Physicists Improving Lives
Pages 3 & 5

APS Election Results
As this issue of APS News goes to press, votes in the APS general election are still being counted. Members are voting for Vice President, Chair-Elect of the APS Nominating Committee, and International and General Counselors. For the first time, members are also electing an APS Treasurer, a position on the Board of Directors created as part of recent changes in APS governance. All those elected will take office on January 1, 2016, when the current Vice President becomes APS President-Elect, and the President-Elect becomes President.

Voting ended on June 30, 2015 and the results can be found at www.aps.org/about/governance/election/

U.S. CONGRESS
Senate Bill Provides 5-year Roadmap for Energy Research Funding
By Towanda W. Johnson, APS Office of Public Affairs
APS has given its support to the newly-introduced Senate bill “Energy Title of the America COMPETES Act (Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act) Reauthorization Act of 2015” (S. 1398). Co-sponsored by U.S. Sens. Lamar Alexander (R-Tenn.) and Chris Coons (D-Del.), and five other senators, S. 1398 would put energy research on a path of sustained, reliable funding under a bipartisan, partial reauthorization of the America COMPETES Act.

“The Senate bill is notable for making science a priority, even in times of constrained budgets,” said Michael S. Lubell, APS director of public affairs.

The legislation would bolster energy research programs in the Department of Energy’s Office of Science (DOE-SC) and the Advanced Research Projects

BILL continued on page 3

PHYSICS OLYMPIAD
United States Traveling Team Selected
By David Voss
In a ceremony on May 27, 2015 at the American Center for Physics in College Park, Maryland, the American Association of Physics Teachers (AAPT) announced the group of five U.S. high school students who will travel to Mumbai, India, in July to participate in the 46th International Physics Olympiad.

...Started in 1967, the Olympiad is an international competition among high school students from more than 100 countries.
This Month in Physics History

July 2, 1591: Death of Vincenzo Galilei

Music, math, and science have long enjoyed a symbiotic relationship, which led to the Renaissance notion that the motion of celestial objects was governed by the Pythagorean doctrine favored by the Pythagoreans. The Pythagorean view suggested that the motion of celestial objects was governed by the Pythagorean theorem, which states that the squares of the lengths of the sides of a right triangle are equal. This view was later refined by the ancient Greek mathematician Aristoxenus, who taught Vincenzo accordingly. But when the lutenist Bardi sent him to teach him the science, Galileo was most aesthetically pleased. At the center of the new musical theory, constiuted the mathematical sciences, along with arithmetic, geometry, and astronomy. The Camerata’s interest in new musical directions would eventually lead to the early development of opera.

Music theory during this period relied on theories drawn from geometry. This was at odds with the separate school of thought based on the work of the ancient Greek music theorist Aristoxenus, who insisted math had little to do with music, and one should rely on one’s senses to decide what music was most aesthetically pleasing. At the center of the controversy was a debate over the best mathematical ratios of the lengths of strings producing “consones,” those sounds (like the octave) deemed most pleasing to the human ear. Since Galileo, despite his proficiency on the lute, had little theoretical training, Ferdinand Bardi was convinced that Galileo’s love of music may have led to the astronomer’s formulation of the law of falling bodies.

Drake’s evidence stems from a page in Galileo’s laboratory notebooks detailing his experiments rolling balls of various masses down inclined planes. Some historical accounts report he measured the speed at which the balls rolled by timing his own pulse. But it is possible, according to Drake, that the idea to add moveable frets to his inclined plane as a ruler—to thereby breaking up the ball’s continuous motion into discrete intervals of time—may have been inspired by the first frets on his lute.

Galileo continued on page 3
The University of Michigan Honors APS Vice President Homer Neal

In April 2014, colleagues and friends from around the world gathered at the University of Michigan for a memorial service and a symposium to honor Homer Neal. Neal was elected in 2013 to the APS presidential line and was named as APS president in 2016.

