TEACHERS CLEARINGHOUSE
FOR SCIENCE AND SOCIETY EDUCATION
NEWSLETTER

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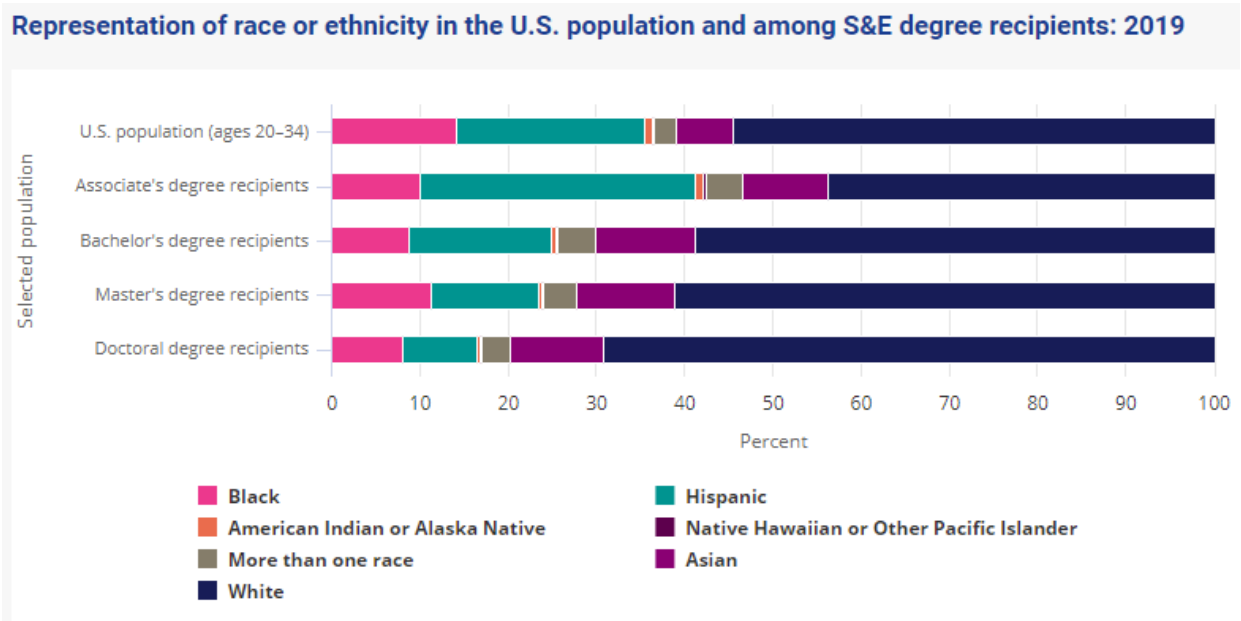
The State of U.S. Science and Engineering

The State of U.S. Science and Engineering summarizes the "nine thematic reports that . . . make up *Science and Engineering Indicators 2022*," grouped into three major sections, as follows:

U.S. and Global STEM Education and Labor Force. Although American students have shown recent improvement in their science literacy (up to 7th of the 37 countries of the Organisation for Economic Co-operation and Development (OECD) on the PISA test), they are still only 25th in math. The math scores of Black, Hispanic, and indigenous students continue to lag behind those of white students, which in turn lag behind those of Asians, and this gap is greater at the eighth grade level than at the fourth. "STEM teachers with less than 3 years of experience were more prevalent at schools with high-minority or high-poverty populations. They also tend to be more prevalent in the southern and western regions of the United States."

At the level of post-secondary education, the percentage of S&E (science and engineering) degrees in the U.S. has increased from 24% in 2000 to 27% in 2019. But it's important to keep in mind that *Science and Engineering Indicators* includes social sciences among the sciences – in fact, most of the bachelor's science and engineering degrees are in the social sciences, biology, and agriculture. At the doctoral level, though, the largest number of S&E degrees, which comprise 65% of PhDs, are in engineering, computer science, and medical sciences.

The following graph shows that Blacks are underrepresented in the number of S&E degrees they receive at all levels, and that Hispanics and indigenous peoples are also underrepresented except at the associates' level. Interestingly, though, two fifths of all college enrollments from American high schools are at community colleges, which in 2019 granted 104,000 associate's degrees in S&E fields, 123,000 in S&E technologies, and 258,000 S&E technology certificates.



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AN EDITORIAL: Has anything changed?

The article on Julie Jungalwala's presentation to the PoLS-T Network on 2 April 2022 (see page 3) refers to the following chart contrasting the "industrial" schools we have now and the "postindustrial" school she feels we need:

Industrial	Postindustrial
Students as passive recipients of content, exercising limited choice	Students as self-directed, entrepreneurial learners
Teacher as deliverer of content	Teacher as designer and facilitator of immersive learning environments
Little differentiation for students' individual strengths and interests	Strengths and interest-based learning for every student
Time-based learning	Competency-based learning
Single discipline-based learning as curriculum driver	Interdisciplinary learning as curriculum driver
Learning grounded in static content and rote memorization of facts	Learning grounded in the real world and practical application
Learning takes place on school campus only	Learning takes place on and off campus, meaningful community, and global partnerships
Content-based assessment, via written tests or exams. Learning assessed by the teacher only	Mastery-based assessment of skills, knowledge and habits of mind. Assessment by self, peers, teachers, and external experts.

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IN THIS ISSUE

The TEACHERS CLEARINGHOUSE FOR SCIENCE AND SOCIETY EDUCATION, INC., was founded at The New Lincoln School on 11 March 1982 by the late Irma S. Jarcho, John L. Roeder, and the late Nancy S. Van Vranken. Its purpose is to channel information on science and society education to interested readers. To this end it publishes this *Newsletter* three times a year. Thanks to funds from tax-deductible contributions, the Clearinghouse is happy to be able to offer its services for a one-time nominal charge. In order to continue offering its services for a nominal charge, it also solicits underwriting of its publications by interested corporate sponsors. All correspondence should be addressed to the editor-in-chief at 17 Honeyflower Lane, West Windsor, NJ 08550-2418 or via e-mail at <JLRoeder@aol.com>.

Editor-in-chief: John L. Roeder, The Calhoun School

Earth Sciences Correspondent: Michael J. Passow, Lamont-Doherty Earth Observatory of Columbia University

Primary Education Correspondent: Bernice Hauser, Horace Mann School (ret.)

Biology Correspondent: Betty Chan, Auron Therapeutics

PoLS-T

Dintersmith: "what school could be"

by John L. Roeder

The first presenter at the first program in calendar year 2022 of the PoLS-T (Physics Of Living Systems Teacher Network) organized by Professor Eric Mazur of Harvard University was Ted Dintersmith. Following a "flipped classroom" proto-

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Wagner: educate innovators

The presenter at the second program in calendar year 2022 of the PoLS-T (Physics Of Living Systems Teacher Network) organized by Professor Eric Mazur of Harvard University was Tony Wagner. Following a "flipped classroom" protocol, participants were asked in advance to watch on Perusall a video of Wagner's talk on "Education for the

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Jungalwala on postindustrial schools

by John L. Roeder

The presenter at the third program in calendar year 2022 of the PoLS-T (Physics Of Living Systems Teacher Network) organized by Professor Eric Mazur of Harvard University was Julie Jungalwala, founder and

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When I saw this chart, my mind immediately hearkened back to Karen Worth's presentation on the then-new *National Science Education Standards*, which I found in our Winter 1996 issue:

Less emphasis on	More emphasis on
PROFESSIONAL DEVELOPMENT	
Transmission of knowledge and skills	Inquiry into teaching and learning
Learning science through lecture and reading	Learning science through inquiry and investigation
Separation of science and teaching knowledge	Integration of science and teaching knowledge
Separation of theory and practice	Integration of theory and practice in classroom settings
Individual learning	Collegial and collaborative learning
Fragmented, one-shot sessions	Long-term, coherent plan
Courses and workshops	Range of professional development activities
Reliance on external expertise	Mix of internal and external expertise
Staff developers as trainers	Staff developers as facilitators, consultants, and planners
PERSPECTIVE ON TEACHERS	
Teacher as technician	Teacher as intellectual and reflective practitioner
Teacher as consumer of knowledge about teaching	Teacher as producer of knowledge about teaching
Teacher as follower	Teacher as leader
Teacher as individual and classroom based	Teacher as member of a collegial professional community
Teacher as target of change	Teacher as source and facilitator of change

Jungalwala asserts that not much has changed in American high schools since the 1980s and cites pre-COVID areas of growing concern. She is arguing for essentially the same thing that Karen Worth was over a quarter century ago – for the *National Science Education Standards*, which were succeeded by the *Next Generation Science Standards* almost two decades later. No wonder that Jungalwala feels that nothing has changed.

- John L. Roeder

Wagner

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Innovation Era: Engaged by Learning," from the NEASC Annual Conference and Showcase, 1-3 December 2020.

Scenes in that video of automatons doing what people used to do prompted Wagner to ask what people can uniquely do that automatons cannot. This, he said, is what we need to education people for. We are no longer living in a knowledge economy, he went on, but rather in an *innovation* economy. Knowledge is an easily-accessed commodity. What matters, he emphasized, is what we can *do* with it. This has profound implications for education and employability, he admonished. Google no longer considers test scores and degrees in its hiring process. Deloite bases its hirings on how well applicants do in collaborative problem solving in summer boot camp.

Wagner distinguished between two kinds of innovation:

1) *bringing new possibilities to life*. This can't be educated for, he observed; indeed, most of the innovators he cited of this type were college dropouts.

2) *creative problem solving*. Wagner delighted that children excel at this, abounding with curiosity. Then, he said, school reduces the questions they ask, as emphasis shifts to getting the "right answer."

Wagner reported that when he interviewed creative problem solvers (of all economic groups, races, genders, and ethnicities), they all responded that they had become creative problem solvers *in spite of* their education – but they could all name at least one teacher who had made a difference. When Wagner interviewed those teachers, he found them to be outliers in their systems, yet similar to each other. Their approaches, he said, were like those in schools at all levels *known* to teach creative problem solving.

Wagner then cited the following contradictions between educating students to be industrial workers and creative problem solvers:

1. *Conventional schooling rewards individual achievement*. In contrast, the teachers Wagner interviewed emphasized *accountable* teamwork.

2. *Compartmentalization of knowledge does not support creative problem solving*. The latter requires an interdisciplinary approach.

3. *The culture of the conventional classroom is one of compliance*. Students in an innovation classroom are expected to question what they are told and to take initiative. Teachers should be mentors and "performance coaches."

4. *Innovation demands taking risks, making mistakes, and failing*. But this is not failure in an academic sense, Wagner said; rather, it is making mistakes to be learned from – since innovation is based on trial and error (which is really the basis of all learning). In view of this, Wagner advocates a mastery approach to learning.

5. *Conventional education motivates students with carrots and sticks*. In contrast, Wagner noted that innovative students are most motivated to do work they consider to be worth doing. Interviews with both parents and teachers of creative problem solvers elicited that all had encouraged *play*, *passion*, and *purpose*. "We are not placed on Earth to serve ourselves," he added.

Wagner made the following recommendations:

1. Imagine a diploma as a certificate of mastery (rather than seat time served).
2. Define the skills important for graduation (critical thinking, questioning, collaboration, communication, creative problem solving).
3. Assessment should be more evidence-based (portfolios) than data-driven (tests).
4. Fund innovative teams of teachers.
5. Foster curiosity of students by allotting time for students to explore interests. (At this point he cited High Tech High and showed a five-minute clip from *Most Likely to Succeed*, which we had watched for Ted Dintersmith's PoLS-T presentation on 22 January 2022.)

In the ensuing Q & A at our Zoom meeting with Wagner on 12 February 2022, he stated that he became a teacher to become the teacher he wished he had had and emphasized the importance of community, voice, and choice. Our educational system is based on industrial production, he lamented. It prepared industrial workers then but it doesn't produce innovators now. Demonstrated successes of alternative models of learning are needed to challenge beliefs in the conventional mode of education, he feels.

In response to Helen Reynolds's distinction between procedural and declarative knowledge, Wagner responded that we should teach knowledge "just-in-time" rather than "just-in-case." He cited scouting as an educational system based on mastery and proficiency, with evidence-based assessment, and went on to point out sports, music, and theater as things in which students develop skills without grades.

In closing, Wagner referred to the Mastery Transcript Consortium Schools and the website <area9lyceum.com>. Unless we prepare our students for the future, he admonished, we might not have a future.

Physics Club of New York

Halpern: how physics is used playing sports

by John L. Roeder

Born in Argentina, Teddy Halpern began his studies in chemistry. But he recognized that he needed to learn physics in order to do chemistry, and eventually he earned a Ph.D. in solid state physics in Germany. For many years he has represented the American Association of Physics Teachers on the Inter-American Congress of Physics Education.

On 3 December 2021 Halpern, who is Professor Emeritus at Ramapo College of New Jersey in Mahwah, spoke to the Physics Club of New York about "The Physics of Sports." He began with what he called his "I don't care" law: "If you like it or not, physics is all around us."

Historically, Halpern attributed sports to an outgrowth of military activity in Ancient Greece. He then proceeded to tell us how physics concepts play a role in sports – and how players of those sports have used those physics concepts in playing them.

The first concept Halpern cited was that of center-of-mass, which plays a role in dance, basketball, snowboarding, the balance beam, and the high jump. He showed how reconfiguration of the body while it is in the air causes the parabolic arc swept out by the head to be less pronounced than the arc swept out by the center-of-mass – and at considerable variance from Artistotle's diagonal straight line upward, followed by a vertical drop in free fall after the impetus of a projectile is used up.

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Schediwy charts improved optical communications through laser interferometry

Ever since the first direct discovery of gravitational radiation in 2015, most scientifically-literate people have been aware that it employed laser interferometry. Indeed, the apparatus for detecting it is the Laser Interferometer Gravitational-Wave Observatory (LIGO), which is a Michelson interferometer designed to detect movement of one part in 10^{23}.

But little did the members of the Physics Club of New York know that laser interferometry can be used to test the Equivalence Principle of General Relativity until Sascha Schediwy of the University of Western Australia (UWA) told them about it on 11 February 2022 (12 February 2022 in Australia). This is but one of the many activities of the International Space Center that UWA has established, Schediwy pointed out.

Schediwy noted that general relativity and quantum mechanics have both been distinguished by meeting all the experimental tests made of them. Yet, he added, these two thoroughly-tested theories clash with each other. The experiment being undertaken by the UWA International Space Center is motivated by the desire to test in an area where general relativity and quantum mechanics converge – where general relativity operates at a small scale.

The historical context of this experiment was the launch failure of Galileo satellites 5 and 6 in the European Union's setting up their version of a GPS system called Galileo, Schediwy observed. The eccentricity of the orbits of these satellites'

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Yokley educates about chiles

When Mary Virginia Orna introduced Robert Yokley as the speaker to the Chemistry Teachers and Physics Clubs of New York on 8 April 2022, she noted that he had recently retired (from Syngenta) and would be speaking to us about his hobby, "Chiles: the Chemistry of Capsaicin."

Yokley began by clarifying the nomenclature: "chili" in the United States, or "chilli" in the United Kingdom, he said, refers to spicy peppers or a meat dish (sometimes with beans) or hot dog topping; "chile" refers to a spicy pepper or fruit pod from plants of the genus *Capsicum*. Within that genus are five species: *C. annum* (mild bells to hot jalapeños), *C. frutescens* (cayenne, tabasco, paprika), *C. Chinese* (hot habanero, Scotch bonnet), *C. pubescens* (Rukutu, rocoto, manzano), and *C. baccatum* (Aji Amarillo, Peppadew, Bishop's crown, chiltepin). The last two species are found only in limited locales in South America.

