling to the barrier, which mitigates the risk of direct transmission, but the smaller droplet nuclei persist in the air, Stefan said.

When they added a 10-meter-per-second breeze from the back to the simulation without a barrier, the larger droplets traveled up to 11 1/2 feet and the droplet nuclei traveled farther.

This study does not call into question the social-distancing standard of 6 feet recommended by the [Centers for Disease Control and Prevention](#) designed to prevent direct contact from the majority of larger droplets. In a typical cough from an infected person, roughly 35% of the droplets might have the virus present, but models of how much SARS-CoV-2 and its variants are needed to infect another person are still being developed, Stefan said.

"A recent review paper on the transmission of SARS-CoV-2 that appeared in the *Annals of Internal Medicine* suggests that

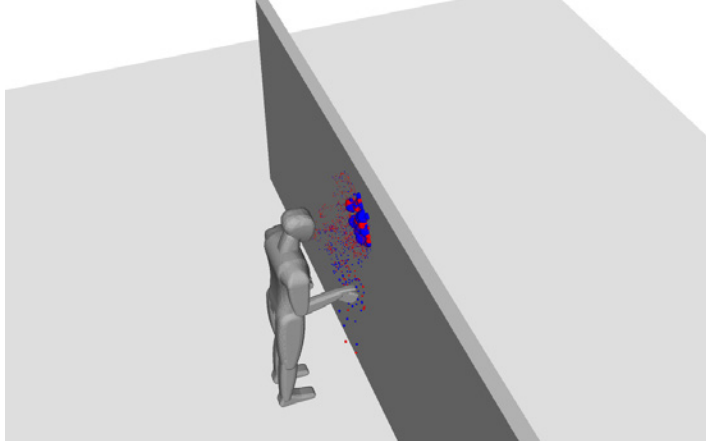
respiratory transmission is the dominant route for transmission. As such, we feel that establishing a credible modeling and simulation tool to model transport of pathogen-containing droplets emanating from coughs and how they persist in public spaces that we all inhabit represents a critical piece of the required science," he said. Partitions, masks, social distancing and staying home when feeling unwell are still important to help cut down transmission, especially with the new, more transmissible variants.

Stefan also conducted computer modeling of outdoor open spaces and found that standing people exposed to a cough from someone in a kneeling position had relatively low risk of exposure compared to people who were seated. This was because of how the droplets and aerosols interact with the complex breezes that move around people. [This work was published](#) in the *International Journal of Computational Fluid Dynamics* on April 1. Stefan's simulations used over four million hours of computer processing time and were run on many computer processors at the same time.

### Simulations support social distancing, masks

Cliff used a commercially available fluid dynamics computer model to simulate various events that expel moist fluid, such as coughing, sneezing, talking and even breathing, to understand how

Time = 2.00387 Seconds

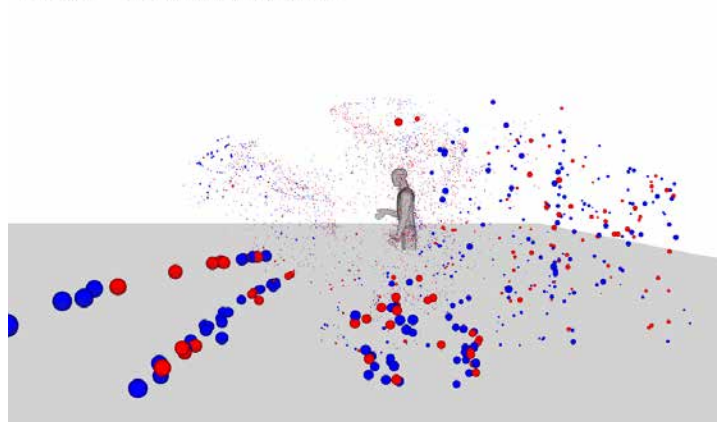


**BUT WHAT ABOUT BARRIERS** — Scientists at Sandia are using high-performance computers to simulate how liquid droplets expelled by coughs react to different environments, including a plexiglass barrier.

Video courtesy of Stefan Domino

Click on the image to watch and download a time-lapse simulation.

Time = 1.0410 Seconds



**COUGHING OUTSIDE** — Click on the image to watch and download a simulation prepared by Sandia scientists showing how large droplets and small droplet nuclei discharged during a cough spread outside in a brisk breeze.

Video courtesy of Stefan Domino

they affect transport and transmission of airborne pathogens. He assumed that viral pathogens were aerosolized in tiny droplets and that the pathogen distribution and concentration could be represented by the concentration of the simulated exhaled vapor.