The first three sessions of the symposium focused on Neal’s experiments at Brookhaven, Argonne, SLAC, Fermilab, and CERN. The fourth session focused on his contributions to the U.S. government as a member of the National Science Board, and to the Smithsonian Institution as a regret. The symposium presentations are available at tech.physics.issu.umich.edu/CWIS/SPT-BrowseResources.php?parentID=707

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Profiles in Versatility (Part 1)

Improving Lives with Physics

By Gabriel Popkin

In spring 2006, Susan Amrose was almost ready to leave physics. She had come to the University of California, Berkeley in 2000 to get a Ph.D. in astrophysics, but more and more she felt her career was not helping people in the way she wanted. That changed when she walked into Ashok Gadgil’s Design for Sustainable Communities course.

Gadgil — a professor of civil and environmental engineering at Berkeley — had 25 to 30 student work in teams to design and build products to solve real public health or environmental problems in the developing world. Gadgil is a physicist by training; he is also deputy director of the Energy Technologies Area at the Lawrence Berkeley National Laboratory, up the hill from the university. He’s spent a career solving problems in some of the world’s poorest places. He created the design course to give students an opportunity to use their physics and engineering knowledge to improve lives and living conditions.

That opportunity was just what Amrose had been looking for. “I want to do rigorous science and engineering, and I want to use that immediately to actually create social impacts,” she said. Amrose joined Gadgil’s lab, earned her Ph.D. in physics, and is now a project scientist at Berkeley, focusing on developing technologies and moving them to market.

Since 2010, she has taught the course that initially inspired her. Together, Gadgil, Amrose, and other colleagues have developed technology that has improved the lives of millions of people.

“She’s very inspiring,” Amrose says. “There are a huge number of students, especially women, in engineering … [who are] looking for some way to apply it more immediately to some of the social problems that are happening now. They flock to Ashok’s lab.”

After earning his bachelor’s degree from the Indian Institute of Technology Mumbai and his master’s from the Indian Institute of Technology, both in physics, he headed to U.C. Berkeley for a Ph.D. Gadgil worked on general relativity problems, but he began to feel something was missing. “All along it bothered me at some level that the place I came from, India, [might not make it in terms of transitioning to a reasonably modern standard of living],” he says. “It seemed that it would be a lost opportunity to not try to see what I could do.”

Fortunately for Gadgil, Berkeley was home to Arthur Rosenfeld, a former particle physicist who went on to develop some of the first computer models for energy use in buildings. His work led to tremendous energy efficiency improvements in buildings in the U.S. and elsewhere. Seeking a way to use his physics background to have such direct social impacts, Gadgil joined Rosenfeld’s research group.

After getting his Ph.D. in physics, Gadgil moved immediately to Lawrence Berkeley Lab, where he has worked ever since. He applied his computational fluid dynamics background to indoor air quality problems, like how to manage radon and other toxic gases that can seep into houses. He developed leasing arrangements that made compact fluorescent light bulbs affordable in the developing world. He also began working on issues related to drinking water. In the 1990s he developed a battery-powered technology to cheaply disinfect drinking water using ultraviolet radiation.

Susan Amrose and Ashok Gadgil in June 2015 inspect the ECAR reactor, a component of the 10,000-liter-per-day water treatment system being tested at Dhapdhpali High School in West Bengal State, India.

Susan Amrose gets users’ impressions of an early version of the Berkeley-Darfur stove.
Homeland Security Theater

It was with a mixture of amuse-
ment, sadness, and dismay that I read the May 2015
issue of APS News on the topic of “Nuclear Needles in Cargo Haystacks,” describing equipment being developed to
detect nuclear weapons in cargo containers. Unfortunately, cargo containers are but one—and perhaps the least likely of numerous means for smuggling nuclear materials. To be really effective the system described in the article would need to scan every car, bus, truck, and even the crossers between the Mexican or Canadian border, every rail car, every airplane, and every boat and private yacht coming into the U.S. And let us not forget those tunnels under the U.S.-Mexican border, which pro-
vide such a reliable supply route for drug smugglers.

This approach is one example of a much larger problem which might be characterized as “homeland secu-
rity theater.” Such efforts serve to deceive people into thinking they are being protected, while their main function is to enrich weap-
ons contractors and their political supporters and allies from the many billions that it would cost to build and operate such systems. It also diverts attention and funding from much more honest efforts to understand and deal with this issue.