Chiles, Yokley went on, originated in Bolivia and Brazil, were domesticated over 7000 years ago, one of the first cultivated crops in the Western Hemisphere. Seeds more than 9000 years old have been found in Tehucan Valley, Mexico. Physician Diego Alvarez Chanca with Columbus's second voyage brought the first chiles to Spain and wrote about their medicinal qualities in 1494. And in the sixteenth century Portuguese sailors took them to Asia.

In Western Europe they have been grown as ornamental plants, because of their diverse beauty, Yokley said. But elsewhere they have been adapted to enhance and transform local cuisine. In Hungary they found their way as the national

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Schediwy

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orbits caused them to move between two regions of gravitational field strength, and this allowed for a test to be made of the Equivalence Principle, because of the ability to measure the change in the frequencies of the atomic clocks aboard the satellites in these two regions. The validity of the Equivalence Principle could be established to one part in 40,000, which is "an improvement of 5.6 times the previous best."

This is being followed by a "$150M mission to fly a laser-cooled, microwave-frequency atomic clock on the International Space Station (ISS)"; known as ACES (Atomic Clock Ensemble in Space), it could possibly be launched in 2024. It is predicted to be able to validate the Equivalence Principle to less than 3×10^{-6}, an 8-fold improvement over the Galileo result. But "Microwave atomic clocks are outdated technology. Optical frequency atomic clocks offer a thousand times greater stability," Schediwy went on. But they require optical links, which are not presently available. This is what Schediwy's group is working on.

Schediwy next described the problems in setting up an optical link and how his group is dealing with them. Atmospheric turbulence interferes with the transmission of laser light in two ways, he said: longitudinal turbulence leads to timing jitter and phase noise, while transverse turbulence causes the beam to wander and produces amplitude noise. Schediwy's group is overcoming these problems with a phase and amplitude stabilization system. It is based in a retrofitted 0.7-meter telescope and uses Michelson interferometry, in which one of the interferometer arms is short and designed to monitor the beam in the long arm, which in effect extends all the way to its destination. It has been tested successfully between two buildings in France separated by 265 meters, and a test over 1.2 km in Perth showed that the optical turbulence of that short horizontal trip matched that of a vertical trip to the ISS. Tests of a vertically-aimed laser beam will be conducted by aiming it toward a low-flying drone.

The test of the Equivalence Principle with an optical frequency clock are expected to narrow the precision to 10^{-9}, 3,000 times better than ACES and 30,000 times better than the current value. Schediwy added that the UWA phase and amplitude stabilization system can also improve the accuracy of the International Terrestrial Reference Frame. He also said that the UWA optical ground station could provide optical communications support for NASA's forthcoming Artemis missions to the Moon. Finally, he invited us to watch his recent TEDx talk at https://youtu.be/lVttztmWt90.

Halpern

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In discussing the high jump, Halpern noted that the center-of-mass of an object can sometimes lie outside it and showed photographs showing that a high jumper's center-of-mass can remain below the bar. He pointed out that Dick Fosbury used this to his advantage in the 1968 Olympics and that high jumpers have used this approach rather than a "scissor jump" ever since. Later, at the Tokyo Olympics, Swede Arman Duplantis used this approach to win a gold medal in pole vaulting. And in 1986 Bob Bramod broke the Olympic long jump record by manipulating his body to lower his center-of-mass (Halpern noted that most long jumpers use a launch angle of 28 degrees). Halpern added that divers and gymnasts also configure their bodies to achieve effects by manipulating their center-of-mass.

Halpern next turned to the effect of rotation in sports. First, he noted that skaters, whose angular momentum is conserved when they are spinning around, can increase their angular velocity by drawing in their arms and reducing their rotational inertia.

Other spin effects result from the effect of the interaction of a spinning object and the air surrounding it. That a soccer ball will lift into the air if kicked so that it spins forward on its underside and tend downward when it is kicked to spin forward on its topside is an example of the Magnus effect, identified in 1852 and explained in terms of Bernoulli's principle, which states that a fluid with greater velocity exerts less pressure and also explains the lift of an airplane wing. Halpern added that the Magnus effect applies to tennis and golf as well, and noted that in 2010 the "Jabulani" golf ball was criticized for its reduced Magnus effect.

Halpern concluded his talk by considering other aspects of force. Golf, baseball, tennis, and table tennis all rely on forces exerted on balls to send them in desired trajectories. In striking a golf ball, he said that a club can produce an acceleration of 1300 times the acceleration due to gravity to enable a golf ball to reach a speed of 150 miles per hour in 5 milliseconds and spin up to 12,000 rotations per second. Tennis players achieve serve speeds of 120 miles per hour and favor deflection opposite their handedness in their serves.

The last example of force which Halpern considered was friction. It acts "against" us, but we need it to walk, he noted. Friction and the Magnus effect are both important in curling. Halpern also talked about the role of forces in sailing and swimming and noted that some swimmers shave their heads to reduce friction with the water.

Yokley

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spice, paprika. Indian curry, Chinese hot and sour soup, Thai peanut sauce, Hungarian goulash, Italian pepperoni, and Cajun jambalaya would be impossible without them.

The pungent compound in chiles was first extracted, with organic

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Etkina: the importance of habits in teaching and learning

After two years of Zoom meetings, the newly-formed PhysTEC Regional Network of Southeast New York had its first in-person meeting, hosted by co-chairs Angela Kelly and Keith Sheppard of Stony Brook University at the University's facility in midtown Manhattan, on 17 May 2022. The goals of the Network are to 1) increase the number of physics teacher candidates, 2) improve physics teacher preparation, and 3) advance precollege physics teaching and learning.

Most meetings of the Network have featured reports from area colleges and universities about their physics teacher education programs. But the speaker for the May meeting, Eugenia Etkina, well-known for her work in physics education at Rutgers University, where she is now Emerita Distinguished Professor of Science Education Learning & Teaching, addressed physics teacher education more generally. Her title, "Organizing Physics Teacher Professional Education around Productive Habit Development: A Way to Meet Reform Challenges," was the same as that for the article she coauthored with Bor Gregorcic and Stamatis Vokos (*Phys. Rev. PER*, **13** (2017)). While she wrote generically in the article, her talk was focused specifically on the ISLE (Investigative Science Learning Environment) program she pioneered at Rutgers.

But the bottom line of Etkina's article and talk were both the same: the development of people who will be good physics teachers because of the habits they have developed. And she envisions those habits developing from the three major ingredients of teacher preparation: disposition ("strong belief or attitude related to some aspect of teaching"), knowledge (including specific content knowledge for teaching), and skills. Those habits can be habits of *mind* (thinking like a physicist or physics teacher), *practice* (seeing physics everywhere, working with groups), *maintenance*, and *improvement.*

Etkina then went on to describe how the two-year masters program at Rutgers uses ISLE to develop these habits. The program contains six education courses, each with microteaching experience (teaching other students), four of the six taught by the same professor. Although Etkina acknowledged that replication of this program elsewhere (as has been done in Slovenia) could use an alternative teaching approach, the Rutgers program uses ISLE exclusively and consistently so that the teacher candidates emerge successful in applying *a* single teaching approach. She also acknowledged that it requires a critical mass of students.

After teachers graduate from the Rutgers program, Etkina organizes them into communities to help them survive and improve. She said that over 90% of her alums are still teaching physics, many serving as teacher supervisors of newer students in the program. One of them is doing a PhD dissertation on the longitudinal effects of ISLE.

The Q&A following Etkina's talk was especially rich. One of the emerging ideas is that it is important for teachers to develop habits in their students – using a cognitive apprenticeship approach. This requires community support, she added, noting that *unsupported habits die*.

Etkina also related that she allows students to resubmit work as often as they like. Their grade is that of the most recent submission. This, she said, is consistent with her experience in doing research and writing grant proposals – and also with her closing statement: "*Assessment is to help people learn.*"

Yokley

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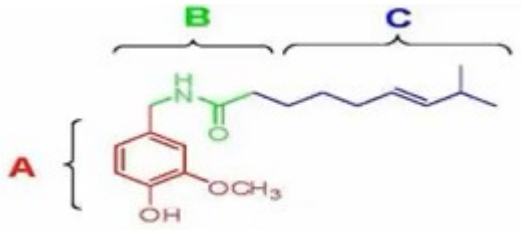
solvents, by P. A. Bucholtz in 1816. In 1876 L. T. Thresh extracted it in a crystalline state and named it *capsaisin* (pronounced "cap-say-a-sin," Yokley said). Two years after that Eudre Hogyes extracted it, but called it *capsicol*, and found that it increased secretion of gastric juices. In 1912 Wilbur Scoville, working for Parke-Davis, now Pfizer, convened a panel of tasters to rate the "heat" of different chiles. And in 1919 the molecular structure of capsaicin was described by Nelson and Dawson.

Further progress came almost a half century later, in 1964, when Kosugi and Inagaki found that capsaicin was actually a complex of six related compounds, which have been called *capsaicinoids*. In 1993 Cordell and Aroujo elucidated the structure of capsaicin, the most abundant capsaicinoid, to be 8-methyl-6-nonenoyl-vanillylamide (the name assigned by the International Union of Pure and Applied Chemistry is 8-methyl-N-vanillyl-trans-6-noneamide). The empirical formula is $C_{18}H_{27}NO_3$, and the structural formula is



The A part of the molecule is similar to vanillin, B contains an amide group, and C is a hydrocarbon chain.

The other capsaicinoids differ from capsaicin in their hydrocarbon chain. Norcapsaicin has one fewer carbon atom (and two fewer hydrogen atoms); homeocapsaicin has one additional carbon atom (and two additional hydrogen atoms). The other three capsaicinoids differ from

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Yokley

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these three by hydrogenation of the double bond in the hydrocarbon chain. The names and empirical formulas of the capsaicinoids and their percentages are as follows:

69% capsaicin: $C_{18}H_{27}NO_3$
22% dihydrocapsaicin: $C_{18}H_{29}NO_3$
<1% norcapsaicin: $C_{17}H_{25}NO_3$
7% nordihydrocapsaicin: $C_{17}H_{27}NO_3$
1% homocapsaicin: $C_{19}H_{29}NO_3$
<1% homodihydrocapsaicin: $C_{19}H_{31}NO_3$.

The "hotness" of capsaicinoids results from their binding to Transient Receptor Potential Vanilloid 1 (TRPV1) nerve receptors in the oral cavity, which are sensitive to heat, acid, and vanilloids. They provide a channel for calcium ions to sensory nerve cells which results in a signal generated to pain-producing areas of the brain. "The 'hot' response releases endorphins in the brain," Yokley said. "These have pain-relieving properties similar to opiates."

In describing the procedure by which the "spicy heat" of a chile is rated on the Scoville scale, Yokley said that it begins by dissolving one grain (0.0648 gram) in alcohol to extract the capsaicinoid, then by diluting this in a 5% aqueous solution of sucrose. Increased concentrations of this sample are given to a panel of five tasters until three of them can detect the "heat." The reciprocal of that concentration determines the Scoville scale rating in SHU (Scoville Heat Units). The ratings, which depend on the capsaisinoid concentration of the chile can vary by more than a factor of 10 due to varying capsaicinoid content resulting from varying growing conditions; they can also vary by 50% due to varying capsaisinoid sensitivity of the tasters. Pure capsaisin, Yokley said, has a rating of 16,000,000 SHU. Among the chiles for which he listed Scoville scale ratings (in SHU) were the following:

Sweet bell	0
Banana	0-500
Pimento	100-500
Paprika	250-1000
Pablano	2500-8000
Chipotle	2500-8000
Tabasco	30000-50000
Cayenne	30000-50000
Thai chili	50000-100000
Habanero	100000-350000
Carolina reaper	2200000

Chiles are rated as non-pungent if they rate below 750 SHU; mildly pungent between 750 and 3000 SHU; moderately pungent between 3000 and 25000 SHU; highly pungent between 25000 and 70000; and very highly pungent above that. Yokley said that the Carolina reaper is still the most pungent, but two new varieties (Pepper X (claiming 3180000) and Dragon's Breath (claiming 2480000) are under scrutiny by Guinness. Yokley also stated that another substance, resiniferatoxin, found in cactus-like plants in Morocco and Nigeria, rated 16 *billion* on the Scoville scale. This Scoville rating makes resiniferatoxin too high for safe human consumption, but it is used as a poison and pesticide. A Scoville rating this high could not be determined by a panel of tasters, but Yokley cited more modern techniques to make measurements that are more objective, precise, accurate, consistent, and less time-consuming: high-performance liquid chromatography and gas chromatography combined with mass spectrometry.

When it came to discussing the safety of consuming chiles, Yokley extrapolated the LD_{50} (dose lethal to 50% of the population) of 118.8 mg/kg for male mice to 9.5 g for a 90 kg human.

When it came to discussing the consumption and production of chiles, Yokley noted that the 0.15 g per person per day consumed by Europeans and Americans lags considerably behind the consumption of what he called the "big four." India is #4 at 2.5 g per person per day, and Thailand is #3 at 5.0, he said; and it should be no surprise that Mexico is #1 at 20.0. But #2 was a surprise to him, and no one in the audience could guess that it is Saudi Arabia – at 15.0. When it came to production, #1 was a surprise: China, producing 11.1 million tons, produces one third of the worldwide annual output of 33.2 million tons; but Yokley observed that most of these are for export. Lagging far behind in production are #2, Mexico, producing 2.7 million tons per year, #3, Turkey, producing 2.1 million tons per year, and #4, Indonesia, producing 1.9 million tons per year.

Next on Yokley's agenda was to observe that chiles are rich in vitamins A, C, and E, and low in sodium and carbohydrates. In addition to the nutrition and flavoring that chiles bring to food, they also have medicinal uses. The Aztecs used them to relieve toothache, and the Mayans to treat respiratory disease. They are also known to relieve psoriasis, decrease arthritic pain and diabetic neuropathy, suppress appetite, kill prostate cancer cells, and decrease colorectal cancer. Outside the human body they repel small mammals, stop barnacles from growing on ships, and kill garden pests.

Yet they have had limited clinical application, due to low selectivity, high toxicity, and pungency. Rather, Yokley said, the goal is to synthesize analogous molecules without the undesirable side effects. One such class of analogous compounds is capsinoids, which differ from capsaisinoids by having an oxygen atom in place of the nitrogen-hydrogen connection, leading to an ester rather than an amide bond. Capsinoids are only about a thousandth as pungent as capsaisinoids, Yokley said.

Orna describes five blue pigments

Mary Virginia Orna, Chemistry Professor Emerita of the College of New Rochelle, was the leadoff speaker in 2022 to a joint meeting of the Physics and Chemistry Teachers Clubs of New York on 28 January. Speaking on "The Modernity of Ancient Pigments," Orna structured her talk on five of them – all blue: Ultramarine blue, Indigo, Maya blue, Egyptian blue, and Prussian blue.

Ultramarine blue. Ultramarine blue comes from a natural mineral, most of which, as noted by Marco Polo, is mined in Afghanistan. Its blue color derives from a trisulfide radical anion (formula $(Na,Ca)_8(AlSiO_4)_6(S,Cl,SO_4,OH)_2$) which absorbs everything but blue. When the mineral is ground, it is seen that most of the material is transparent, and separating the pigment from it is a laborious process which makes it very expensive. Orna showed a picture of a piece of jewelry using ultramarine blue from 2700-2600 BCE Mesopotamia and said that the oldest published use of ultramarine blue as a pigment is in Turkmenistan wall paintings. Traces of the pigment on preserved teeth from the tenth century suggest that an artist using it to paint had used her mouth to sharpen her brush, much as women painting radium paint on watch dials would later do in the twentieth century. Michelangelo used ultramarine blue in painting the ceiling of the Sistine Chapel in 1511, but only sparingly, because he had to bear the expense for it. Later, when he painted *Last Judgment* (1534-1541), he used it more generously, because the pope was paying for it.