“I introduced spatial and temporal concentrations into the modeling to develop quantified risks of exposure based on separation distance, exposure duration and environmental conditions, such as airflow and face coverings,” said Cliff. “I could then determine the probability of infection based on spatial and temporal aerosol concentrations, viral load, infectivity rate, viral viability, lung-deposition probability and inhalation rate.”

The model also confirmed that wearing a face mask or face shield significantly reduced the forward travel of exhaled vapor and exposure risk by about tenfold. However, the vapor concentrations near the face persisted longer than without face coverings.

Overall, the model showed that social distancing significantly reduced the exposure risk from aerosols by at least tenfold and allowed time for dilution and dispersion of the exhaled viral plume. Other models quantified the degree that being upwind or crosswind of the source of the cough reduced exposure risks, and the degree being directly downwind of the cough increased exposure risks.

The exposure risks decreased with increasing distance, but the greatest increase in benefit was at three feet. Cliff’s models also quantified the degree that wearing a mask reduces exposure risks at various distances.

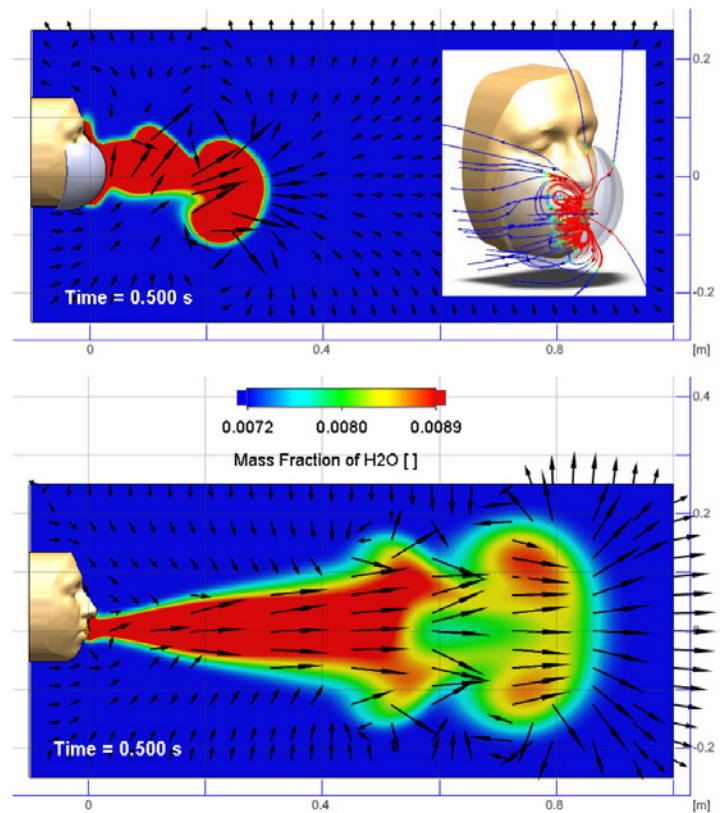
In short, the computer modeling confirmed the importance of social distancing and wearing masks. In addition, staying upwind and increasing fresh air ventilation in places like grocery stores, [restaurants](#) and schools can help to reduce the exposure risk.

Cliff also conducted computer modeling of school buses and found that opening windows on school buses increased ventilation and reduced exposure risks. Specifically, to achieve sufficient ventilation, at least two sets of windows should be opened, one near the front of the bus and one near the back of the bus.

### Stockpile stewardship work aids simulations

Sandia researchers were able to apply many of the same computational tools used in their nuclear stockpile stewardship mission to simulate droplets from coughs and sneezes, as well as Sandia’s advanced high-performance computing resources. For the nuclear deterrence mission, these tools study such things as how turbulent jets, plumes and propellant fires react in different conditions.

“We can deploy our simulation tool capability to other applications,” Stefan said. “If you look at the physics of a cough or a sneeze, it includes attributes of these physics that we normally



**MASKING UP** — A simulation shows how a face mask stops virus-laden vapor expelled during a cough. **Image courtesy of Cliff Ho**

study at Sandia. We can simulate the trajectory of droplets and how they interact in the environment.”

Those environmental conditions can include variables, such as temperature, humidity, launch trajectory, and crosswind strength and direction. They can also include natural and man-made barriers.