Those interested in a carefully thought-out examination of the nuclear weapons problem might consult a recent book [1] which focuses on controlling or eliminat-
ing fissile materials themselves to eliminate the threat of nuclear war and terrorism.

Alfred Carroll
Princeton, New Jersey


PUBLISHING

Is Double-Blind Review Better?

By Shannon Palus

Referees reviewing a paper are always anonymous. But have you ever wondered if, among those who submitted a paper, could remain anonymous to a peer reviewer?

Maybe you have one or a few people who can’t stand you for personal reasons. Maybe you’re an up-and-comer in your research area—and want to maintain your level playing field, with just as much opportunity as someone with a famous name. Maybe you are in the minority—i.e., not a white male—and want to buffer yourself against implicit bias.

With those benefits in mind, Nature Geoscience and Nature Climate Change decided to offer a double-blind option to authors: Take out all identifying information from your paper, and the editor will not tell your paper’s reviewer your name. After 21 months, fewer people had used the option than expected and the results was no notable difference in the quality of reviews. But the response from authors was positive, so as of March this year, Nature started offering authors a double-blind peer review process across all its journals.

If double-blind peer review isn’t a one-size-fits-all-fields proposition. Many factors affect the viability of the option. Nature Physics is offering the option, as part of the Nature deci-
sion. To our knowledge, it’s the only physics journal to do so currently. The journal’s chief editor, Andrea Toroni, isn’t sure that it will be pop-
ular. “Physicists work in a relatively open and collegial way and rely extensively on arXiv,” Toroni wrote in an e-mail.

We can also turn to history for one scenario of how it will work out. The APS Physical Review journals ran the experiment in 2012. Indeed, recent studies confirm what the committee then suspected. A 2012 study in the Proceedings of the National Academy of Sciences showed that their own double-blind experiment for papers on materials for a lab position were more favorably read when the name at the top of the resume was “John,” rather than “Alice.”

So the CSWP suggested that double-blind review should be the standard. When they talked to Brown, the editors felt that trying to hide every single author identity would probably be unsuccessful, and authors more than triple effective. Even in the days before researchers routinely uploaded their papers online, the culture of openness and connections made authors easily identifiable, says Brown. “Communities were

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line in two years or less is simply not rewarding.

Corporations want the benefits of research, but the corporate tax rates are patently unfair. They benefit global companies that can take advantage of loopholes to reduce their taxes dramatically, while requiring most other companies and small businesses to pay the full 35 percent federal rate on a hodgepodge corporate tax reform is in the Washington air. It would most likely reduce the tax rate and plug loopholes, keeping the legislation revenue-neutral.

Part of a likely reform package would be a sweeterie to repatriate the $2 trillion more currently stashed overseas by global American corporations — eight high-tech companies, including Apple, Google, and Microsoft, account for more than a fifth of the total — and not subject to federal taxation so long as the proceeds are reinvested abroad.

With interest rates low, American companies such as Apple have been happy to use their overseas holdings for loans to buy back stock or for other domestic purposes. But as rates rise, such tactics will become increasingly less attractive.

A 5 percent to 10 percent tax on repatriated funds would generate a one-time capitalization of $100 billion to $200 billion for a self-sustaining research investment fund. It would constitute an annual corporate investment income of $4 billion to $8 billion. Private directors, drawn from the science and technology community, the finance community, industry, and labor, would largely control the operation of the fund. But representatives of selected federal science agencies would provide a public nexus.

Describing in detail how the fund would operate requires more space than this column permits. Suffice it to say, it would contain safeguards to prevent appropriators from gaming the system; it could provide matching funds to encourage appropriation to boost science; it would rely on agencies to provide prioritized lists of peers-reviewed projects; it could provide seed money for major initiatives and projects; it could allocate funds to long-term applied research for which neither industry nor government can afford to develop and design research projects at its own expense.

Will it be easy to establish a research investment fund? No. Could it happen? Possibly. Do we need it? Absolutely yes.