In 1787 Nicholas Vauquelin determined that a blue substance found in lime kilns had the same chemical structure as ultramarine blue, and in 1828 J. B. Guimet and C. G. Gmelin both claimed the prize as the first to synthesize it – from sodium sulfate, sulfur, silica, and iron-free clay, with large amounts of sulfur dioxide emitted. The availability of synthetic ultramarine blue, Orna said, caused its cost to drop to 1/80 of its former value. Ultramarine blue continues to be in great demand for consumer products, primarily plastics. The synthesis of ultramarine blue, Orna added, has also opened the door to other synthetic pigments. As the trisulfide radical anions are replaced by disulfide radical ions, the blue gives way to a sequence of blue greens, greens, yellow-greens, and yellow.

Indigo. Indigo is a dye that can be obtained from over 300 plants of the *Indigofera* genus and other genera that

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Manoharan explains structural color

On 17 February 2022 Vinothan Manoharan of Harvard University presented a Physics Today webinar on "Structural color: from birds to materials," based on work in his lab and by associates at Yale and in Korea. Following the king's advice in *Alice in Wonderland* to start at the beginning and stop at the end, he started at the time of the dinosaurs, 200 million years ago. They are now believed to have been covered by feathers, he said, splitting into two clades – one avian, the other non-avian – about 150 million years ago. But because dinosaurs didn't fly, these feathers must have had another purpose before they were used for flight by the descendants of the avian dinosaurs; some think it was for coloration.

Manoharan next stated that a fossil of a microraptor about 120 million years old was found to be preserved so well that imprints of the melanosomes, which give rise to color, could be matched with the melanosomes of modern day birds to infer that the microraptor's feathers were black, with an iridescent sheen that varies with the viewing angle, as is characteristic of modern day crows. This, he said, was an example of a *structural* color.

Structural color differs from ordinary color, which depends upon light absorption by pigments of all the colors of incident light except the color of the object. Structural color, he said, is based on a different mechanism – a nanoscale structure comparable in size to the wavelength of light which selectively scatters the color of light that is seen and lets the other colors pass through.

Manoharan went on to note that the phenomenon of structural color has been known since the time of Robert Hooke, who examined peacock feathers under his microscope and concluded from wetting them that their color came from reflection and refraction (rather than absorption). Newton similarly concluded that the feathers' colors came from "thin plates" in their structure, which were structural features.

But understanding the cause of structural color required a wave theory of light. In the early twentieth century, Lord Rayleigh developed a model which explained structural color as arising from constructive interference of light reflected from the top and bottom of films whose thickness was half the light's wavelength. The Braggs applied their formula for constructive interference of X-rays by adjacent planes of atoms in a crystal – and when this is applied to light, it amounts to the same thing as Rayleigh's model. Manoharan said that it has been found to explain structural coloration in the magpie – a simple model for iridescence in porous structures. Tail feathers were found to contain ordered arrays of pores with spac-

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Orna

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grow on four continents. Orna observed that nature had protected them from being eaten by giving them a bad taste. Reaction of indoxylic acid in these plants with a dicarboxylic enzyme leads to the formation of indoxyl, which forms indigo from oxidation in air. In addition to its use as a dye, indigo has been found to be used as pigments in paintings (among them Da Vinci's *Last* Supper) from the 13th through 19th centuries.

But extracting indigo dye was a laborious process, and Orna noted that indigo plant growers were exploited until a way was found to synthesize it. This was done under the auspices of Adolph von Baeyer beginning in 1865. By 1883 he had discerned the formula for indigo, and a procedure for synthesizing it was realized when Karl Heumann accidentally dropped a thermometer into a bath of aniline and sulfuric acid and the mercury from the broken thermometer reacted to form mercuric sulfate and anthranilic acid. Aniline, cyanide, and formaldehyde react to form indoxyl. Because indigo is insoluble, its use as a dye requires reduction – with sodium dithionate ($Na_2S_2O_6$), a process that releases sulfur dioxide.

Concerned by the use of three toxic chemicals and the emission of corrosive sulfur dioxide, Tammy Hsu proposed a "greener" alternative to achieving the main goal of indigo – dyeing blue jeans. Her method began with identifying the gene that codes for the enzyme that indigo plants use to convert indoxyl to soluble indican, expressing it in *E. coli*, extracting the indican from the culture medium and adding it directly to yarn as the glucoside, then adding β-glucosidase to hydrolyze the indican to indigo. Orna added that in addition to being useful as a dye, indigo (along with Tyrian purple and isoindigo) also has semiconductor properties for which many new uses are being developed.

<u>*Maya blue*</u>. A "cousin" to indigo, Maya blue was first discovered in wall paintings at Chichen Itzá in 1931. Orna pointed out the surprise that this simple clay-like material could be so stable, as demonstrated by its preservation in the wall paintings, without a metallic chromophore. Sixty years later it was found to be a hybrid nanomaterial with an indigo chromophore (indigo nanoparticles intercalated in ion channels of clays). Orna considered it to be "the first ever hybrid organic-inorganic pigment, a nanomaterial centuries ahead of its time." Chemists, she added, are now looking for other materials like it.

<u>*Egyptian blue*</u>. Egyptian blue, which dates to 3100 BCE, was the first pigment to be synthesized. This synthesis, from silicon dioxide, calcium oxide, and cupric oxide, resulted from analysis of ancient samples of this pigment, which Orna showed displayed as points on a ternary phase diagram to show the amounts of each of the three ingredients. Substitution of barium for calcium in the above process, with higher temperature and a lead catalyst, is found to produce Han blue in China. The use of Egyptian blue has not been seen historically between Nefertiti (1340 BCE) and the Swiss Monastery of Müstair (860 CE), and only recently has Egyptian blue usage been identified in early Medieval and Renaissance works. This leads some art historians to wonder whether the "recipe" for Egyptian blue had become lost. As the two pigments previously presented have "21st century properties," Orna noted that Egyptian blue does, too: it is luminescent in infrared light, thus able to add visibility to things at night. She also provided the link to a YouTube video: https://www.youtube.com/watch?v=K2Bwmdl61Sw

<u>*Prussian blue*</u>. Diesbach and Dippel made this pigment from an alchemical recipe in the early 18th century. It was "outed" by John Woodward in 1724: "To an alkali calcined with bullock's blood, dissolved and brought to boil, add a solution of alum and English vitriol. During the effervescence which follows, the mixture turns green. Allow it to stand, then strain." The residual greenish precipitate turned blue as soon as "spirit of salt" (HCl) was poured on it.

Three hundred years later we know that Prussian blue is a mixed-valence compound containing Fe(II) and Fe (III) and that the blue color is due to charge transfer between the two iron ions. The English vitriol, ferrous sulfate, provided the Fe(II). The bullock's blood provided the hexacyanoferrate ion, $[Fe^{III}(CN)_6]^3$. The accepted formula is $Fe_4[Fe(CN)_6]\cdot nH_2O$. Prussian blue has been found as an artist's pigment since 1709, also in house paints, laundry bluing, wallpaper, blueprints, and cloth dyeing. It is also a nontoxic antidote for poisoning by monovalent cations like Tl^+ and Cs^+. However, Orna added, ingesting it for this purpose leads to spectacularly blue feces! Additionally, like indigo, it is a semiconductor and is viewed as a safer electrode for batteries.

Orna closed her talk by telling us about her forthcoming book, *March of the Pigments: Color History, Science, and Impact*, to be published later this year by the Royal Society of Chemistry, written before the present talk was assembled. There was a great deal of interest in having her return when we can resume in-person meetings to talk about this book and sign copies for those interested in purchasing them.

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question – "Do you think adults can work together to make our schools great?" (p. 177) – from a student named Oscar in Newark. His final words are "Oscar, don't give up on us."

- John L. Roeder

Manoharan

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ings consistent with the observed colors – different for different viewing angles because of different spacings between the ordered arrays for different viewing angles: angle-dependent, iridescent structural color.

Manoharan went on to note that there is another type of structural color seen in blue birds. He used the plum-throated cotinga as an example and showed that an electron microscopic indicates spherical air pores in disordered arrays. Nevertheless, the disordered arrays are able to produce constructive interference of reflected light with blue wavelengths, as shown with a similarly disordered array of polystyrene nanospheres in the lab.

When arranged in ordered arrays, the polystyrene nanospheres produced the angle-dependent colors predicted by the Bragg equation. But why did they produce the blue color, with only weak variation with change in viewing angle, when placed in disordered arrays? Manoharan explained that although the arrangement of the nanospheres is disordered, it nevertheless shows short-range correlation, the net effect of which is approximate parallel alignments of the spheres, no matter what the direction of light or viewing angle; and the separation of these alignments, which is the spacing between spheres, produces constructive interference of blue reflected light.

Manoharan next suggested that an interesting practical application of structural light would be to make color displays without pigments that also look the same from all viewing angles, and he reported that funding from the Korean government enabled him and his associates to do this. But they found that unless they coated a thin film of the nanospheres, the reflected color was white, not blue. The white light was found to result from multiple scattering: if the array is sufficiently thick, it can backscatter the red and green light that is transmitted, and the backscattered red and green can mix with the reflected blue to produce white. The researchers recognized from this that they needed to have spherical particles whose diameters equaled half the wavelength and that the thickness of the arrays had to be small enough to avoid backscattering. But the maximum thickness turned out to limit the particle size. The solution was to coat a 20-200 nm core with high index of refraction with a 200-400 nm polymer shell with low refractive index which scatters only weakly. The color is determined by the polymer shell, which determines the inter-particle spacing, but the maximum thickness to avoid backscattering is determined by the core.

Varying the radius of the shell with the same core diameter produced the expected variation in color – until they tried to make red. When they made the polymer shells half the wavelength of red light, they got purple. When they went back to the birds, they found that all the blue birds they studied were blue because of structural color, but that red color in birds is due to pigment.

When they analyzed the spectrum of light reflected by the shells designed to reflect red light, they found that there was actually a peak in the red region – but that it was dwarfed by a peak in the blue. Subsequent solution of Maxwell's equation for the scattering of light by a sphere accounted for the peak in the blue, but this peak had been obscured in the production of all the other colors. Only in the experiment to produce red light were the two peaks separate, and they combined to make purple. The blue peak was moved into the ultraviolet region by making the core smaller, using microfluidics to generate 100 nm double emulsions containing 200-300 nm core-shell particles, which were known as "photonic capsules." Reflected red light was made in this way, but Manoharan acknowledged that it is not "particularly saturated." A more saturated red has subsequently been made by making the core of air, which has a low refractive index, and the shell of higher refractive index silicon dioxide – but Manoharan acknowledged that it is more pinkish.

He closed his presentation, though, with the observation that the type of nanospheres used to make the pinkish red reflected light are similar in structure to the air pores which give the continga its blue structural color. Therefore, birds could, in principle, have a red structural color by increasing the distance between pores. Alas, he conceded, evolution didn't go there.

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Dintersmith notes that "Transformational leaders . . . energize constituencies . . . with a compelling vision of how they can best prepare students for a very different world," then "articulate an aspirational goal for student outcomes, give teachers and principals permission to innovate, empower teachers to design authentic accountability frameworks, adopt the iterative principles of design thinking," and "enlist their community in the aspirational goal of reimagining school." (p. 190)

"It Takes a Village." Innovation is easier when "everybody's doing it," and Dintersmith found such community-wide efforts in Cedar Rapids, IA; Atlanta, GA; Pittsburgh, PA; and Honolulu, HI.

In his "Reflections" at the end of the book, Dintersmith contrasts his educational vision with that of 1893 in the table posted at the beginning of this review. This he follows with a speech he'd like to hear from an American President about needed changes in education, but adds, "Don't hold your breath." (p. 219) Yet Dintersmith admits to finding many glimmers of hope, including the

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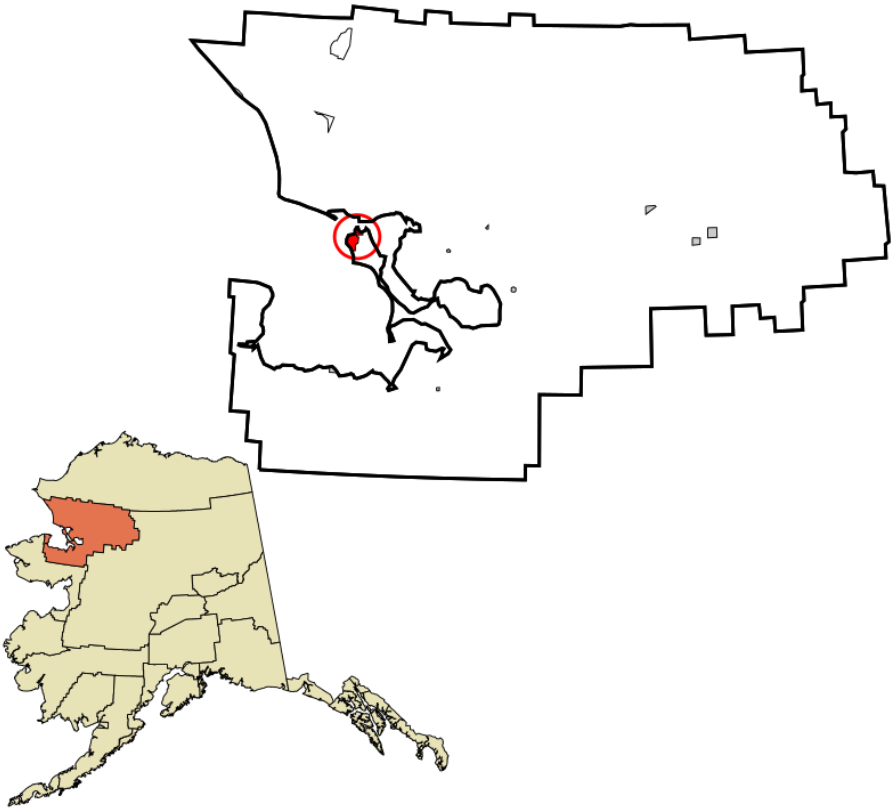
The Ikaaġvik Sikukun: the Ice Bridges Project

by Michael J. Passow
Earth Sciences Correspondent

Back in 1982, when the Teachers Clearinghouse for Science and Society was being established, not much thought (compared with today) was given to climate change and polar societies. In the subsequent decades, it became clear that global climates are changing and that polar conditions are among the most affected. Given such recognition, scientists from The Lamont-Doherty Earth Institute of Columbia University (LDEO) entered into agreements with village elders in Alaska to study the impact of such changes and seek solutions to adapt and mitigate severe consequences.

Their program is called the Ikaaġvik Sikukun Project. The Inupiaq term means "ice bridges" and refers to the combination of efforts of Columbia geologists and Indigenous Knowledge-holders to study the changing sea-ice environment of Kotzebue Sound in northwestern Alaska (see map).



Research questions about bearded seals (ugruks) were developed through cooperation between the scientists and the Indigeneous Village Elder Council. Research cuts across disciplinary boundaries and addresses needs of both the local and scientific communities. In addition to sharing results broadly and in ways that respects the oral traditions, a videography team has documented many aspects of the project. One place to view links to these videos is <https://earth2class.org/site/?p=16971>.

The ugruks and their indigenous hunters are sensitive to ice conditions. The seals follow the melting Chukchi Sea ice edge into Kotzebue Sound and rest on the floating ice floes. They feed on the abundant fish, clams, and shrimp. The hunters have gone after the ugruks for centuries, and much of their cultural history depended on abundant harvest for clothing, food, and even housing. The Elders noted that that the sea ice begins melting about three weeks earlier than just a couple of decades ago, and the season ends much earlier (sometimes in late May, rather than early July. Another part of the problem is that hunters must now travel further in their boats to reach the ice floes, increasing the danger in case of foul weather and adding to fuel costs.

One of the hunters started a journal of observations about 2002 and began noting changes over time. Such phenology can be useful, but 'harder' evidence often provides more useful guidance for actions. Because of the vastness and inaccessibility of the region of study, the Columbia team came to rely on drone technology Here is a link to some of their work: https://www.youtube.com/watch?v=Bi20CFp9kqY&list=PLM4Od3HF5F4UOfBvGKSlzZR2UontfLZeP&index=5.