Along with studies done by others on cough spray, Sandia’s computer-simulation capabilities add the value of seeing how droplets from a cough will react to different conditions. Sandia’s simulation tools combine the mass, momentum and energy of the droplets to capture detailed evaporation physics that support the ability to distinguish between droplets that deposit and those that persist in the environment.

The research projects were funded by Sandia’s Laboratory Directed Research and Development Rapid Response, the Department of Energy’s Office of Science through the National Virtual Biotechnology Laboratory, a consortium of DOE national laboratories focused on response to COVID-19, with support provided by the Coronavirus CARES Act. [i](#)

### LABNEWS Notes

**EDITOR’S NOTE:** We’ve stopped printing the *Lab News*, but will continue to publish every two weeks. We want you to remain in our community of readers, so please send your comments and suggestions for stories or for improving the paper. *Lab News* welcomes guest columnists who wish to tell their own “Sandia story” or offer their observations on life at the Labs or on science and technology in the news. If you have a column (500-800 words) or an idea to submit, contact *Lab News* editor Jim Danneskiold at [jddanne@sandia.gov](mailto:jddanne@sandia.gov).





LEGACY — The Combustion Research Facility at Sandia/California.

Photo by Randy Wong

## After 40 years, CRF still driving toward future

By **Michael Langley**

The weather on March 6, 1981, was nothing too remarkable for the San Francisco Bay Area — a little drizzle with temperatures in the 50s and a fairly calm wind.

The remarkable event of that day was taking place on Sandia's California campus, but even those who participated in the opening of the newly built Combustion Research Facility had no idea how much it would change the world.

### CRF in the beginning

"It was designed to provide an understanding of combustion in response to the energy crisis," senior manager Craig Taatjes explained, referring to the oil embargo by members of the Organization of the Petroleum Exporting Countries that drove a surge in gasoline prices and a supply shortage in the United States. At that time, the nation grown increasingly dependent upon imported oil and needed to find ways to be more energy self-sufficient.

"The other part of the vision was that it be a collaborative facility where researchers from around the world could participate, teach us and learn from us," said Craig, who supervises the center's physical sciences efforts. "One of the big visions was to bring together the

applied offices and fundamental offices in one place."

"There are diagnostics and scientific measurement approaches developed and really understood deeply in the more fundamental side of the CRF that then are brought over and applied to more complex problems in the engines program," added Director Sarah Allendorf, head of the Chemistry, Combustion and Materials Science Center that manages CRF.

Senior manager Chris Shaddix, who heads energy and transportation sciences, expanded on the benefits of having applied science researchers and fundamental scientists under one roof.

"The applied people too would sometimes modify techniques, out of necessity, to make them work in their environment," Chris said. "That would lead to new insights that were useful to doing more fundamental studies. That was a common thread."

### Center of innovation

Sarah and her senior managers rattled off a list of technological advances that didn't exist before researchers at CRF invented or

began using them in new ways. Ion imaging, developed in the late 1980s at the California facility, uses powerful lasers to ionize gas molecules and projects the resultant ions onto a two-dimensional detector. The position that the ions strike on the detector reflects the speed and direction the molecules were traveling when they were ionized, which can be used to understand the details of the chemical reactions that formed the molecules. The technique was a new way to understand fundamental chemical physics processes that had never been documented.

"That ion imaging is used in hundreds of labs around the world now," Sarah pointed out, "and is a foundation for other types of experiments that have expanded our understanding of gas phase chemistry."

Other technologies also developed at CRF include the Chemical Kinetics, or



FOUNDATIONAL — The Combustion Research Facility sits on the Livermore Open Campus portion of Sandia/California.

Photo by Dino Vournas

CHEMKIN, software package written to calculate combustion chemistry and now used by industry around the world; a process called Rapid Reduction of Nitrogen Oxides to help clean up engine emissions; and use of photo-ionization mass spectrometry to unravel complex combustion chemistry and atmospheric chemistry.

“And most recently ducted fuel injection is the big one,” Craig said of [the technology](#) being developed by researcher Charles Mueller to fine-tune the fuel-air mixture in diesel engines by controlling the flow of fuel into the combustion cylinder.

“It’s offering essentially an elimination of soot from diesel engines, which would be a huge, huge breakthrough,” Chris said.

## Overcoming early challenges

In the early days, it was a challenge to convince others to adopt the technologies and data that came from CRF. Bob Carling spent 38 years at Sandia, 27 of them doing work in the facility, and he recalls the first decade.

“It took a while for the engine companies to really understand the value of what we can provide them as they design these engines. I think they saw us early on as a novelty,” he said. “As time went on, they became more and more dependent upon understanding what was going on inside the cylinder which we were uncovering.”