PROFILE OF THE WEEK

A Physicist Among the Angels

By Alaina G. Levine

Matthew Davis acknowledges what we are all thinking: that being a physicist can generate major superpower status, no matter the sec-

tor. “We do use a standard set of physics sets you apart in business,” he says. “It checks the box that says ‘He’s smart. He can handle anything.’”

So to Big Bang Theory star, science consultant, and former entrepreneur and philanthropist to plan his career, he easily saw the disci-

pline’s relevance to his new, emerging technology-based company, which is especially timely and relevant because “Ethiopia is trying to make itself a power exporter,” says Davis, and its government is keen to invest in energy-related enterprises. But its national grid needs work, he admits.

“Ventures used RENEW’s investment to successfully develop a smart meter system for the purpose of bringing electricity to other countries in the region, and is now negotiating contracts with a number of national and regional governments across subsaharan Africa and the Middle East — including Ethiopia — to modernize their power grids and save billions of dollars from poor grid management,” he adds. Interest-

ingly, the meter was designed and customized by Daniel Giazov, an engineer who worked in the U.S. for many years before returning to his home country, Ethiopia, to develop the energy industry. Even-

now is working with prospective investors to develop a smart-meter and -generator manufacturing plant in Ethiopia.

RENEW has also provided capital to manufacturers in the food industry. It has made investments in an Ethiopian specialty coffee farm, which ultimately helped to bring its crop into the U.S. market. Davis founded Fresh Injera, Ethiopia’s largest commercial manufacturer and exporter of injera, a staple bread of Ethiopian cuisine. The invest-

ment is financing the construction of a new export-focused factory that will enable Fresh Injera to triple daily production of injera, and to hire 30 additional employees, primarily women, to staff the new venture. Davis is also consulting to our investments,” he says.

RENEW’s contribution is expected to spur new growth in related businesses. Davis himself is now negotiating contracts with a number of regional and bilateral aid donors to provide matching funds to encourage the Ethiopian government to foster more local investment and development in energy-related enterprises. But its national grid needs work, he admits. And soon, RENEW will be in the tanzania business too. Currently, the major global investor in energy projects throughout the Middle East, Africa, and Asia, is involved in a project from that is a research. “The companies want the potential to have a huge impact in supporting higher-wage jobs and spurring growth in related businesses that are connected to this industry.”

Davis aspires into impact invest-

the large companies have been

The show’s science consultant, APS Life Member David Saltzberg, is a physics professor at UCLA. Laureate Brian Schmidt says “Net-

working is an important part of the scientific process and, therefore, doing it well is an important part of being a successful scientist.

The innate skills each of us has in network-

ing are important. But with other skills, most of us can improve with training. This book is about the basic skills you need to learn to better communicate with your colleagues.”


STEM SCHOLARSHIPS

“The Big Bang Theory” Team Supports STEM Students

The cast, crew, and one of the creators of the hit television show “The Big Bang Theory” announced yesterday that they are endorsing a new scholarship program at the University of California, Los Angeles (UCLA). The scholarship, which includes engineering, and mathematics (STEM) undergraduate degrees.

According to the university, the initiative will provide $4 million from nearly 50 people associated with the television program, which is in its eighth season. The show’s science consultant, APS Life Member David Saltzberg, is a physics professor at UCLA.

In a press release, UCLA Chancellor Gene Block said “We are grateful for The Big Bang Theory’s interest in education, and those contributors agree with us that economic standing should not hinder a deserving student who... at a degree from a university of UCLA’s caliber.”

During the coming 2015-2016 academic year, 20 students will be chosen from among those admitted to UCLA, and these students will receive funding based on financial need. In each of the following years, five additional students will be selected. STEM News contributing corres-

pondent Alaina G. Levine is the author of a new book, Networking for Nerds, which draws upon her experience in science and commu-

nication to advise and guide individuals in the care and feeding of their careers as part of scientific and technology communities. From graduate students to senior researchers, Networking for Nerds offers tips on networking for STEM professionals.