Research has indicated that arctic regions will be among the areas most affected by climate changes, so projects like Ikaaġvik Sikukun are very important to serve as an example of how Science can be used to improve Society. Participation of local residents in such an integral way also opens new career opportunities for younger generations.

The ultimate goals of the Program include findings that will lead to predictions about details of the changing cryosphere of Kotzebue Sound, especially how such changes will impact the ecology and the Iñupiaq way of life that is dependent upon it. This approach will address key questions concerning the mechanisms and impacts of rapid changes taking place in the Arctic while ensuring that answers incorporate traditional ways of knowing and are relevant to local needs. This is a true example of 21st century "Science and Society."

Things Learned about the Past from Timbers in Warehouse

by Michael J. Passow
Earth Sciences Correspondent

Most dendrochronologists (tree-ring scientists) collect study samples in forests, often in far corners of the world. But Cari Leland, Makund Palat Rao, and Ed Cook of the Lamont-Doherty Earth Observatory of Columbia University Tree-Ring Lab (TRL) have made many interesting discoveries about the Past by poking around nineteenth century warehouses in the Chelsea section of Manhattan.

Each year, about a thousand old buildings in New York City are demolished or renovated. The timbers used in their construction can reveal the social and environmental history of the trees from which they were logged. The TRL scientists have been allowed access to some of these buildings, especially the Terminal Warehouse built in Chelsea in the 1890s. Examining the wood used in the structure, they found that many came from trees which were part of the primordial Eastern Woodlands Forest, which stretched from Canada to the Gulf of Mexico before the arrival of the Europeans. Many began to grow in the seventeenth and eighteenth centuries, and one was a sapling in the early sixteenth century.

The age of the tree can be revealed by the number of tree rings visible either in its cross-section end or by using a sharp coring tool to obtain a pencil -thin tube. By analyzing overlapping cores, a longer record can be established. The varying widths of the tree-rings reveals much about the climate at the time it was growing — wide rings indicate warm, wet conditions that were good for growth, and narrow rings the reverse.

TRL scientists also use a new technology called "blue light intensity" (BI) that can measure the density of the rings which form late in the growing season and have been correlated with climatic changes.

Many buildings were constructed in the nineteenth century when NYC was a bustling seaport and millions of immigrants were arriving to begin life in America. Much of the original forests in the NYC metropolitan area were clear cut for fuel and timber, but logging continued elsewhere along the East Coast. The expanding railroads provided both a demand for fuel wood to run the steam engine locomotives, and also an effective method of transporting logs across the country or to seaports, such as Savannah, from which they could be shipped to New York.

Trees growing in the seventeenth and eighteenth centuries lived through a climatic period known as the "Little Ice Age" (from the 1300s to the 1850s), when temperatures were generally cooler than now. Part of the warming came from the Industrial Revolution's increased demand for fossil fuels.

Here are three sources for more information:

https://lamont.columbia.edu/news/new-york-citys-hidden-old-growth-forests
https://dcaps.library.cornell.edu/projects/nys-historical-dendrochronology-project
https://esajournals.onlinelibrary.wiley.com/doi/10.1002/fee.2410

Logs from renovated warehouses in NYC. (Photos courtesy of Dr. Makund Palat Rao, LDEO TRL).

Water, Water Everywhere, and Nowhere

by Michael J. Passow
Earth Sciences Correspondent

There is no doubt that water is one of the most essential and necessary compounds on our planet, but its uneven distribution causes serious societal problems. In some places, there is too little water, resulting in short- and long-term drought accommodations; and in other places, there is too much water, leading to flood damage and deaths. Who is monitoring global water conditions, and what might be done to minimize damage?

While most water observations take place at local level, multinational organizations are also concerned. As of 2017, the World Bank reported that more than 660 million people in the world lacked access to improve water drinking supplies (1). The United Nations developed, in 2015, a fifteen-year plan for 17 Sustainable Development Goals (2), among which #6 focuses on Water and Sanitation (3). (The Sustainable Development Goals are described in detail in the Winter/Spring 2018 issue of this *Newsletter*.)

In many locations, even where there once was adequate water available, Global water deficits are increasing (4), and sources are quickly being depleted. In Yemen, the water table is dropping by about nearly 2 meters per year, and although test wells have been drilled 2 kilometers deep, no additional water has been found. Iran similarly is facing acute water shortages. Iran and Egypt now import more wheat than Japan, traditionally the world's largest importer.

The importance of this is that water deficits can be disguised as other problems. It takes water to grow crops. For example, it is estimated that one ton of grain requires 1,000 tons of water, so importing grain is, in effect, importing water.

Egypt, Ethiopia, and Sudan are battling each other for water from the Nile River, which now only trickles into the Mediterranean. It may be only a matter of time before water battles become actual battles. Israel is well known for its water management programs (5) but may yet get entangled in fighting over the Jordan River.

Mexico has states where the water table is dropping by as much as 3 meters per year. The battle over the Rio Grande between the US and Mexico is well known.

Even where there may be adequate groundwater amounts, the quality may be unacceptable due to natural contaminants, such as arsenic (6), road salt, and rare gases.

Many non-governmental agencies are trying to make a difference in this global battle. One is the Rotary Safe Water Project. This Project seeks provides safe, clean drinking water to disadvantaged communities all over Africa. Run by the Sea Point Rotary Club (in a district that includes the Western Cape, Namibia and Angola), the Safe Water Project uses its funds to purchase and distribute portable water purifiers – the LifeStraw – that effectively remove bacteria and parasites from contaminated water. "The LifeStraw significantly impacts on the incidence of diarrhea, the biggest killer of children in sub -Saharan Africa." (7)

Even in more-developed countries, such as the USA, regions are experiencing severe water deficits. The current drought in the Southwest may be the worst in more than 1200 years (8). There is sufficient evidence that the current situation may be exasperated, or at least impacted by human-induced climate change (9).

The US Geological Survey has a division that focuses on Water Resources (10). USGS Scientists and technicians, together with university and other partners, monitor, assess, and conduct research about a wide range of water resources and conditions, to assist local and regional water management.

On the flip side, other locations suffer from too much water. As this essay was composed, Petropolis, a city near Rio de Janeiro in Brazil, was trying to recover from receiving 130 mm of rain in about 3 hours, producing widespread deadly (more than 130 deaths) flooding and resulting landslides (11).

Heavy precipitation may be just one cause for damaging flooding. NOAA predicts sea level rise will cause future flooding, even in inland areas (12). Historically, states in the East, Southeast, and Midwest have been most likely to experience river, coastal, or flash floods. Flash floods causes most of the deaths (usually between 30 and 180 annually). Damage amounts to billions of dollars. (13).

Another major cause of flooding internationally are the El Niño-La Niña phenomena. Although the most spectacular examples have affected Australia and New Zealand, ENSO-La Niña also impacts the amount of water in the Western U.S. Increased precipitation also adds stress on reservoir dams, which could collapse and results in serious downstream flooding.

One university response to this issue is the CWC — Columbia Water Center. Their mission is to creatively tackle water challenges of a rapidly changing world where water and climate interact with food, energy, ecosystems, and urbanization (14). The CWC is part of the Columbia University Earth Institute (15). The EI

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Water

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plays a major role in the new Columbia Climate School, which offers "non-degree education programs for a wide cross-section of society, including K-12 programs for teachers and students, leadership and communications training, and executive and other professional programs for businesses and governments. Non-degree programs will offer the same level of rigor and quality as our degree programs and allow the Climate School to deliver high-caliber programs on a flexible schedule to participants around the world." (16)

References:

(1) Water Supply Overview: Development news, research, data | World Bank
(2) Home - United Nations Sustainable Development
(3) Water and Sanitation - United Nations Sustainable Development
(4) https://www.theglobalist.com/the-global-water-deficit/#:~:text=The%20Global%20Water%20Deficit.%20It%20is%20a%20product,are%20often%20discovered%20only%20when%20wells%20go%20dry.
(5) Water Management in Israel - Fanack Water
(6) Worldwide Occurrences of Arsenic in Ground Water (science.org)
(7) https://www.relate.org.za/causes/rotary-safewater-project#:~:text=The%20Rotary%20SafeWater%20Project%20provides%20safe%2C%20clean%20drinking,effectively%20remove%20bacteria%20and%20parasites%20from%20contaminated%20water.
(8) Megadrought in Southwest North America worst in 1,200 years - The Washington Post
(9) Megadrought grips California, impacting the Coachella Valley - KESQ
(10) https://www.usgs.gov/mission-areas/water-resources.
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(12) NOAA sea level rise report shows flooding across the US | Popular Science (popsci.com)
(13) US States Most Prone To Flooding - WorldAtlas
(14) https://water.columbia.edu/content/about-us
(15) https://www.earth.columbia.edu/
(16) https://www.climate.columbia.edu/education

Dintersmith

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col, participants were asked in advance to watch on Perusall the video which Dintersmith had prepared, "What School Could Be," and watch a film he had produced, *Most Likely to Succeed*.

In his talk, Dintersmith began by relating how "formulaic" science courses in a northern Virginia high school led him to major in physics at the College of William and Mary, where he did a senior research project to predict the scatter plot of low energy atomic collisions with punch cards on an IBM main frame computer. This was followed by graduate school at Stanford University, where he found that he liked physics' correspondence between the real world and abstract representations but didn't see himself being a path-breaking research physicist. So he took the summer after his first year of graduate school off to work for a firm doing mathematical modeling of social phenomena, particularly in education. (Among the people he worked with was Hugh Everett, famous for his many-worlds interpretation of quantum mechanics.)

After that he switched to a mathematical modeling program in graduate school to examine the risk of natural gas storage tanks on tankers, financial systems, and biological systems to earn his Ph.D. He then spent 25 years in venture capital and over a decade on issues about school, in the course of which he reimagined school wholesale, based on many visits and interviews and experiences with his own children, made films, and wrote books.

Dintersmith described his observation that students who succeed in 1) memorizing, 2) replicating low-level procedures, and 3) following instructions excel. He also noted that these are things that machine intelligence is programmed to do. Instead, he thought, we should equip students with skills to identify problems they want to solve and challenges they want to take on. To this end he produced *Most Likely to Succeed*, wrote *What School Could Be* (reviewed on page 30), and established <whatschoolcouldbe.org> to enable teachers to communicate in furtherance of these ideas. Dintersmith stated that he feels we are missing out in getting kids interested in science and would like to see an ungraded middle school course on the entire gamut of the sciences developed and taught to do this. He added that he doesn't see student ability to think creatively or conceptually being valued anywhere in education, including college.

Another thing Dintersmith said he'd like to get away from is right-answer questions, which are the scourge of standardized tests, and use Fermi questions instead. This, he added, also dovetails with the imprecision of the real world. As an example of a question he likes, Dintersmith cited one posed by Eric Mazur: What happens to the di-

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Dintersmith

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ameter of a hole in a piece of metal when it is heated? Dintersmith stated that auto mechanics and plumbers are more likely to answer it correctly because of their direct experience; therefore, we should show respect for these professions.

Dintersmith would like to see such a question posed every month and would like to encourage students to do more original work on their own, especially in teams. "Innovation is not a spectator sport," he concluded.

The film, *Most Likely to Succeed*, begins with a quotation from John Dewey: "If we teach today as we taught yesterday, we rob our children of tomorrow." It goes on to point out that, since the late 1990s, the U.S. economy has been able to produce more wealth by hiring fewer people and that 53% of college graduates are underemployed. After IBM's Big Blue defeated Gary Kasparov at chess in 1997, IBM built Watson to win at *Jeopardy!* Software can now construct a well-written essay from information supplied to it. What happens to society, the film's narrator asks, when human jobs can be done by a computer or robot?

Most Likely to Succeed traces the origin of our present educational system to 1843, when Horace Mann witnessed the revolution in Prussian education due to Johan Gottlieb Fichte – for every German boy, aged 7-14, according to age, ability, and subject matter – and persuaded American industrialists that it's the way to train their workers. This led to setting up the present curriculum of what students should know by the Committee of Ten. But, the narrator counters, the twenty-first century economy values skills different from what twentieth century education provides.

The film then moves to High Tech High in San Diego, which responded to this dichotomy with teaching free from standards and standardized tests. One example presented is a physics and humanities unit on why civilizations rise and fall, team-taught in a seminar and lab format, with the expectation that students would represent their theories with constructed mechanisms. The film points out that projects such as these are the types of things people do when they create something. They require innovative thinking, not just content knowledge. This is what U.S. students need in order to compete with other countries, not the ability to do "cookie cutter" types of jobs. Skills are more important than a "body of knowledge" – especially "soft skills" like confidence, ability to collaborate and learn from criticism, critical thinking, time management, and making decisions.

Tony Wagner decries the present U.S. high school curriculum as "test prep." (Wagner has already been introduced to *Newsletter* readers in our Spring 2012 issue, and followed Dintersmith as the PolS-T speaker for the following month, as described on pages 3-4 of this issue.) With students seeing the SAT as the key to admission to a good college and a good job, many feel that "acing the test" is of primary importance in high school, although research has shown that students don't retain material crammed to ace a test. Eric Mazur points out that situations in life don't correspond to the condition of taking a test. And, the film points out, the jobs that can be done without higher-order thinking skills are being taken over by technology.

Without evidence that High Tech High's project-based curriculum offers a more successful future, the film asks whether we should alter school to require more work than reimagine it. It does note, though, a few relevant facts: the scores of High Tech High's students on the California High School Senior Exit Exam (English and math) were 10% above the state average, and 98% of these students were granted college admissions. And at the same time High Tech High also gave its students unique opportunities for personal growth.

The film also notes that its producers visited other schools which have deviated from traditional approaches to education and found that each one was different. When the group met on Zoom with Dintersmith on 22 January 2022, I asked whether they had taken as much footage at the other schools as they had at High Tech High before deciding to tell their story through the developments there. The short answer to my question was "yes," but the long answer was much more interesting and informative and sang Dintersmith's praises for his director, Greg Whatley.

Dintersmith related that he first approached Whatley with his initial idea for the film and a list of people to be interviewed and in what order. He said that Whatley felt that the result would be boring, and they ended up with 900 hours of footage from all the schools they visited – for a 90-minute film. Dintersmith wanted to tell the story through the footage gathered at several schools, and he said that Whatley made such a cut for him but told him he wouldn't like it. Dintersmith agreed that Whatley's judgment was correct, and they decided to focus the story on two students and four teachers at High Tech High. What Dintersmith said he learned from this is not to tell people what they should believe. Rather, show them scenes from which they can draw their own conclusion.

Most of the rest of the discussion was centered on Dintersmith's mantra to focus on students rather than on test data. One particular anecdote he shared was what he called the greatest educational decision Finland ever made. Faced with a budget shortfall, they canceled standardized tests for a year. But far too many of the comments and questions from teachers in attendance spoke about administrators, many of whom had never taken a physics course, who were more interested in standardized test scores than in the efforts their teachers were making to make learning physics an exciting experience.

Jungalwala

(continued from page 3)

executive director of Institute for the Future of Learning, a nonprofit organization dedicated to helping transform the "one size does not fit all" model of education. Following a "flipped classroom" protocol, participants were asked in advance to watch on Perusall a video of Jungalwala's talk on "Pandemic vs. Portal: The Human Side of Changing Education."

Jungalwala began by observing that not much has changed in American high schools since the 1980s. If this is the "normal" to get back to, she suggested that we wouldn't want to get back to it if we could. The time preceding COVID, she went on, has been characterized by VUCA (Volatility, Uncertainty, Complexity, and Ambiguity). Already in pre-COVID times, she said, there were areas of growing concern, put forth in the following ways, with considerable overlap:

1) Tony Wagner's Global Achievement Gap, which recommends a) critical thinking and problem solving, b) collaboration across networks and leading by influence, c) agility and adaptability, d) initiative and entrepreneurship, e) effective oral and written communication, f) accessing and analyzing information, and g) curiosity and imagination.