The main strength of CRF is the people who work within its labs, who come to Sandia from across the globe to tackle global issues, drawing inspiration from one another.

“It’s safe to say that every group of researchers that’s ever been at CRF has essentially been world leaders at what they do. We expect that actually at CRF. After a few years at Sandia, we expect you to be a world leader at what you do,” Chris said.

Sarah and Bob both emphasized the importance of bringing international researchers to CRF.

“We work collaboratively. We engage with the science community,” Sarah said. “We have been very intentional around bringing in the international community.”

Bob said, “Climate change is a worldwide problem,” adding that he championed

the Livermore Open Campus where the CRF sits so that they could bring in the best minds from around the world.

## Industry partnerships lead to real change

Bob, who was the CRF director for the last five years of his career, said part of the center’s success was the visible results researchers were generating.

“One of the things we always emphasized was trying to find ways to publish our information,” he said. “The work they were doing was fundamental science that every car manufacturer in the world should incorporate into their engine designs.”

Sarah was also quick to point to the business partnerships that have driven innovation across several industries over the last four decades, including auto making, steel, glass and energy production.

“They do work in their own labs, where we’ve done the pre-competitive research that is shared publicly, and they will go do specialized, proprietary research,” she said. “The state of American industrial research has changed massively in the last 40 years. Many of those industries had their own research labs that we would complement. Many of those research labs just don’t exist anymore. Our pre-competitive work allows our industrial partners to focus their precious research dollars on the pieces that is their competitive advantage.”

## CRF down the road

All of this is just the tip of the iceberg keeping the CRF relevant in the 21st century and driving future innovations.


“There are still unsolved problems. It’s been a continual evolution and some of these advanced technologies give us a very detailed understanding of all the internal

processes going on that we really had no idea of 40 years ago,” Chris said. “In recent years there’s been a new understanding and new approach to combustion engines that actually look promising for making significant gains in efficiency. The new engine technologies that some researchers at CRF are working on could get at least 30-40% more efficiency out of engines than any existing technology.”

CRF’s research and people have shaped industrial development, the nation and the world for decades.

“Over the past 40 years, the CRF has delivered ‘exceptional service in the national interest’,” said Andy McIlroy, Associate Labs Director of Integrated Security Solutions, who began his Sandia career in the CRF and now leads the Sandia division that houses it, “providing the technical basis for dramatic reductions in criteria pollutants and increased fuel efficiency of combustion systems, in turn leading to improved community health, lower environmental impact and improved energy security for the nation. I’m proud to have been part of that history and look forward next generation of exceptional accomplishments.”

For Sarah, CRF has grown well beyond the mission first envisioned for it. “We have a reputation and that’s our brand. Our reputation is one of innovation, collaboration and the constant addressing of new challenges,” she said.

“There isn’t a single modern vehicle on the road today that hasn’t benefitted from the work done at the CRF,” Bob said. 



**REPUTATION FOR INNOVATION** — Former CRF director Bob Carling, posed for this photograph outside of the facility in 2013. **Photo by Dino Vournas**



# Prehistoric humans first traversed Australia by 'superhighways'

*Sandia supercomputer creates most detailed analysis ever of continental human migration*

By **Troy Rummeler**

**S**ometime between 50,000 and 70,000 years ago, prehistoric humans took their first steps into Sahul, an ancient landmass made up of modern Australia, New Guinea and Tasmania. But nobody knows which way they went after that.

“One of the really big unanswered questions of prehistory is how Australia was populated in the distant past. Scholars have debated it for at least 150 years,” said Sandia archaeologist and remote sensing scientist Devin White.

Now, an international team of scientists using a Sandia supercomputer in the largest reconstruction ever attempted of prehistoric travel has mapped the probable “superhighways” that led to the first peopling of Australia. Their results were published April 29 in [Nature Human Behaviour](#).

Their methods could help organizations like the United Nations and the Federal Emergency Management Agency forecast modern day human

migration resulting from climate change or sudden humanitarian crises, while the new maps could inform the search for undiscovered archaeological sites. The research team believes it also might be possible to apply their approach to other areas of the world, further illuminating the human story

since the first migrations out of Africa about 120,000 years ago.

## Supercomputer blazes billions of trails

Powered by 125 billion simulations run on a supercomputer typically used to develop autonomous systems and machine learning technologies, the team’s research is the first high-resolution computational analysis of human migration at a continental scale, dividing the entire supercontinent

For more than 15 years, Devin has used geospatial analysis, remote sensing and high-performance computing to study human transportation networks.