Levine goes into detail about myths surround-

networking, how to articulate your skills and expertise, whom to network with, and how to make best use of social media. In his introduction to the book, Nobel Laureate Brian Schmidt says “Networking is an important part of the scientific process and, therefore, doing it well is an important part of being a successful scientist.

The innate skills each of us has in network-

ing are important. But with other skills, most of us can improve with training. This book is about the basic skills you need to learn to better communicate with your colleagues.”


Books

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frequently small enough that you could infer.”

Still, the editors thought offering an anonymous option could speed up the reviewing process. “So, in 1980, the Physical Review editors instituted the first ever blind-review journals. The upshot — only an update to the submissions guidelines and a sentence in an editorial in PRL.

As the appeal of the journal itself grew, it attracted more submissions, and the double-blind option grew in popularity. It was difficult to maintain,” says J. Matthews, Physics Today associate editor. “People actually feel that knowing who the authors are provides additional qualifications. It’s important actually to define the double-blind method, when it is used, that is a computer science science because this is largely an open system. Therefore researchers whose data are less

Peers, it’s a completely different system for which science makes it impossible to strip our identity. In the same name, Science, only offers single-blind. It goes against the grain, then, the idea that computer science is largely split between the two systems. That’s according to Roch Taroni, Chair of the Association for Computational Linguistics Board Conference Committee, which was tasked with a review of the respective roles of ACM’s conferences. “Some conferences in public- reference abstracts are peer reviewed in computer science.

Computer science is, like physics, enjoys a fair amount of sharing and openness (though there is no arXiv equivalent). So that throws out the advantages for the double-blind the author. The double-blind system might flourish simply because a different model is not as deeply ingrained in the culture: The field is young, with its first journals born in the 1950s and 1960s [1]. “Computer science was a science, but also an experimental discipline,” says Guerin. “Once you offer double-blind it is the way to go over single-blind is an experiment with no clear conclusion.”

People on the double side believe it leads to a more objective outcome,” says Guerin, who has sat in on a lot of discussions debating the idea. “On the other hand, people actually feel that knowing who the authors are provides additional qualifications.”

Computers are doing the double-blind, when it is used, is a computer science computer science because this is largely an open system. Therefore researchers whose data are less

“Every one of the applicants we interviewed was engaging, interesting to talk with, and displayed high qualities that indicated potential for excellence in Ph.D.-level research,” he said. “It was a disappointment that we were not able to offer admis- sion to all of them.”

The new Physics Transitional Master’s program at UCF will recruit four students per year and prepare them to continue on to a Ph.D. program at UCF or elsewhere. These students will be placed into undergraduate and graduate courses depending on their level of prepa- ration, following a knowledge-assessment, taken only by gradu- ate students before classes begin. During their first summer in the program, students will participate in workshops and seminars, and writing skills by participating in the UCF Summer Research and Writing Institute.

Talat Rahman, Site Leader at UCF, said “a national program can be a real catalyst for change. It’s the best way to prepare students for a successful research career.” Rahman is most excited that the Bridge Program will encourage diversity in thinking. She’s currently working with teams from six states to bring Bridge students to some teaching, as all graduate students do at UCF, so that students can go through this experience, learning the research and teaching each other through the process. UCF is committed to funding the program for three years beyond APS funding and hopes that heightened aware- ness will encourage more URM students to apply directly to UCF, and further enhance diversity in the applicant pool.

With the addition of UIC Bloom-ington and UCF, there are now 12 new slots for Bridge students this year. At press time, 25 students were placed into APS Bridge sites and graduate programs. For students that aren’t placed at APS Bridge sites, the Bridge Program circu- lates their applications to more than 45 additional doctoral- and master’s-granting institutions. These institutions, each com- mitted to improving diversity in physics, make offers based on funding availability and matches in research interest. Bridge Program staff expects that the total number of students placed will effectively erase the achievement gap.

For information on bridge pro- gram see bridgephysics.org/about/diversity.cfm

The author is Outreach & Com- munications Specialist at the A.J. Drexel Autism Institute in Phila- delphia. Until a few months ago, the author was the APS Bridge Programs Coordinator.