2) Sir Ken Robinson's Creative Schools, emphasizing Curiosity, Creativity, Criticism, Communication, Collaboration, Compassion, Composure, and Citizenship.

3) The Hewlett Foundation's Deeper Learning Network, calling for a) mastery of core academic content, b) critical thinking and complex problem solving, c) collaboration, d) effective communication, e) learning how to learn, and f) an "academic mindset."

4) Partnership for 21st Century Skills, built on a) learning and innovation skills (Communication, Collaboration, Creativity, and Critical thinking), b) life and career skills, c) information, media, and technology skills, and d) key subjects (3Rs and 21st century themes).

5) Institute for Future of Learning Worthy Skills: a) self-directed learning, b) creativity and innovation, c) planning, adaptability, and agility, d) strength, awareness and application, e) self-efficacy, f) global citizenship, g) relationship building, and h) critical thinking and problem solving.

Achieving the goals emerging from these areas of concern, Jungalwala averred, requires a *shift* from what she called "industrial" schools to "postindustrial" schools, which she distinguished in a chart which is reproduced in the editorial on page 2 of this issue. She particularly emphasized the last of these distinctions and added that moving to postindustrial schools also requires a *shift* in *adult* behavior: from a) mitigating risk to embracing it, b) exerting control to distributing autonomy, c) knowing to learning, d) having answers to asking questions, e) staying within department lines to working across them, f) having clear roles to tolerating ambiguous roles, g) valuing and prioritizing what we assess to prioritizing what we value and figuring out a way to assess it, and h) "Don't rock the boat" to pushing back when and where it is necessary in support of the vision.

A figure from Myers and Zanin, "Debriefing and Grief: Easing the Pain," adapted by Cheri Lovre, persuaded Jungalwala that, rather than recover or regain whatever educational losses resulted from COVID, we need to *reinvent* our educational system. To do this, she feels, we must acknowledge three truths:

1. "It is way past time for systemic equity and dignity and belonging for all children in our schools."
2. The purpose of our schools is "to prepare children for an unknowable future" – "a pretty daunting task," very different from what schools were originally designed for.
3. "There is so much we know . . . about how people learn, develop, grow, and thrive, and a lot is still not reflected in many of our schools."

To these three truths she iterated five questions to be answered/decisions to be made:

1. What is worth learning? (Curriculum)
2. How is it best learned? (Pedagogy)
3. How do we know it has been learned? (Assessment)
4. How can we unleash teacher talent in support of this learning? (Teacher Professional Development)
5. How do we lead the change? (Change Leadership)

Jungalwala then fashioned a template with the three truths heading columns and the five questions marking the rows, and shared the way she and a colleague had filled it out:

Truths/ Questions	Changing World	Sci. of Lng. & Devel	Systemic/Equity
Curriculum			
Pedagogy			
Assessment			
Tchr P D			
Chg.Ldrshp			

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Princeton Propellers

Sadoway presents perspectives on industrial electrochemistry

Donald R. Sadoway, Professor of Materials Chemistry at the Massachusetts Institute of Technology, spoke on "Electrochemical Energy Storage" at the 12 April 2022 meeting of the Princeton Propellers. His talk turned out to consist of three vignettes, all related to the theme of planetary decarbonization and profitable sustainability: 1) decarbonization of manufacturing, typified by steel-making; 2) grid level storage; and 3) making the transition to electric vehicles.

The world produces two gigatons of steel per year, Sadoway opened. The traditional process produces carbon dioxide emissions not only from heat provided by fossil fuel combustion but also from making the coke in which carbon serves as the reducing agent to act on iron in iron oxide. Recognizing electrons as an alternative reducing agent (Gives Electrons Reduction, goes part of the well-known mnemonic device), Sadoway hit upon the idea of electrolyzing molten iron oxide to produce iron. It releases molecular oxygen at the anode, liquid iron at the cathode, and costs less than a blast furnace and emits no carbon dioxide. This, in turn, led to the founding of Boston Metal – with funding from Bill Gates's Breakthrough Energy Group and other sustainability-minded investors. (Sadoway mentioned that Gates had come to *him* after enjoying Sadoway's chemistry lectures.)

Grid level storage, Sadoway said, must be long lasting, safe, flexible, and low-cost. He stated that he began with the last criterion, which excluded lithium. Noting that experts are naysayers, he avoided them and went to an aluminum smelter for inspiration and ended up with a storage battery structured on three immiscible layers – of liquid magnesium, a molten salt electrolyte, and liquid antimony – which is 80% efficient and maintains the required high temperature from its current flow. It was developed with a team of bright MIT students and led to formation of the Liquid Metal Battery Corporation, later renamed Ambri (taken from MIT's location in Cambridge, MA). Sadoway also reported developing a battery with electrodes made from lithium and a combination of lead and antimony that retained 99% of its capacity after 5000 recharging cycles; and an energy storage system with calcium and antimony electrodes and a calcium chloride electrolyte between them.

When it comes to energizing electric vehicles, Sadoway said that he expects lithium battery costs to increase and seeks a battery without lithium, cobalt, carbon, and the likelihood of fire. He expects that the most likely sources to meet this need are universities and startups. But one element he stressed is in greater need to transition to electric vehicles is copper, to satisfy the greater need for wiring. Sadoway also pointed out the large currents needed to re-energize electric vehicles in short times. Energizing a car to half its 100 kWh capacity in six minutes with a voltage of 250 volts requires a current of 2400 amperes! To achieve the transition to electric vehicles Sadoway sees Avanti commercializing the aluminum-sulfur battery; and he sees a bright future in industrial electrochemistry. But, he added in the ensuing Q&A, upscaling results in the lab to an industrial level takes time.

Redjal describes Stereotactic Radiosurgery

Dr. Navid Redjal, Director of Neurologic Oncology at the Capital Health Medical Center in Hopewell Township, Mercer County, New Jersey, explained why stereotactic radiosurgery has revolutionized treatment of neurologic diseases, especially cancer, in his talk to the Princeton Propellers on Zoom on 8 March 2022. The reason is that technological improvements in the detail of imaging have improved the ability to target areas in need of surgical attention.

The premise of radiation therapy has been that ionizing radiation can damage DNA in tumor cells. Conventional radiation therapy has targeted broad areas of the body, with concomitant side effects. In contrast, stereotactic radiosurgery targets smaller areas with intersecting beams from several directions. This has been effective treating tumors resistant to conventional radiation treatment and has a smaller effect on neurocognitive function than conventional treatment. A notable patient cited by Dr. Redjal was former President Jimmy Carter, successfully treated when he was 88 years old. Currently stereotactic radiosurgery is effective for treating tumors that are less than four centimeters in size; but Redjal expected larger tumors to be treatable – and with reduced side effects – as technology improves.

Redjal cited three types of stereotactic radiosurgery: cyber knife, gamma knife, and proton beams, the last of which can be targeted to maximize dose at a desired depth – and, by minimizing exit dose, is the best for children. Orthogonal X-ray beams monitor movement of the patient to insure that the radiation reaches the target. The only drawbacks he listed are radiation necrosis, edema, and delayed secondary radiation.

Redjal also stated that stereotactic radiosurgery also can be used to treat metastases of cancer to the brain, neuralgia, and tremors and that it is more effective than microsurgery in some cases. It also promises to be a future treatment for such functional disorders as obsessive compulsive disorder and eating disorders. But the multimillion dollar cost of the equipment discourages replacing currently operating equipment with new.

Webinar highlights DOE educational programs

On 30 November 2021 the United States Department of Education hosted the first of three webinars to emphasize the importance of environmental literacy. Titled "Energizing STEM," it featured educational programs available from the US Department of Energy (DOE). Host Patti Curtis began by listing the three main environmental goals set forth by the Biden Administration: 1) Reduce the level of greenhouse gas emissions from what they were in 2005 by 50-52% by 2030; 2) Achieve a carbon-free electric grid by 2035; 3) Reduce carbon dioxide emissions to zero by 2050.

Noting that she had been charged with achieving the three above goals, Secretary of Energy Jennifer Granholm added that she was "obsessed" with using "clean" energy, not only to replace energy sources which had disproportionately polluted Black communities but also to create good paying jobs in what promises to be a $23 trillion market. Noting that equity in employment required an inclusive STEM workforce, she recognized the need to increase funding for STEM research at Historically Black Colleges and Universities (HBCUs).

The Biden Administration therefore has a program for funding STEM research at HBCUs, which is channeled through the White House Initiative on Advancing Educational Equity, Excellence, and Economic Opportunity through HBCUs (originated in 1981 by President Jimmy Carter at the end of his term in office). The Senior Associate Director of this initiative, Dr. Arthur McMahan, spoke about this initiative and stated that STEM education is the language of ingenuity and productivity, important for the scientific and social advancement of all. McMahan observed that funding STEM research at HBCUs is important because HBCUs are anchor institutions in the communities they serve.

Several DOE representatives then described the many programs by which their department seeks to provide opportunities for students underrepresented in STEM research programs. Kerena Taylor, a lawyer in the Office of Economic Impact and Diversity, spoke about the Inclusive Energy Innovation Prize. David Canty, Program Manager of the Minority Serving Institutions Partnership Program (MSIPP) of the National Nuclear Security Administration, described how MSIPP is set up to prepare a diverse workforce through partnerships with Minority Serving Institutions. Alexander Dodinez-Robinson, Program Manager of the Minority Serving Institutions Internship Program of the National Nuclear Security Administration (NNSA-MSIIP), described how NNSA-MSIIP offers internships both during the summer and for a full year. Melinda Higgins, Tribal STEM Advisor in the Office of Nuclear Technology, described consultation, collaboration, and communication with tribes affected by DOE activities to provide STEM opportunities, among them a "Navigating Nuclear curriculum for elementary, middle, and high schools. And Christy Jackiewitz, Chief of the Minority Educational Institution Division's Office of Economic Impact and Diversity, described the Minority Educational Institution Student Partnership Program (MEISPP) and the Omni Alliance Internship Program.

Two DOE representatives described competitions which have proved to be very popular in drawing entrants. Amanda Joyce of the Office of Cybersecurity, Energy Security, and Emergency Response, described the Cyberforce Competition, which is a simulation that originated at Argonne National Laboratory and has now grown to involve ten of the national labs. Holly Jamesen Carr, Director of the Solar Decathlon in the Building Technologies Office, explained that the Solar Decathlon is a collegiate competition to prepare the next generation of designers and constructors of low-carbon buildings powered by renewables – beginning in 2002 on the National Mall and held various other places since. Build Challenges for residential buildings are held every two years, Jemesen Carr said, and Design Challenges are held every one or two semesters for residential and commercial buildings. Entries are evaluated on the basis of ten criteria.

(*Editor's Note*: The link to all of the US Department of Education's archived STEM webinars, briefings, newsletters, and other resources is https://www.ed.gov/stem?utm_content=&utm_medium=email&utm_name=&utm_source=govdelivery&utm_term=#archived-briefings.)

Jungalwala

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Citing a quotation from Søren Kierkegaard that "Life can only be understood backwards; but it must be lived forwards," Jungalwala closed by posing the question: "Is it possible to design, build, and live a life of your own choosing?" To respond to that question she advocated drawing what she calls a Life Map after reflecting on key events that have had a positive and negative effect (here she injected a quotation from John Dewey that "We do not learn from experience . . . we learn from reflecting on experience."). By listing her date of birth on the left and drawing a continuous line to show the highs and lows of her life, with annotations, she shared her Life Map with us and urged us to make our own – and then to reflect on what it tells us about our values, the risks we took, the ways we overcame obstacles, patterns in our behavior, and changes we wish we could make. Continuation of that map into the future, she noted, is our learner's journey, facing fear and uncertainty, meeting mentors, taking action, facing challenges and possibly reaching an abyss, finally sharing what we have learned with others and mentoring them. Jungalwala hopes that the PoLS-T Network can serve as this kind of support for many of us.

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Webinar highlights EPA educational programs

On 19 January 2021 the United States Department of Education hosted the third in a series of webinars to emphasize the importance of environmental literacy, this one with particular emphasis on the role of the Environmental Protection Agency (EPA) to promote it. Host Patti Curtis began by saying that "President Biden has called for a whole-of-government approach to combat the climate crisis facing our nation and our planet." She continued by observing that in that approach is a commitment to environmental justice and stated that the webinar would feature a team from EPA to explain how their resources can be used to "think globally, teach locally" about these issues.

Melissa Payne described EPA's Air Quality Flag Program, in which students obtain green, yellow, orange, and red flags and fly one of the appropriate color to transmit information about the air quality level to others. Sarah Matthews added information about the National Service Center for Environmental Publications (NSCEP) – at https://www.epa.gov/nscep – which provides lesson plans, including one on the Paper Wad game, in which students represent cilia in lungs, whose job is to block paper wads representing air pollution.

Rebecca Dodder then listed the elements of what she called Energy 101: The Big Picture: 1) primary energy resources (fossil, non-fossil-non-renewable, renewable); 2) technologies to convert primary sources to usable forms (refineries, power plants); 3) end-use sectors (residential, commercial, industrial, transportation); 4) air pollutants (nitrogen oxides, carbon monoxide, sulfur dioxide, particulate matter); 5) greenhouse gases (carbon dioxide, methane, nitrous oxide, carbon); 6) water used for energy. These elements are all important factors in the EPA-developed game, "Generate: the Game of Energy Choices."

Dodder was then joined by classroom teacher Emma Refven of Durham Public Schools to describe the play of the game. (Refven co-authored reference #4 in our Fall 2021 issue to describe the game to readers of *The Science Teacher*.) Dodder and Refven explained that each team gets a grid and chooses energy pieces, labeled by primary energy sources, purchase and opportunity cost, the amount of energy produced, carbon dioxide emission, and air quality impacts. Purchasing a piece in round one costs the purchase cost and thirty times the annual cost. The purchase price in round two increases by thirty times the cost of carbon dioxide emissions. Each round presents new challenges (such as the carbon price) and opportunities (renewables and efficiency options). The goal is to power the grid for the least cost.

Generate is available at www.epa.gov/air-research/air-quality-and-energy-choice-stem-activities-educators. A virtual version is available with pieces on Jamboard. The 2021 updated version reflects the lower cost of solar and wind. A new Mobility game is also being developed.

The last part of the webinar was devoted to some of EPA's incentive programs. Melissa Anley-Mills described EPA challenges that offer cash prizes to winning entrants, listed at https://www.epa.gov/innovation/-epa-challenges-prizes. Sonia W. Tong Argso described one of these challenges — the EJVideo Challenge. Michael Band (from the EPA Office of Environmental Education) described awards for students and educattors and environmental education resources available at https://www.epa.gov/students. The website to subscribe to the Office of Environmental Education's listserv is https://www.epa.gov/education.

(*Editor's Note*: The second webinar in the series, featuring environmental educational materials from NOAA, was described in our Winter 2022 issue.)

Jungalwala

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Jungalwala's chart comparing Industrial and Postindustrial schools reminded me of the charts Karen Worth showed in describing the hoped-for effects of the National Science Education Standards (NSES) to the New York Academy of Science on 3 November 1995, as reported in our Winter 1996 issue (one is reprinted in the editorial for this issue, on page 3). Then I noticed that neither those standards nor their successor, the Next Generation Science Standards (NGSS), were listed among her "areas of growing concern." I thought, therefore, that at our Zoom meeting on 2 April 2022 I should ask her how she felt about the NSES or NGSS. I was surprised to learn that she had not become acquainted with them.

In response to a question by Nicole Harvey about retaining teachers, Jungalwala acknowledged that the role of the teacher has much added and needs redesigning and stated that teachers should receive six-figure salaries. C. J. Geraci of Phoenix, AZ, expressed concern about administrators with no teaching experience. And Donna Jones, who teaches at a private school, where students are "customers," expressed concern about a student wanting to drop a course because of not doing "A" work and wanting to Google answers when there is no way to short-cut learning. In response to the last, Jungalwala noted that student grades in America have divided into two categories, "A" and "not-A."