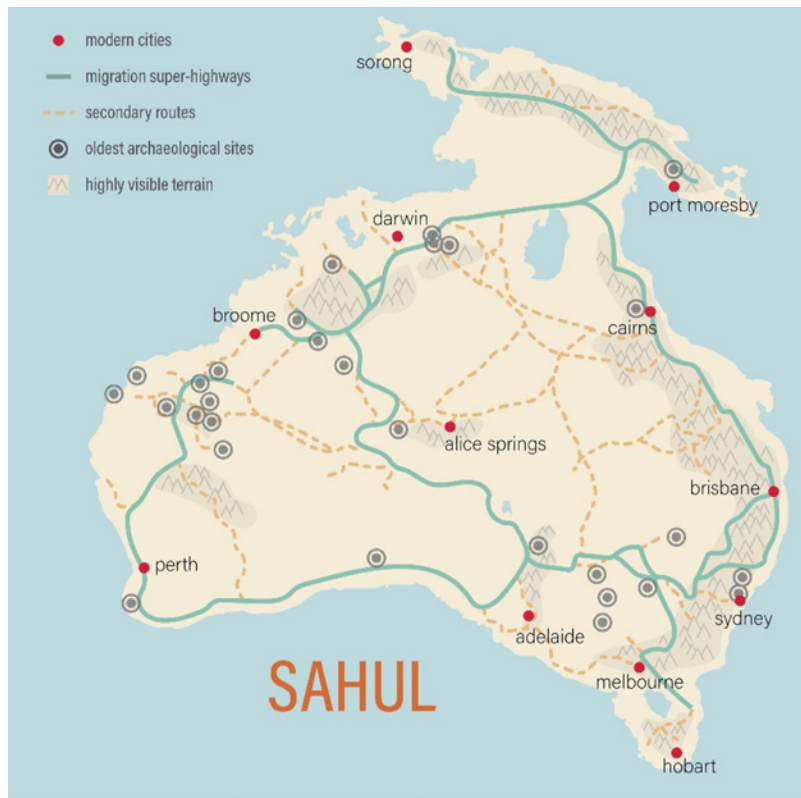
Archaeologist and computational social scientist Stefani Crabtree, a fellow at the [Santa Fe Institute](#) and professor at Utah State University in Logan, Utah, led the study.

“We decided it would be really interesting to look at this question of human migration because the ways that we conceptualize a landscape

should be relatively steady for a hiker in the 21st century and a person who was way-finding into a new region 70,000 years ago,” Crabtree said. “If it’s a new landscape and we don’t have a map, we’re going to want to know how to efficiently move throughout a space, where to find water and where to camp — and we’ll orient ourselves based on high points around the lands.”

Researchers packed a virtual 25-year-old woman with 10 kg (22 pounds) of tools and water and sent her on billions of walks across the continent as it would have looked 50,000 years ago. Her task: find the paths that require the fewest calories to traverse without straying too far from reliable sources

of water or from highly visible landscape features like large rock outcrops. The team found that the simulations returned to certain paths again and again, which the researchers dubbed “superhighways,” that line up well with the earliest known archaeological sites on the continent.



**TAKE A WALK** — Green lines mark the primary travel routes, or “superhighways,” an international team including Sandia National Laboratories now believe were used by Australia’s first human inhabitants on this map of the continent as it looked approximately 50,000 years ago.


Image by Meg Davidson

into pixels 500 meters (1,640 feet) across.

“It is the largest and most complex project of its kind that I’d ever been asked to take on,” said Devin, who wrote the primary algorithm used, called “From Everywhere to Everywhere,” and overhauled it to program the way-finders.

Researchers affiliated with the Australian Research Council [Centre of Excellence for Australian Biodiversity and Heritage \(CABAHI\)](#) also contributed to the project and explained the strong connection between Aboriginal communities, the landscape they have traveled across for millennia and a timeless realm known as the Dreaming.

“Australia’s not only the driest, but it’s also the flattest populated continent on Earth,” said Sean Ulm, the center’s deputy director and a distinguished professor of archaeology at Queensland, Australia-based James Cook University. “Our research

shows that prominent landscape features and water sources were critical for people to navigate and survive on the continent. In many Aboriginal societies, landscape features are believed to have been created by ancestral beings during the Dreaming. Every ridgeline, hill, river, beach and water source is named, storied and inscribed into the very fabric of societies, emphasising the intimate relationship between people and place. The landscape is literally woven into peoples’ lives and their histories. It seems that these relationships between people and country probably date back to the earliest peopling of the continent.” 