Reference

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Note: The author is the physical science and National Science Foundation, under award #0424739, and by the American Physical Society.

University of Pennsylvania Press, a division of the University of Pennsylvania. For more on the background of this Physics Today article [1].

IUPAP continued from page 1

and Fields; Aihua Xie, Oklahoma State University, Chair of the IUPAP Commission on Biological Physics; and Beverley Berger, representing the

Olympiad continued from page 1

than 60 nations. The national teams compete to solve challenging theoreti- cal and experimental physics problems. U.S. participation began in 1986. This year, team selection began in January with 4,300 high school students from around the country who took a rigorous physics test. Eventually 20 students cleared the hurdles and arrived in College Park in early May for Physics Boot Camp, a two-week training and test- ing period. At the end of the boot camp, the students were interviewed by the traveling team headed to India. The five are: Zachary Bogodar (Solon High School, Solon, OH), Adam Busig (Montgomery Blair High School, Silver Spring, MD), Kevin Li (West Windsor-Plainsboro High School South, Princeton Junction, NJ), Kaio Zhang (Chapman University, Stevenson High School, Lincoln- ville, IL), and Saranesh Prembabu (Dougherty Valley High School, San Ramon, CA).

Helping the students train are college students, professors, and pro- fessors who volunteer as coaches. “This selection of junior coaches has been phenomenal this year in terms of their engagement and involvement with the students,” said Paul Stanley, academic direc- tor of the team. In addition to Stanley, they are Giahuong Dong (Bucknell University, Pennsylvania Press, a division of the University of Pennsylvania. For more on the background of this Physics Today article [1].

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microwave oven-sized device became known as UV Waterworks, and Gadgil says this has improved the lives of more than five million people.

In 2000, Gadgil took on a new drinking water challenge: removing arsenic from groundwater. In India and Bangladesh, surface water is often contaminated with fecal matter, and municipal water treatment facilities do not exist in many places. Governments have responded by encouraging people to drill millions of rudimentary wells to look for it far beyond the camps’ borders, where they were not used to paying for drinking water.

At about that time, Gadgil learned of a process developed in Nepal that uses iron oxide, i.e., rust, to bind arsenic; the arsenic mixture clumps and can then be filtered out. Amrose joined the project in 2006, and they discovered that they could create the rust on demand, as it were, by applying a small voltage to steel plates submerged in arsenic-laced water. In other words, the absorption was “manufactured” directly in the water where it was needed. Amrose named the process electrochemical arsenic remediation, or ECAR.

In the lab, they tested a version of their device to show prototypes and improve the design. When they couldn’t find a nonprofit interested in manufacturing the stove (Gadgil notes that many nonprofits working in the developing world can be technophobes), Gadgil helped find one himself in 2009; that nonprofit, called Potential Energy, began distributing a sheet-metal stove that could be filtered out. None proved to be acceptable, and culturally and acceptably. The researchers returned to Darfur several times to field-test prototypes and improve the design. It further; they have field-tested a version of the stove at least some of the time.

Potential Energy has distributed more than 46,000 stoves, with plans to distribute another 5,000 by year’s end, and Berkeley researchers are modifying the design for use in other countries. The ultimate goal is to distribute millions of stoves around the world, Gadgil says, and make a dent in the commonly-cited figure of four million people who die every year from indoor air pollution. A study that measured stove use in a refugee camp with sensors and cell phone surveys found that among people given stoves, around three-quarters used the stoves to cook at least some of the time.

A growing community

The development engineering community that Gadgil has seeded up to three liters of water at a time. They found an Indian company, Luminous Water Technologies, to license the technology and develop it further; they have field-tested a 100-liter prototype. Amrose and Gadgil recently traveled to West Bengal, India to launch the demonstration of a device that can process 10,000 liters of water per day. If the device succeeds (a complete field test can take up to a year or more), they hope to move to large-scale manufacturing and distribution.