In a discussion of her Life Map, Jungalwala noted that "life happens *for* you, not *to* you." She also read a passage from "Pandemic as Portal" that the pandemic is an opportunity.

Dept. of Ed hosts webinar on *Call to Action*

The lead story in our Fall 2021 issue was *Call to Action for Science Education*, and on 25 March 2022 the U.S. Department of Education presented a webinar calling attention to why it was written, who wrote it, what has been done since, and what we can do in the future. The opening speaker, Mark Schneider, Director of the Department's Institute of Educational Sciences, noted that he had taught middle school science for 12 years and observed that science taught well opens eyes to the world around us. But it's often not taught well – or prioritized, he conceded. Noting the correlative importance of student motivation, he lamented the NAEP (National Association for Educational Progress) results which showed that 40% of high school seniors showed less than a basic level of understanding of science and emphasized the need to improve the science education of students before they reach the twelfth grade. It must be a national priority along with English and math, he asserted.

Prioritizing science education is a major theme of *Call to Action*, and this theme frequently surfaced in the comments made by the five speakers associated with the report, beginning with Heidi Schweingruber, Director of the Board on Science Education for the National Academies of Science, Engineering, and Medicine, who was also one of the four editors of the final report. Noting that *Call to Action* had been commissioned by the Carnegie Corporation of New York, she cited the report's emphasis that science thinking and understanding are important for all and need more curricular attention. She also noted that *Call to Action* championed the Next Generation Science Standards for K-12 and applauded the emergence of Active Learning in higher education.

Next, two members of the committee authoring *Call to Action* – Nancy Hopkins-Evans, of Instruction Partners, and Margaret Honey, President and CEO of the New York Hall of Science and Chair of the committee – presented an overview of their report. Hopkins-Evans began by stressing the report's emphasis on more equitable science education as a national priority, with emphasis on K -16 and the role of local communities and the concern that science could get lost in STEM, as indicated by the fact that the average time allocation in elementary school is only 20 minutes per day for science, as contrasted with 90 minutes for English/Language Arts, and 60 minutes for math. Honey continued the presentation with the recognition that elementary and middle schools attended mostly by students of color and from lower socioeconomic levels continued to have fewer hands-on experiences for their students and that their teachers were less experienced. At the high school level, 29% schools do not offer a course in biology, 42% do not offer a course in chemistry, and 59% do not offer a course in physics. At the college level, most STEM courses continue to be taught in lecture format. Science education must give students access to how scientists do their work rather than ask them to memorize information, Honey emphasized.

Honey next singled out the five priorities listed in *Call to Action*: the importance of time, materials, and resources; a strong diverse teaching workforce; supportive pathways to science; improved assessment and accountability systems; and documentation of progress. This last priority was also one of three items for taking action cited by Honey, the other two being formation of local and regional alliances and elevating the status of science education.

Jim Short of the Carnegie Corporation of New York, which commissioned and funded *Call to Action*, discussed other things that Carnegie Corporation is doing on behalf of science education. One of these is an open-source middle school science curriculum developed by a consortium of ten states and now available for adaptation and use at <www.openscied.org>. Erika Shugart, Executive Director of the National Science Teaching Association (NSTA), concluded the formal presentation by discussing NSTA's role in advocacy for quality science education.

The formal presentations were followed by a vigorous Q&A, which interested readers can access by going to www.ed.gov/stem, where all Department of Education webinars are archived.

SCI & SOC ED MEETINGS

21-23 July 2022. NSTA National Conference on Science Education, Chicago 22. Visit <http://www.nsta.org>.

24-28 July 2022. 2022 National Energy Conference for Educators, Albuquerque, NM. Visit <needorg.secure.force.com/event/home/2022nationalconference>.

Clearinghouse Update

From time to time we update our readers on situations which have been described in our *Newsletter*.

The Cost to Achieve Zero-Carbon Emissions

Mekala Krishman, a partner at the McKinsey Global Institute wrote on 11 March 2022 about the $275 trillion cost of achieving zero greenhouse gas emissions by 2050, as calculated in a larger report prepared by that institute (Resource #1, this issue). On 20 March 2022 the *Trenton Times* ran a follow-up article by Gernot Wagner of Bloomberg describing how and why we must do this.

U.S. Science and Engineering

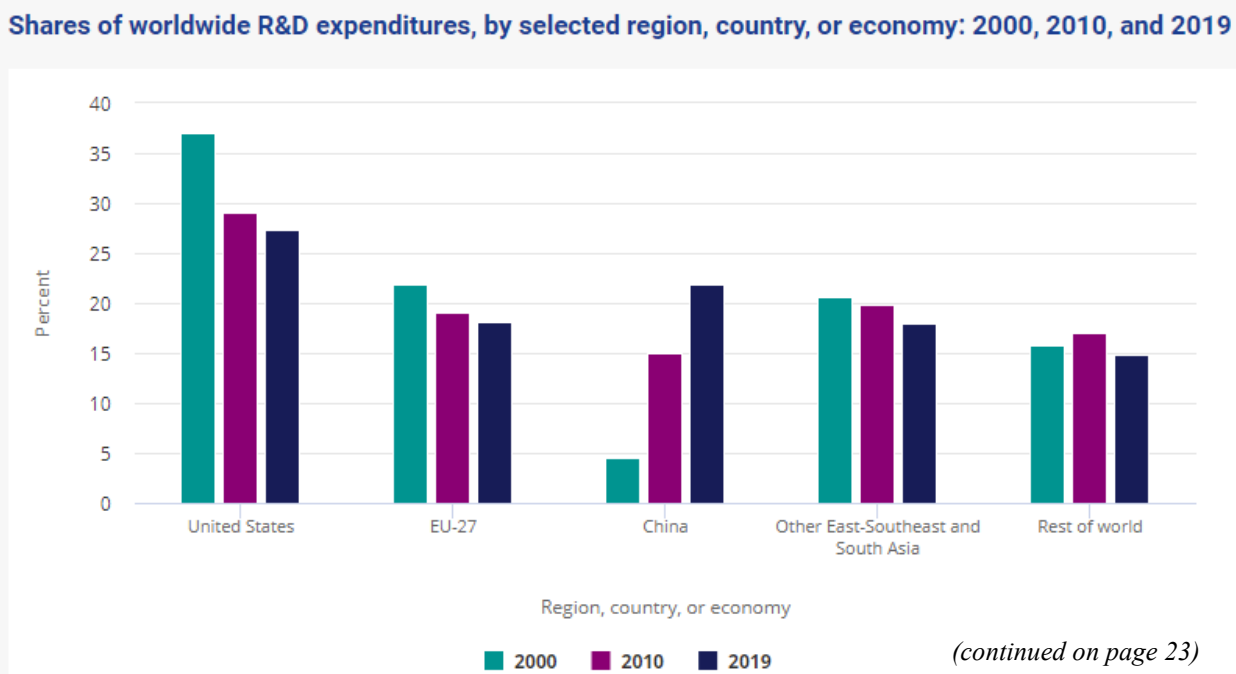
(continued from page 1)

Internationally, both India and China award more "first-university" (bachelor's) degrees than the U.S., followed by Brazil, Mexico, UK, Japan, Turkey, Germany, South Korea, and France. The 38,000 S&E doctorates China awarded in 2018 exceeded the 31,000 awarded by the U.S. But the U.S. hosts 18% of all international students, more than any other country, and they study S&E at higher rates than Americans.

The U.S. STEM workforce consists of 16 million workers with a bachelor's degree or higher and 20 million with less than a bachelor's degree. Although, as shown by the above graph, Blacks, Hispanics, and indigenous peoples are underrepresented in the group holding bachelor's and higher degrees, they are *not* underrepresented in the group with less than a bachelor's degree. Another group which is underrepresented in the STEM workforce is women. They comprise almost half the total workforce but only a third of the STEM workforce. The STEM workforce comprises 23% of the U.S. workforce, earns a higher median salary ($55 K rather than $33 K) and has lower unemployment (2% *vs*. 4%).

Confidence in scientists to act in the best interests of the public is quite high: 84% of U.S. adults rate their confidence as fair or high, and the percentage doing so increases with their level of education.

U.S. and Global Research and Development. The following graph shows that China's expenditures for research and development in the 21st century have far outpaced those of the rest of the world so that China's percentage of global research and development has skyrocketed while the percentages from everywhere else in the world have declined.



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New Technologies to Pave Way to Zero-C

An important necessity for achieving zero-carbon dioxide emissions by 2050 cited by Bill Gates in *How to Avoid a Climate Disaster* is the development of new technologies to achieve that goal. Notices of several have been received by the *Newsletter* since publication of our preceding issue. They can be grouped as follows:

Batteries are in important technology in a world in which everything possible is electrified.

From *New Atlas* on 27 February 2022 comes word that Monash University has developed a lithium-sulfur battery that controls the movement of polysulfides that form and had been a problem. This technology provides an alternative to lithium-ion batteries and their need for cobalt, manganese, and nickel.

Another report, from June 2022, states that Alsym is developing batteries that are "water-based" and don't use *any* lithium but use manganese and metal oxides.

Cement is the primary ingredient of concrete and the "second most widely used substance on Earth next to water," and making it emits carbon dioxide and requires high temperatures and large amounts of energy, as Gates singles out in his book.

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U.S. Science and Engineering

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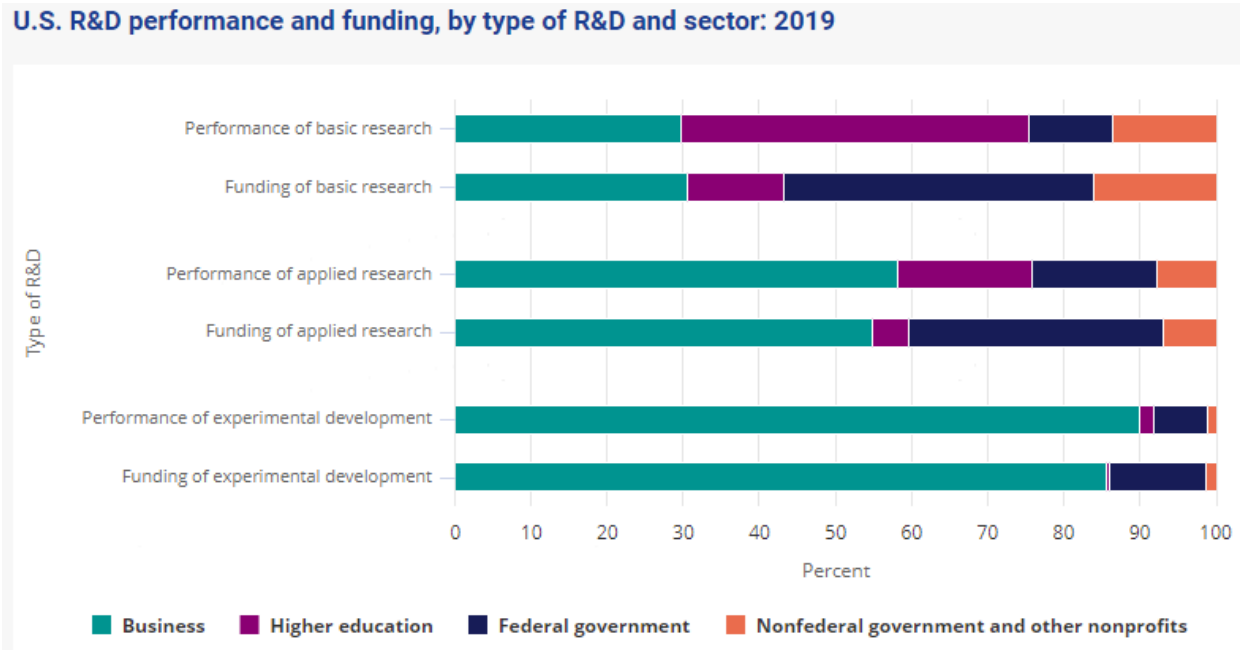
This research and development is distributed in three categories: 1) basic research, 2) applied research, and 3) experimental development. The following graph shows how the performance and funding of research and development is carried out among four sectors: business, higher education, the federal government, and other governments and nonprofits. It shows that the business sector funds essentially all its research and development. The federal government funds only 21% of research and development (down from 31% in 2010, when more was provided to business); but the federal government is the leading funder (41%) of basic research, most of which is done by higher education. Forty percent of the federal research and development funds were overseen by the Department of Defense, mostly for experimental development. The remainder went to the Departments of Health and Human Services, Energy, and Agriculture, also to NASA and NSF.



U.S. and Global Science and Technology Capabilities. These are indicated by publications, patents, and KTI (Knowledge and Technologically Intense) industry output.

As in the case of research and development expenditures, China has surged ahead in peer-reviewed publications, and in this case eclipsed America's lead in 2016. It now publishes 23% of the peer-reviewed S&E publications in the world, followed by the U.S. at 16%, India (5%), Germany (4%), UK (4%), and Japan (3%). China's publications are mostly in engineering, India's mostly in computer and information science. The other countries' publications are in the health sciences. These areas of emphasis give an indication of the priorities of these nations.

The importance of scientific publications is indicated by the number of citations they receive, as indicated by the index of cited articles. Here the U.S. has led with an index which has remained steady at 1.8, but the following table shows that the index of cited articles has increased for publications from elsewhere in the world.

Index	2000	2018
U.S.	1.8	1.8
EU	0.9	1.3
China	0.4	1.2
Japan	0.5	0.9
India	0.4	0.8

Japan's 2010 lead in international patents has now been supplanted by China, as the following table shows:

% of patents	2010	2020
Japan	35	15
China	16	49
U.S.	15	10
EU	12	8
S. Korea	10	11

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U.S. Science and Engineering

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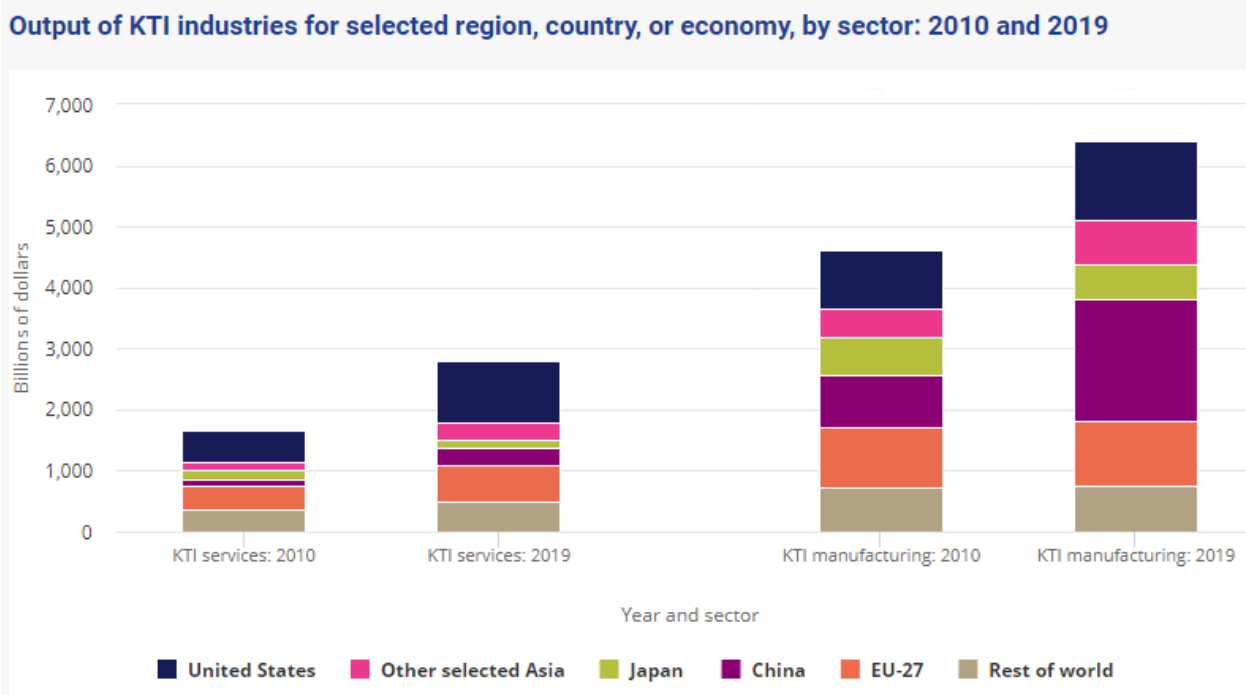
The output of the KTI industry is the third indicator of science and technology capabilities. It is divided into two sectors: services and manufacturing, the latter consisting of aircraft; computers; electronics and optics; pharmaceuticals; and other chemicals, transportation, and equipment, including scientific instruments. The following graph shows KTI services output and KTI manufacturing output in 2010 and 2019. Although it shows that the US maintains its lead in services, it shows that China has taken the lead in manufacturing (beginning in 2011) – from 18% in 2010 to 31% in 2019. But the U.S. still leads in aircraft, medical equipment, and pharmaceuticals.