**SUPERHIGHWAYS DOWN UNDER** — An international team including Sandia has constructed a computer model that reveals the probable “superhighways” that led to the first peopling of Australia. **Video courtesy of the Centre of Excellence for Australian Biodiversity and Heritage**

## 2021 EMS awards recognize waste reduction, simplified processes, environmental stewardship

By **Dan Ware**

**T**his year, Sandians celebrated Earth Day 2021 with a week of virtual activities and presentations that culminated with the annual Environmental Management System Environmental Excellence Awards, which recognize the accomplishments of members of the workforce who helped the Labs reduce its impact on the environment.

Projects and activities were awarded in five categories: Above and Beyond, Greenie, Kaizen, Resource Conservation and Sequoia.

**Above and Beyond:** Nichole Rinaldi, a mechanical engineer with the Facilities Division. She was nominated for her work updating Sandia’s Design Manual and Specifications to ensure all new buildings and major renovations comply with the DOE Guiding Principles for High Performance Sustainable Buildings. Her work will help alleviate conflict in regulations and Sandia’s Prime Contract about requirements for compliance with Leadership in Energy and Environmental Design (LEED) certification or Guiding Principles.

**Greenie Award:** Mario Hidalgo, the Environment, Safety and Health Coordinator for Pulsed Power Sciences, for his exemplary commitment to excellence and environmental stewardship. He brought together managers and lab owners to identify ways to reduce releases of sulfur hexafluoride and improve

how the gas is managed by the Advanced Science and Technology Division.


**Kaizen Award:** Nathan Golden and Bernadette Mahedy of the Sandia New Mexico Corporate Moves team. Nathan and Bernadette were honored for their support of the Materials Sustainability and Pollution Prevention Program for resource conservation, waste minimization and goal of zero waste. Through their efforts, the Moves Team expanded services to use commercial green moving containers, known as “eCrates,” instead of standard cardboard banker’s boxes. In fiscal year 2020, roughly 8,500 eCrates helped the Labs potentially keep approximately 14 tons of non-hazardous waste out of the landfill, with an estimated taxpayer cost savings of about \$34,000 in box purchases.

**Sequoia Award:** A cross-division collaboration to reduce Labs-wide waste by addressing damaged Sandia-owned mobile devices and batteries. The team developed the new process that now treats only batteries as hazardous waste, not the entire device. Previously, damaged mobile devices were disposed as hazardous waste. Now the damaged device is either repaired and returned to the user or sent to Sandia Reapplication and only the battery is disposed of. The process reduces the hazardous waste stream, with an annual projected cost savings of \$295,800. Team members included Matthew Shain, Alison Winstead, Michael Lee and Douglas Hopinkah from Environment,

Safety and Health; Christopher Lucero, James Ferree, Robert Goodpastor, Norman Hettinger and Adrian De La Cruz from Information Technology; Philip Rivera from Reapplication; and Jesse Farr from Waste Management/Pollution Prevention.

**Resource Conservation:** Honorable mention in the category goes to a team of Environment, Safety and Health coordinators and staff from the Advanced Science and Technology Division. Health coordinators Mario Hidalgo and Bobby Pacheco teamed up with Laurel Jones, Joe Stewart, Benjamin Hughes, Jack Cassidy, Estevan Sisneros and Shannon Feathers III to devise a way to prevent the risk for release of approximately 75 pounds of sulfur hexafluoride, which is equivalent to 778 metric tons of carbon dioxide. The project allowed savings of \$10,000 as part of the replacement of an old sulfur hexafluoride reclaiming unit.

“This year’s participants really embraced the idea of “prehab, not rehab” with their efforts, said EMS Environmental Excellence Awards program coordinator Ben Henning. “Instead of just looking for reduction of tangible wastes or water usage, the majority of our participants made large-scale programmatic or process changes that help eliminate negative environmental risks and impacts before they even start.”

More information, nominations and winning projects are at [EMS Environmental Excellence Awards](#). 



# HR | Employee Benefits Survey Results



## Employee Benefit Preferences Survey — August 2020

The survey provided valuable insight into employee understanding of benefits and their value.