Summary

Sometimes Gadgil finds projects that need his expertise, and sometimes projects come to him. In 2004, someone from the U.S. Agency for International Development called Gadgil and told him about the dire situation of women in refugee camps in Darfur. These women, displaced from their villages by war, needed large amounts of firewood to cook on. But wood is scarce in the semi-arid Sahel region, so the women had to look for it far beyond the camps’ borders, where they were exposed to increasingly frequent sexual violence and kidnappings.

Amrose and Gadgil decided to make a better cookstove, but he recognized that his years spent modeling airflow gave him the skills he would need to produce one that would burn less wood. He spent a year raising funds to travel to Sudan, along with several colleagues. They brought four fuel-efficient cookstoves that other groups had developed, and asked women in the refugee camps to try them out. It was a hard sell—after all, the women rejected them for reasons that would have been impossible to know without visiting in person. For instance, the women insisted that they be able to see the flame, so they could know when to add wood. “All the time we paid attention to what the women cooks wanted,” Gadgil says. Amrose and other students in Gadgil’s Design for Sustainable Communities course chose to work on the challenge and design a stove that met multiple criteria: cheap, made out of readily available materials, and culturally acceptable. The researchers returned to Darfur several times to field-test prototypes and improve the design. When they couldn’t find a nonprofit interested in manufacturing the stove (Gadgil notes that many nonprofits working in the developing world can be technophobes), Gadgil helped find one himself in 2009; that nonprofit, called Potential Energy, began distributing a sheet-metal stove that could be produced for $20, stamped in India and shipped to Sudan, where local workers assemble it by hand. It uses less than half the firewood and produces far less black carbon and carbon dioxide emissions than the traditional fires the women were using, thereby improving women’s health in multiple ways.

Potential Energy has distributed more than 46,000 stoves, with plans to distribute another 5,000 by year’s end, and Berkeley researchers are modifying the design for use in other countries. The ultimate goal is to distribute millions of stoves around the world, Gadgil says, and make a dent in the commonly-cited figure of four million people who die every year from indoor air pollution. A study that measured stove use in a refugee camp with sensors and cell phone surveys found that among people given stoves, around three-quarters used the stoves to cook at least some of the time.

A growing community

The development engineering community that Gadgil has seeded supports dozens of engineering projects for the developing world, including ECAR, further stove design projects, and ReMaterials, a company Amrose collaborates with that produces modular, recycled roofing materials for use in low-income urban neighborhoods. In 2014 Gadgil was inducted into the National Inventors Hall of Fame. And earlier this year, the APS Forum on Physics and Society gave Gadgil its Leo Szilard Lecture-Award, which his mentor Rosenfeld won 29 years ago. “In my mind, Ashok is the best heir to Arthur Rosenfeld,” says Valerio Thomas, an industrial engineering professor who chaired the prize committee. She commends Gadgil for “really thinking the needs of people … . He really has a comprehensive approach, and he’s able to do that over and over again.”

The author is a freelance writer based in Mount Rainier, MD.
Reducing CO₂ emissions to address global warming is a high priority for many policymakers in Washington and in capitals throughout the world. One of the most obvious targets for achieving such a goal is transport. We have discovered that we must generate less CO₂, currently relies heavily on the use of fossil fuels. Several approaches immediately come to mind, although each has its own set of challenges.

For example, we could adopt new social patterns to reduce our transportation needs. But that would take time and almost certainly disrupt the way we live. Alternativa-ly, we could substitute hydrogen made from a renewable energy feedstock (water or biofuels) for gasoline, diesel fuel, or natural gas. But we don’t yet have the technologies needed to produce or store hydrogen efficiently.

Or we could substitute electricity obtained from a green grid. At present, an electric car probably offers the most promising path. Hybrid-electrics, plug-in hybrids, and all-electric cars already exist. Unfortunately, most of us don’t drive all-electric cars because they have limited range and often create “range anxiety” for their drivers. And of course they cost more.

Many of us would be delighted to drive an electric car powered by renewable energy, such as solar and wind, as long as it costs the same as a car with an internal combustion engine (ICE). A range comparable to an ICE car can be charged in the several minutes it takes to refuel an ICE car. None of that is possible at the present time.