In all sections of *The State of U.S. Science and Engineering* there are sidebars describing the effects of COVID, but most of the numerical comparisons in the report are of data from 2019 with data from earlier years in the century. The Preface to *The State of U.S. Science and Engineering* can be viewed online at <https://ncses.nsf.gov/pubs/nsb20221/preface>, from which all other sections can be accessed.

New Tech for zero-C

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According to the *The Real Deal* for 22 April 2022, Gates's Breakthrough Energy Ventures and DCVC have funded Brimstone Energy to develop zero-C Portland cement.

According to a 21 February 2022 report from Worcester Polytechnic Institute, researchers there have developed "self-healing Enzymatic Construction Material" which "provides a pathway to repair or even replace [traditional] concrete in the future." The enzyme carbonic anhydrase absorbs carbon dioxide in its manufacture.

A report in *Physics* on 22 April states that physicist Ankita Gangotra seeks to reduce concrete usage through 3D printing.

A 17 May 2022 report cites Heidelberg Cement's ReConcrete-360° recycling process, which "retrieves hardened cement paste from waste demolition concrete for use in place of limestone in clinker and cement production."

Hydrogen combusts with oxygen all too easily and thus requires careful handling. As a gas, it also occupies a lot of volume for the energy it can provide. But it is also one of the few portable fuels that don't emit carbon dioxide.

A report in *Smart Energy International* on 25 February 2022 describes Carbon 280's hydrogen-storing Hydrilite, "a non-toxic, non-reactive-metal dust suspended in mineral oil to which . . . hydrogen bonds as a hydride."

Another report, from 13 June 2022, describes the successful operation of a gas turbine with hydrogen gas in Norway.

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The Top Five Science Stories of 2021 according to Kaku

by Jack DePalma

Michio Kaku recounted on his 29 January 2022 radio show, "Explorations," what he felt were the top five science stories of 2021. The first story shared was of the omicron variant of COVID-19. The good news is that it seems the omicron mutation is less severe than the original COVID-19 virus was but that may be due to those many vaccinated and infected being less severely affected. However, the bad news is that omicron is a more infectious form of this novel respiratory virus; and when viruses spread among populations, they can (and maybe will again in this case) mutate into another variant which may become more deadly. How will the active virus evolve as it spreads among the vaccinated and unvaccinated alike worldwide? To allow the spread of the virus with no check could fill up the hospitals near and far with those very ill, mostly immunocompromised and the unvaccinated, including some children. To "let it rip" (as Kaku called the uncontrolled spread among the human herd) is not actually a plan. Although many here in the United States are vaccinated and boosted, it is not known if and how the possible next variant will affect the population. Will the pandemic become endemic? It seems we shall see but the novel coronavirus SARS CoV-2 has already killed many here and worldwide. Unmentioned by Kaku were the technologically advanced and mostly available vaccines developed and used in many places worldwide that have been proven to be safe and very effective against the most serious consequences of the novel COVID-19 virus. We need remain cautious and vigilant but that story has already been written in 2020.

The next story Kaku tells is the recent achievement in China of their experimental fusion device. It has recently attained energy break-even for a 17-minute period when operating at five times the temperature of the sun. This is in fact quite an achievement. Within the next decades fusion power seems ready to become available for energy production. Fusion requires such extreme conditions, a gaseous density with a very high temperature which is needed to maintain a controlled reaction in a near vacuum within a magnetic bottle. This was the challenge, and always near but never yet achieved. Fusion power production is still unrealized but now it seems soon will be reached in a sustained process. Fusion as an energy producer is, as Kaku emphasized, far superior to the other form of nuclear energy production. Nuclear fission power is very expensive and very dirty. Fissionable isotopes can also be used to build nuclear weapons. Fission power production is fundamentally dangerous in all stages of development and operation, and after spent fuel is removed and reactors decommissioned. That the USA (where nuclear fission was first achieved) still has no actual strategy developed or planned for the long-term storage of the hundreds of thousands of tons of high-level nuclear spent fuel and nuclear and radioactive waste byproducts is really a problem. Fusion reactors use ordinary water for fuel (hydrogen not uranium) and produce much, much less radioactive waste and byproducts. A fusion reactor if out of control will promptly shut down. Fusion cannot be used to produce nuclear bombs. Helium nuclei and neutrons are the only product besides energy in a fusion reaction. The ITER fusion device in France will soon be ready. When fired up in the next few years it is expected to achieve break-even fusion power production similar to the Chinese device. In this way copious energy resulting from fusion may finally be realized. Although all this may be in the future, an actual working device in the near term seems promising news indeed.

The third story reported on is about is the new 10 billion-dollar Webb space telescope. Launched recently in 2021, it is now at location far from Earth and seems to have unfolded properly. It now needs to become as cold as outer space. With seven times more light gathering ability (and in the infrared region) this is a major improvement over the Hubble Space Telescope. The Webb is a most modern telescope, representing the state of the art. Meant to look through space dust and to see through the clouds; to see the early, mostly dark nascent universe and to peer into the Galactic center. The Webb is designed to detect heat as it looks out into deep space; back into the earliest times. The Webb is looking for black holes and any indications of the first ever glimmers of distant light and thermal signals from the Big Bang. As it is able to see distant exoplanets, the Webb space telescope is prepared to take detailed photographs of over 500 planets outside the solar system.

The next top science story of 2021 clarifies and fact checks the many science fiction tales that have it that anti-matter is strange, exotic stuff. Specifically, how does anti-matter actually behave in gravity? Now it has been demonstrated that anti-matter does in fact act just like ordinary matter does; it shows that anti-matter will fall in gravity. Anti-matter does not exhibit anti-gravity. This story answers the question – does anti-matter behave similar to ordinary matter in gravity? Measured to an accuracy of one part in 100 million, it now seems sure that an anti-proton acts just like a proton does in gravity; it falls. Imaginative authors may have reversed that but experiments Kaku mentioned have demonstrated that anti-matter and matter do indeed act the same in the weakest force, gravity. So contrary to science fiction, conjecture and recent movies the results are in. Anti-matter may in fact have an opposite electric charge as its matter counterpart; but anti-matter acts just like ordinary matter in gravity.

Finally, Kaku reports, with mention of information and game theory and including the history lesson of the many

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RECOMMENDED SCIENCE AND SOCIETY EDUCATIONAL RESOURCES

1. Mekala Krishman, "The Anatomy of the net-zero transition," *Project Syndicate* (11 Mar 22).

Written by a partner at the McKinsey Global Institute, this article is based on a larger report prepared by that Institute and highlights "six key characteristics" of the transition to zero greenhouse gas emissions by 2050:

1) Universality
2) Significant economic shifts, requiring $275 trillion capital ($9.2 trillion per year, $3.5 trillion more than at present). The creation of 200 million new jobs and losing of 185 million old ones will require a lot of "worker reskilling."
3) Front-loading of policies and investments (up from 6.8% of GDP to 9% from 2026 to 2030)
4) Required greater investment in the developing world than in the developed world
5) Short-term risks, such as worker dislocation and stranded assets (retired before the end of their useful life)
6) Major opportunities.

2. Rowan M. Thomson, "Advancing equity, diversity, and inclusion: A how-to guide," *Phys. Today*, **75** (1), 42-49 (Jan 22).

Citing the same lack of equity, diversity, and inclusion (EDI) among physicists that Chandralekha Singh lamented in keynoting the IBM Quantum Educator Summit in August 2021 (see our Fall 2021 issue), Thomson points out that "the 'perturbation' (incremental) approach to EDI that the field has taken up to now has failed" and presents "eight ways that physicists can help to advance EDI." They would have EDI becoming a core principle operating at every level in the physics community.

3. Hannah Pell, Ryan Hearty, and David Allard, "Why did the Three Mile Island Unit 1 reactor close?" *Phys. Today*, **75**(6), 46-52 (Jun 22).

This article raises the problem posed by the shutdown of economically unsustainable nuclear reactors today that will be needed to generate greenhouse gas-free electricity in the future. This is what happened to the sister of the reactor whose partial meltdown in 1979 had held us on edge for weeks. Come 2017, Pennsylvania was producing natural gas from fracking underground shale so cheaply that TMI Unit 1 had become economically unviable, and this article tells the story of what happened. It also notes that a reactor in western Pennsylavnia was "rescued by legislative action" and states that New York, New Jersey, and Ohio had succeeded in maintaining nuclear reactors in operation by providing economic support for them (but does not acknowledge that even in New York and New Jersey there were premature reactor closures).

4. Esther M. Morgan-Ellis, "Virtual Community Singing During the COVID-19 Pandemic," *Am. Sci.*, **110** (1), 28-35 (Jan-Feb 22).

It was recognized early in the COVID-19 pandemic that group singing was a superspreader event, and this article describes what avid group singers did to cope with it. Because Zoom is plagued by long time delays (known as latency) and captures only one voice at a time, it could be used only for participants to mute themselves and sing along with a pre-recorded performance. But other technologies allowed participants to record their parts separately while listening to the accompaniment and have them assembled together into a "virtual choir," and TikTok and Facebook Live have allowed groups to layer their parts in, one at a time. Morgan-Ellis describes her own experiences as well as the results of interviews she conducted. As was the case with many of us, Zoom allowed her to connect with many others she would otherwise never have met.

Top Five Science Stories

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speculators who invested in the tulip bulb craze of Newton's day; here he tries to inform those choices we sometimes make; to help us to wisely decide by redirecting investors to be smarter, more informed, better citizens, to become socially sensitive, successful, and savvy investors. Kaku says that bitcoin may be nothing more than chance speculation with little or no redeeming social value, similar to those who invested blindly, seeking profit from tulip bulbs. Young folks speculate and will try to strike it rich. Older folks rather want to save and build and to not lose the whole stack in one roll of the dice. But which choice is best in the long run; and best for the social contract too? Kaku here suggests stocks when purchased as investments, beside hopefully generating profits over time, do hold additional value beyond the profits garnered, a redeeming social value. Money when shared acts not just as a chance gamble but is used to make something real through investing in a real thing, like supporting a charity with a raffle and mortgages used to purchase houses with borrowed funds. This builds society and trust and pays off to both investor and borrower. Kaku holds that bitcoin (and similar crypto-currencies) like other similar speculative bubbles similar to tulip bulb speculation are different. Is there any redeeming value to this type of activity, he asks? Products produced using capital will add value to society and increase trust in con-

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REVIEWS OF SCIENCE AND SOCIETY EDUCATIONAL RESOURCES

Kate Moore, *The Radium Girls* (SourcebookseXplore, Naperville (IL), 2020).

This book is the young adult version of Kate Moore's *The Radium Girls: The Dark Story of America's Shining Women*, published in 2017. It is an enthralling but barely-known account of numerous young women who unknowingly went to work in factories that were producing dial watches and other products utilizing radium, a substance not then classified as dangerous and harmful. As a result, these individuals became very ill, suffered greatly and often died of radium poisoning, a diagnosis consciously overlooked or avoided by prominent physicians.

The book highlights and captures their long struggle and fight against the heads of factories and corporations to get their cases not only heard in the legal system but also recognized in the media. I strongly recommend it to everyone as it is an insightful lens into myriad products coming into the market economy without careful scrutiny or investigation that in some cases may be powerful and successful remedies for specific procedures but may also cause great harm to humanity.

If I were in the classroom today, I would have no hesitation cajoling my colleagues to assign this book to their students no matter what subject they are teaching. Although I have not yet read the adult version of this moral tragedy, I was so moved and intrigued by the young girls' stories in this young adult version that I felt compelled to write this review for the Clearinghouse *Newsletter.*

- Bernice Hauser

Dave Levitan, *Not A Scientist: How Politicians Mistake, Misrepresent, and Utterly Mangle Science* (Norton, New York, 2017). 256 pp. $15.95 (paper) ISBN 978-0393353327.

This book consists of descriptions of strategies employed by politicians to describe a science topic they oppose. In the Foreword the author describes the strategies as scientific errors and fabrications. In his Introduction Levitan describes information about the Mt. St. Helens eruption in 1980, as presented by President Ronald Reagan. Reagan began by saying, "I'm not a scientist…," a sure sign that what he was about to say had no basis in fact. Reagan continued, "That one little mountain out there has probably released more sulfur dioxide into the atmosphere of the world than has been released in the last ten years of automobile driving…" Levitan points out that Reagan was off by a factor of 40: Mt. St. Helens emitted 2,000 tons of SO_2 each day; human sources in the U.S. 81,000 tons each day!

There are twelve chapters in the book, each describing a fabrication or scientific error employed by politicians, and advice about how to identify them. This review will present six of them. The second chapter is titled "The Cherry-Pick." This strategy involves using just one data point as proof of a fact. One of the examples Levitan cites involves a 2015 quote from Senator Ted Cruz (R-TX). Cruz, speaking on the topic of the climate emergency, began his presentation by saying, "The satellite data demonstrate that there has been no significant warming in 17 years." What Cruz conveniently overlooked was that the data he was describing indicate that there was a reduction in the *rate* of warming, not in the warming itself. Identifying satellite data in particular identifies Cruz's statement as a cherry-pick. Levitan indicates that there is a network of thousands of land-based temperature stations. These and other monitoring stations are used to gather a multitude of data points used to monitor the temperature of the planet. The time scale used by Cruz was also a cherry-pick. It is the longer, more general trends in the data that count. Levitan cites other examples of cherry-picking by politicians, including former Alaska governor Sarah Palin, addressing the issue of receding glaciers.

Chapter 4 provides information about a strategy called "Butter-Up and Undercut." This strategy was employed by President G.W. Bush in dealing with the National Institutes of Health (NIH). During the Avian Flu, described by Levitan as a near miss to a pandemic, Bush praised the work of the NIH, saying, "The people who work here are really important to the security of this nation." Bush followed his verbal support with NIH funding that barely kept up with inflation, vetoing a bill that would have added one billion dollars to NIH funding. Levitan writes, "The Butter-Up and Undercut is among the most nefarious of the errors and rhetorical devices explored in this book."

The "Literal Nitpic" involves denying causality. Levitan presents the example of Senator James Inhofe (R-OK), stating that there has never been groundwater contamination as a result of hydraulic fracturing in his state. The situation, however, is that oil companies are not required to disclose the chemicals that are used in the fracking process. If you don't know what chemicals are being used, you can't identify the fracking fluid as the source of contamination. Inhofe's statement identified hydraulic fracking, leaving out all the other steps involved in the fracking process. A NitPic! Legalizing marijuana for medical use has also been a topic that has been nitpicked. Levitan advices, "To fight back against the literal nitpic, look carefully at word choice, as well as the specifics and details of the argument."