### Results Overview



**54%**

Participation rate = **54%**  
(compared to 45% benchmark)



**75%**

Benefit programs satisfaction = **75%**



**3-Year**

Staged strategy approach starting with changes in CY 2021



Responses were generally consistent across demographics



**CY 2021:** A consumer directed medical plan option with lower monthly premiums lets employees put money in a Health Savings Account for longer-term healthcare needs

**WE GOT RESULTS** — More than half of employees took the Employee Benefits Preference Survey in August and most said they were satisfied with current benefits. Human Resources has analyzed the survey results to refine benefit options as part of a three-year strategy. **Graphic by Laura Hatfield and Stephanie Blackwell**

## Benefits Preference Survey offers employee insights

By **Shelley Kleinschmidt**

**B**enefits are important to Sandians, and feedback from the August Benefits Preference Survey provided insight into what employees value most, said Mary Romero Hart, senior manager.

Human Resources is using the results to continue to improve Sandia Total Rewards — the package of health and wellness, retirement savings, voluntary benefits, time away from work and

work/life programs — to align with employee preferences.

With a participation rate of 54%, compared to the 45-50% industry benchmark, the survey shed light on where preferences vary among different groups. A common thread was that, overall, Sandians like their benefits and give especially high marks to the on-site medical clinic, wellness programs, flexible work options, sickness absence and paid time off and the Sandia Employee Recreation Program.

Satisfaction with benefit programs is 75%, similar to the industry benchmark. The data also show that although there is no great difference across age groups, Sandians in their 20s and 30s appreciate the balance of work and life the most, while older staff appreciate job security the most.

While satisfaction is high, the survey also revealed opportunities to make short- and long-term improvements, such as a health program option with lower

employee costs. HR has conducted an in-depth analysis of the survey results, which it is using to develop a strategic benefits roadmap for the next three years.

“Our focus is a staged process of adjustments so we can begin offering some improvements as soon as possible, based on what we heard through the survey,” Mary said. With that information in hand, work is underway to add an optional, consumer-directed, high-deductible medical plan with a lower monthly premium that lets employees set money aside in a Health Savings Account for longer-term health-care needs. Pending the always required government approval of any changes to Sandia benefits, details about the option will be in Open Enrollment communications this fall.

Survey data also indicate HR can further build employee satisfaction through the Total Rewards programs. Potential areas for change, all of which also depend on government approval, include programs to help with student loan debt, vacation buy/sell options, and further extension of recognition strategies.

### Total Rewards helps attract, retain people

The Total Rewards program, which evolves based on knowledge of employee needs and the market landscape, supports Sandia in reaching its full potential, Mary said. The goal is to find ways to attract and retain the right talent to execute Sandia’s mission, Mary said.

The survey and benefits planning roadmap tie directly to Sandia’s Strategic Priorities 6 and 7: ‘Deploy outstanding engineering, science, and technology to our mission’ and ‘Unleash the power of Sandia.’

“We know that traditional benefits no longer ensure a company’s competitive advantage. Employees are individuals and expect more unique, customized personal benefits where possible,” Mary said.

In fact, the survey revealed that 76% of Sandians indicate they want flexibility to choose benefits that best meet their needs.

The format of the Benefits Preference survey was different and more lengthy than the traditional ‘How satisfied are you?’ type of survey. Mary said Sandia gained much more insight from the dynamic survey format because it gave employees the opportunity not only to share their understanding and opinions of the value of

Sandia’s benefits program, but also provided hypothetical trade-off decisions, similar to the way one might make decisions about other types of purchases. Aon, an independent consulting firm, conducted the survey on Sandia’s behalf and performed the initial analysis. Only collective results were reported to Sandia.


Mary said the survey analysis incorporates a robust scenario modeling tool that “enables data-driven approaches to guide planning more finely tuned to employees’ perspectives.

“The detail will help guide us in aligning benefits with what employees across the multigenerational workforce want,” she said.

She said that another survey insight

was that when employees better understand their benefits and the complete package of available benefits, they have greater job satisfaction.

“The results also aided us in seeing some places where increased education and engagement with the workforce are needed,” she said. “We are looking at ways we can improve in this area to make sure employees have the best understanding of what is available to them and how to most effectively choose and make use of their benefit options.

“We genuinely appreciate the time and thought employees gave to this important survey and I want to say thank you to everyone who participated,” Mary said. 



**WE LIKE IT** — Last year’s Benefits Preference survey showed that medical, 401k and paid time off benefits were the benefits most valued by employees.