Moreover, a widespread infrastructure for charging cars is an imperative, and it does not yet exist. Today there are about 10,000 public-access charging stations are available in the entire country, compared with approximately 120,000 gasoline fueling stations, and charging time is generally too long to be truly useful. Even though electric car owners can charge them at home or in some cases at work, it will be many years before a charging infrastructure will be able to satisfy the nation’s needs if every American is driving an electric car. At the moment the closest thing to a widely useful electric car is the Tesla, which has a range of a few hundred kilometers. But it comes at a price that is out of reach of most Americans, and with the exception of rapid charging at Tesla Supercharger Stations, it generally takes hours to fully charge.

Batteries lie at the heart of the limitations of electric cars. The best chemistry for portable applications today is lithium-ion technology, which American-born physicist John Goodenough developed in the 1970s and SONY first commercialized in the 1990s.

Lithium-ion batteries have a relatively high specific energy (energy stored per unit weight and volume). But they are expensive. And despite a major concerted worldwide research effort, their specific energy has increased only marginally, still leaving them far below that of gasoline.

Halting the use of fossil fuels for transportation will require either major improvements in hydrogen fuel-cell technology and hydrogen-production energy efficiency or breakthroughs in the use of electricity and finding a means to use electric cars with batteries at their present state of development by changing the relationship of price and performance of the vehicle to transportation.

I recently attended a conference at Oak Ridge National Laboratory focused on new and better chemistry to bring us closer to an all-electric-car goal. “Beyond Lithium Ion (BLI) VIII” was the latest in an annual series of such meetings. Compared with the irrefutable exuberance of the 2009 BLI conference, when lithium-air chemistry seemed to be feasible, and the gloom which permeated the 2012 gathering, when lithium/air chemistry seemed to be feasible, “Beyond Lithium Ion (BLI) VIII,” was the latest in an annual series of such meetings.

Improving specific weight and volumetric energy density and ultimately finding a means to use electric cars with batteries at their near-state of development by changing the relationship of price and performance of the vehicle to transportation. Of course a battery for stationary use does not have to be light in weight nor fit in a small enclosure. Of course a battery for stationary use does not have to be light in weight nor fit in a small enclosure.

The Tesla Model S is widely seen — Consumer Reports recently called the Tesla Model S the best car it ever tested — as a very successful technological demonstration of what is possible with an electric car. But for the very high price.

Lithium-air, which seemed so promising in 2009, now appears to be extremely difficult to implement. Lithium-sulfur has become a leading candidate, although its chemistry is extremely complex. Even though a small company has begun to market a lithium-sulfur battery, experts believe that we are many years from a practical product suitable for mobile applications. Indeed, it is not clear that any chemistry beyond lithium-ion will be practical in the foreseeable future.

And when researchers find a suitable chemistry, we should recall that it took more than 20 years after their invention for lithium-ion batteries to be commercially produced.

Toyota, which uses lithium-ion batteries in its plug-in Prius — the standard Prius presently uses nickel-metal-hydride batteries — is studying a magnesium-ion battery. This chemistry shows promise because magnesium has two valence electrons, it does not form dendrites (which can cause a short in a battery), and it is plentiful and inexpensive. Although it is unlikely a magnesium-ion battery will have an energy density better than that of lithium-ion batteries, it might cost significantly less.

It appears at present that nature is not giving us what we want: greatly improved battery chemistry. It almost certainly will be inputs to a business model rather than sources of energy feedstock (water or biofuels) for gasoline, diesel fuel, or natural gas. But we don’t yet have the technologies needed to produce or store hydrogen efficiently.

Reducing the use of fossil fuels for transportation is a primary goal, powering cars with electricity (i.e., using electricity produced in a power plant as an energy-transfer medium) is not the only possible means. We can power a car with hydrogen, but as I already noted, using hydrogen is fraught with difficulties. Producing it is inefficient, presently requiring a platinum catalyst; it has a low mass density and must be stored onboard as a liquid or a high-pressure gas; and it is generally produced from fossil fuels, which are expensive. A new chemistry might make home energy storage cost effective.

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