Graphic by Michael Vittitow





**DIGGING IN THE DIRT** — Sandians spend a Saturday preparing the urban garden at Rio Grande Food Project in Albuquerque for spring planting. The garden will soon be home to tomatoes, green beans and bell peppers that will be distributed to clients. **Photo by Randy Montoya**

# Planting seeds and growing hope

*Sandia gives more than half a million dollars to nonprofits this spring*

By **Katrina Wagner**

**S**andia's workforce has always recognized the critical role it plays in supporting the community where they live and work.

NTESS, on behalf of Sandia, gave more than \$538,000 in grant awards this spring as part of its corporate contributions program.

"Sandia's grants focus on improving family stability and educational success by supporting nonprofits that address the greatest challenges in Albuquerque and Livermore communities," said Amy Tapia, manager for community involvement.

Educational success programs support the academic achievement of underserved K-12 students. Efforts to improve family stability include helping people who are experiencing food insecurity and addressing the underlying causes of poverty.

One such service organization is the Rio Grande Food Project on Albuquerque's west side.

"We have been a very fortunate recipient of Sandia grants since 2018," said Ari Herring, executive director. "You've invested \$90,000 in our hunger relief work over the last few years." Sandia's grant money has helped to purchase food and fund fuel and maintenance for the refrigerated food rescue trucks the project uses to pick up food from local grocery stores. The grants also provide a salary for essential operations staff who coordinate volunteers and manage the sourcing, intake, storage and distribution of over 80,000 pounds of food every month.

"Each week, this food pantry is helping 950 kids, adults and seniors with a week's worth of food, and Sandia has been essential in helping us do the work we do," said Herring. "I really believe that food is a human right and I'm bothered that so many people don't have access to or cannot afford the food they need to live a

healthy life. The people we serve are like family, and a third of the people who get food here are kids. It's unacceptable that kids skip meals."

Her project works not only to distribute food to the community but also to connect people to the resources they need, such as utility bill assistance and nutrition education. Healthy recipes are distributed with the food clients receive.

They also operate an urban garden where community members harvest fruits and vegetables such as spinach, beets, kale, tomatoes, asparagus, strawberries and grapes for immediate distribution to households in need. The garden also provides an educational space where volunteers share the health benefits of eating fresh produce.

Sandians volunteered in April to prepare the garden for spring. The compost pit was moved, soil was turned over and trees were trimmed.

"This garden provides extra food, and it's also a gathering space where people get to meet with others and help the garden





**MAKING ROOM FOR GROWTH** — Tracy Flynn, left, and Marlene Vega trim branches at the Rio Grande Food Project's urban garden in Albuquerque as part of National Volunteer Month in April. "I'm blessed to have the time and opportunity to serve," said Tracy. "The garden lets people get back to nature and provides healthy food options for those in need. Digging in the dirt is cool too."

Photo by Randy Montoya

thrive," said Herring. "Sandia has helped move our urban project from a side project to a central part of our work that provides fresh fruit and vegetables for the low-income households we serve."

Fertile Groundworks in Livermore, California, receives funding from Sandia

to help with growing and harvesting locally grown produce for community kitchens and food pantries in the area. They also teach community members how to improve their health and well-being by growing food for themselves and others.


More than 95 percent of the produce grown there is donated to people experiencing food insecurity.

"We gave 20,700 pounds of produce to food pantries in 2020, and 3,000 pounds so far in 2021," said Brenda Kusler, executive director. "Sometimes we're the only produce people get."

The nonprofit used Sandia grant money to install irrigation and plant 110 trees — plums, peach, apricot, apple, walnut and fig. The funding also helped add 4,500 square feet of garden beds and paths to grow more vegetables.

Fertile Groundworks also provides education and support to local schools, corporations and other community groups to help them create and sustainably operate their own gardens.

Sandia's corporate contributions coordinator, Roberta Rivera, said, "We always receive a great number of grant applications, but the pandemic has certainly increased the number of applications as more and more nonprofits seek out funders to help them continue their critical work."

Sandia will fund additional agencies as grants totaling more than \$500,000 are distributed this summer. Find out about Sandia's corporate contributions program [here](#). 

## Mileposts



Lori Kozlowski

35



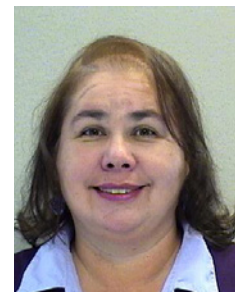
Julia Baca

20



Daniel Petersen

20



Randy Edwards

15

## Recent Retirees



Doug Bentley

35



Patrick Candelaria

33



Emily Baca

30



Mohsen Kotobi

6