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Politicians employing the "Certain Uncertainty" want 100 percent proof of cause before a scientific problem is addressed. This is the tactic that has been used to deny action on the climate emergency. Consider the following examples:

- from G.W. Bush in a political debate in 2000: "Look, global warming needs to be taken very seriously, and I take it seriously. But science, there's a lot - there's differing opinions. And before we react I think it is best to have the full accounting, full understanding of what's taking place."

- and a quote from G.W.s brother, Jeb Bush: "I don't think the science is clear of what percentage is man-made and what percentage is natural. I just don't - it's convoluted. And for the people to say the science is decided on this is just really arrogant, to be honest with you."

- and a quote from Senator Marco Rubio (R-FL): "I believe the climate is changing because there has never been a moment where the climate is not changing. The question is, what percentage of that… is due to human activity?"

Levitan concludes that "With regard to scientific issues, elected officials pick and choose when to argue that uncertainty is both present and important, and the decision has rarely had anything to do with the actual state of research in that field."

In chapter 11, Levitan identifies "Lost in Translation" as a tactic used by politicians to defend their losing positions. He identifies a rule that can be used to evaluate scientific statements of any type: if something sounds completely outlandish, it probably is. Levitan writes of the details of what Senator Rand Paul (R-KY) identified as EPA overreach. The story is about the imprisonment of a man in Mississippi who, according to Paul, was jailed for 10 years because the man was convicted of putting dirt on his own land. That certainly sounds outlandish! When the facts in the case are examined, Paul's claim was found to be outlandish. Levitan lists all the facts in the case, completely refuting Senator Paul's description. The case actually involved corruption involving construction of low-cost housing. Paul's description was made outlandish as a means to falsely identify overreach on the part of the EPA.

In chapter 12, the "Straight-Up Fabrication" is explained by Levitan. He uses a number of examples, and my favorite involves former Arkansas governor Mike Huckabee, speaking in an interview while he was running for the Republican nomination for president. Asked whether man contributes to global warming, Huckabee responded, "He probably does, but a volcano, in one blast, will contribute more than 100 years of human activity. So when people are worried about it - you know?" It sounds like a fabrication, and it was!

Levitan concludes his book by writing, "As they have told you many times by now, your elected officials are not scientists. Keep that in mind as they try to sneak their not-science past you." The book is enjoyable to read and presents much valuable information. It may be something we will want to keep close as we head into another political campaign filled with those who are obviously not scientists and work hard at misrepresenting scientific facts.

- Frank Lock

(*Editor's Note*: Frank Lock is a retired high school physics teacher and Climate Reality Project Leader and Mentor.)

Amanda Ripley, *The Smartest Kids in the World and How They Got That Way* (Simon & Schuster, New York, 2013). 306 pp. $8.80. ISBN 978-1451654424

When I started reading this book, I was unhappy that it took me nine years to discover it. I pay close attention to education issues, and when I saw the book title, I was immediately drawn to it. I took extensive notes as I read, as the book is full of valuable information, particularly about the Program for International Student Assessment (PISA).

The first chapter tells how the PISA originated. While studying physics at the University of Hamburg, Germany, Andreas Schleicher became interested in education assessment. He wondered what might happen if an education assessment of what kids around the world knew was done, while controlling for the effect of things like race or poverty. Schleicher collaborated with Thomas Neville Postlethwaite, an educational scientist, to develop the first international reading test. This led to the administration of the first PISA, in the spring of 2000. The assessment was designed to be completed in two hours, and students in forty-three countries participated. It was developed by the Organization for Economic Co-operation and Development (OECD) and managed by Schleicher. Ripley indicates that the test was designed "to measure teenagers' ability to think critically, and solve new problems in math, reading, and science."

Educators from every country had helped to develop the assessment, and the rankings of that first assessment were announced in December 2001. Finland was ranked highest. German students performed below average for the developed world in all three subjects assessed, much to the dismay of German education officials. Students in the U.S. ranked below students in Canada. The U.S. education secretary vowed that "The No Child Left Behind

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reform legislation would improve America's standing." His forecast was wrong, as the performance of U.S. students remained the same in every round of the PISA.

Ripley met with Schleicher in 2010 and quotes him as saying, "PISA is not a traditional school test, it's actually challenging because you have to think. PISA (is) radically different (from) any other test." Ripley decided to complete the assessment, to learn what the PISA is like. Information about the assessment is included in her book. She writes that she graded her own test, and that "Smart tests usually have to be graded by humans." Her experience convinced her that the PISA measures critical thinking skills. She writes, "Economists had found an almost one-to-one match between PISA scores and a nation's long-term economic growth."

Ripley writes that U.S, students had scored twenty-sixth in math on the international test, and that, "Math is a language of logic. Mastering the language of logic helps to imbed higher order habits in kids' minds: the ability to reason, for example, to detect patterns and to make informed guesses."

Ripley describes the experience of three exchange students from the U.S. – in Finland, South Korea, and Poland. She learned that in Poland, students were not allowed to use calculators in class. As a result, students were doing a lot of math in their minds. She writes, "It was the difference between being fluent in a language and not." She also learned that students' grades on tests were announced publicly. Learning from failure on challenging work was being encouraged.

In examining the quality of U.S. textbooks compared with international texts, Ripley notes that internationally, the average eighth grade math text is 225 pages, while U.S. eighth grade math texts averaged 800 pages! The international texts addressed fewer topics, and addressed them in depth. In writing about the experiences of the U.S. students in the countries in which they temporarily resided, she describes a situation involving a "stoned kid" in a school in Finland. Despite the addiction of the student, he was still a model student, unlike similar students in U.S. schools.

Ripley describes the high quality of teachers in Finland as being due to the challenging qualifications required for teaching certification. She found that the teacher-training colleges in Finland were as selective as Georgetown, UC-Berkeley, or MIT. Finnish pre-service teachers completed their training with a full year of in-service with three mentor teachers. She concludes that in comparison, U.S. teacher-training programs are "A bit like recruiting flight instructors who had never successfully landed a plane, then wondering why so many planes were crashing." Ripley uses my favorite word to describe the rebooting of Finnish education – *modernizing*. The Fins didn't reform their system, they *modernized* it. The transformation that took place in Finland was wonderful to read about. Ripley's description of the experience of a Finnish exchange student in a U.S. school in Michigan is also fascinating to read.

Getting a quality education in Finland and South Korea is described by Ripley as "a serious quest, more important than sports or self-esteem." She also writes, "In these countries, people thought learning was so important that only the most educated, high-achieving citizens could be allowed to do the teaching." Included is information about the relationship between completing the survey that accompanies the test and performance on the test. This seems to result from diligence, persistence, and conscientiousness on the part of the students.

Ripley describes how, despite the challenges faced by the Polish people, Poland went from below average on the PISA to above average, from 2000 to 2006, while the scores of U.S. students remained flat. The education leaders in Poland replaced the "dumbed-down mandates that had forced teachers to cover too many topics too briefly," with a new core curriculum, that laid out fundamental goals and left the details to the schools. Testing was designed to provide help where it was needed by students, teachers, and schools. The education leadership viewed the PISA as a rational, sophisticated tool. The scores from 2003 were encouraging. Polish 15-year-olds ranked above 15-year-olds in the U.S. Ripley reports that by 2009 "Poland was outperforming the U.S. in math and science." Despite the fact that the poorest kids in Poland were worse off than those in the U.S., they outscored their counterparts in the U.S.

Among the Education Superpowers, funding was tied to need – the more remote or disadvantaged the school, the more funding it received. Ripley reports a lack of high-tech tools in high-achieving schools. She also indicates that sports programs were not associated with those schools, "There was no confusion about what school was for – or what mattered to kids' life chances. (Polish school principals) did not have to spend time worrying about whether the new math teacher could also coach baseball."

In describing the matriculation exam used by Finland, which is used to determine where students would likely go to college, Ripley writes, "The test had been around for more than 160 years and was deeply imbedded in the system. The countries with the best education outcomes all had these tests at the end of high school." Finland's exam stretched out about 50 hours over three weeks," and, "Teenagers from countries with these kinds of tests performed over sixteen points higher on PISA than those countries without them."

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In addressing the issue of diversity, Ripley indicates that "The U.S. closely tracked the race of students because of its history of institutionalized racism; other countries did not, which made comparisons difficult." Her analysis of the performance of African-American students on PISA is striking, but not surprising. She writes, "African-American kids were more likely to encounter inferior teaching and lower expectations in school, and they were disproportionately tracked into the lowest groups for reading and math lessons." One of the causes of segregation in U.S. schools is the use of local property taxes to fund local schools. In educating our children using that funding strategy, the rich get richer, and the poor get whatever is left! As a PhysTEC Teacher-in-Residence for three years, I was appalled at the degree to which the schools I visited are segregated. It is interesting to read of what goes on in the highly successful Singapore education system, which Ripley describes as "(being) another planet compared to most countries."

In writing about the importance of excellent school leadership, Ripley quotes a teacher as saying, "(The principal) knows what to do. I feel like I am trusted. And every time I need help, I can trust she will help me." She also indicates that there are no private schools in Finland, and no vouchers or charter schools.

Ripley includes an interesting illustration comparing American states with other countries on the basis of math scores, reproduced below, to begin a chapter titled "coming home."

The United States Revisited: If states were countries, which countries would they be? (Map derived from analysis of math performance across states and countries in Peterson et al., Globally Challenged.)

This book includes excellent appendices, including one titled "how to spot a world-class education." There is no question in this reviewer's mind that anyone and everyone concerned with U.S. public education must read this book. The U.S. education system is beyond reform. Reform has been tried since 1983. The system must be *modernized,* using lessons learned from countries that have gone through the process!

\- Frank Lock

Ted Dintersmith, *What School Could Be* (Princeton, Princeton, 2018). xxvii + 234 pp. ISBN 978-0-578-50443-8.

Ted Dintersmith had already provided his vision of "what school could be" when he produced his documentary *Most Likely to Succeed* and the companion book he wrote with Tony Wagner, and he contrasts this with the type of school set up in 1893 in the following table found on page 216 of this book:

1893	New Vision
Industrial	Innovative
Centralized	Decentralized
Data-driven	Purpose-driven
Micromanaged Classrooms	Trusted Classrooms
Standardized Curriculum	Organic Learning
Drill	Create
Content and Low-level Skills	Essential Skill Sets and Mind-sets
College Ready	Life Ready

But Dintersmith felt that he didn't have any answers for how people who were attracted to his ideas could similarly transform their own schools. So, as he explains in the prologue to this book, he spent the academic year 2015-2016 searching for these answers – 245 nights in hotel rooms, 68 TSA pat-downs, 100 community forums, 200 school visits, and 1000 meetings – "organized by Riverwood Strategies, experts in advance planning for campaigns." (p. xxv)

Dintersmith reports that he found students thriving where they could develop Purpose, Essentials, Agency, and Knowledge, what he calls the "PEAK Principles" (p. xx), to which he refers repeatedly in relating the experience of his travels, which he organizes topically rather than chronologically, with the following chapter titles.

"Conventional Schools and Their Contexts." Dintersmith's first visit was to a conventional school he calls "Eisenhower High," a product of the system set up in 1893 in anticipation of a transition to an industrial economy. With 10% federal funding, 50% state funding, and 40% local funding, this system served the industrial

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economy well. But Dintersmith counters that in today's innovation economy we need to teach students to leverage machine intelligence, not to replicate it by testing students' abilty to memorize. He introduces us to Doug Lyons, who "calls college admissions the 'elephant in the room' that blocks high school innovation" (p. 17) and "AP courses as 'mountains of content minutiae.'" (p. 17) Lyons instead advocates having students learn by working together on real-world challenges.

"Real Gold amid Fool's Gold." Amid the "Fool's Gold" of conventional education, Dintersmith found the "Real Gold" of innovative education in such diverse locations as Fort Wayne, IN; Sitka, AK; Dunbar, WV; Charleston, SC; Fargo, ND; Reno, NV; Grand Rapids and Adrian, MI; and Austin, TX. Among the commonalities I noticed were 1) enthusiasm and quick learning of the youngest students, and 2) interest stimulated by making things. Commonalities highlighted by Dintersmith were the PEAK principles.

"Prepared for What." Although college has become "*the* goal for *all* students," (p. 45) "the dream" (p. 46) (instead of the means to it), and the goal of life (rather than preparation for it), Dintersmith did encounter programs channeling students (who were turned off by college readiness) toward career readiness – in such diverse locations as Cheyenne, WY; Charlotte, NC: Albuquerque, NM; Helena, MT; and Jackson, MS. Yet he laments that an AP student is more respected than a CTE student. He buttresses his point by citing that Lawrenceville Academy students could not pass in the fall the final exams they had taken the preceding spring. He adds that "higher-order competencies like creativity, communication, critical analysis, collaboration, leadership, tenacity, and entrepreneurship" (p. 64) can't be measured by standardized tests. Dintersmith is heartened by the prospect that the Coalition for Access application platform will accommodate a digital portfolio, also by the "Mastery Transcript," which "replaces subjects with critical skills, grades with levels of mastery, and test scores with authentic portfolios of student work." (p. 68) By reflecting student ability to think as well as memorize, these approaches will foster teaching what Dintersmith calls "hirable proficiencies" (p. 70) as well as preparing students for college. If college is no longer the only possible outcome of a high school education, its value in students' lives would have different significance.

"The Ivory Tower." That Richard Arum and Josipa Roksa found "no statistically significant gains in critical thinking, complex reasoning, and writing skills for at least 45%" (p. 72) of the 2300 undergraduates they studied in *Academically Adrift* causes Dintersmith to call into question the present value of a college education, rating it "problematic" in 2017, a downgrade from "excellent" four decades earlier in providing a path to a good job – while its cost had increased by almost a factor of 20 and at a rate twice that of medical care. He advocates pushing "higher education to better meet the needs of our students instead of pushing our students to better meet the needs of higher education" (p. 86) – and at Arizona State University and Evergreen State College (WA) he found efforts to do that.

"Letting Go." In the shortest chapter of the book, Dintersmith acknowledges that both parents and teachers need to become decreasingly necessary in the lives of our children and students. Here he discusses the example of an understanding mother who had home-schooled a son who had a good sense of what he wanted.

"Social Equity." The dichotomy between high- and low-income parents, which also reflects the degree to which they are involved in their children's education, also translates into what has become the "achievement gap" between whites and Blacks and Hispanics. Measured by standardized tests, it has remained static since at least 1986. Dintersmith writes that we "dwell on the wrong 'achievement' and the wrong 'gap.' Achievement should be based on challenging real-world problems, not standardized tests." (p. 125) He recalls receiving news of the decision in *Fisher v. University of Texas at Austin* while visiting Selma, AL. It said that the Texas law to admit the top 10% of all Texas graduating classes discriminated against students from schools with higher test scores; this decision reawakened in him the realization that "college is by, for, and of the affluent." (p. 122)

"Human Potential." Early in his book Dintersmith writes that "the purpose of U.S. education is to rank human potential." (p. xx) Instead, he argues, schools should be *developing* human potential, and in this chapter he gives examples of doing that from such diverse places as Salt Lake City, UT; Little Rock and Fort Smith, AR; Williamsburg, VA; Coachella Valley, CA; BoysTown (now in 12 locations), Nashville, TN; and Portland, OR.

"Doing (Obsolete) Things Better." Even doing something known not to be effective "better" should result in the same problems, and Dintersmith shows this with a "test-and-measure strategy" in post-Katrina New Orleans; "more charter schools, better test scores, more kids into college" (p. 156) in Colorado; the chaos in Milwaukee from giving parents the option of choosing their children's schools; the disruption with which former Teach for America executive Kevin Huffman improved test scores as TN commissioner of education; and the chief of staff to FL Governor Rick Scott likening educating a child to fixing a car. In addition, Dintersmith was invited to a 2015 White House Summit on next-generation high schools and was put off by the recommendation to make calculus available to all students. Instead of teach-

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At the Global Supply Chain Sustainability Summit

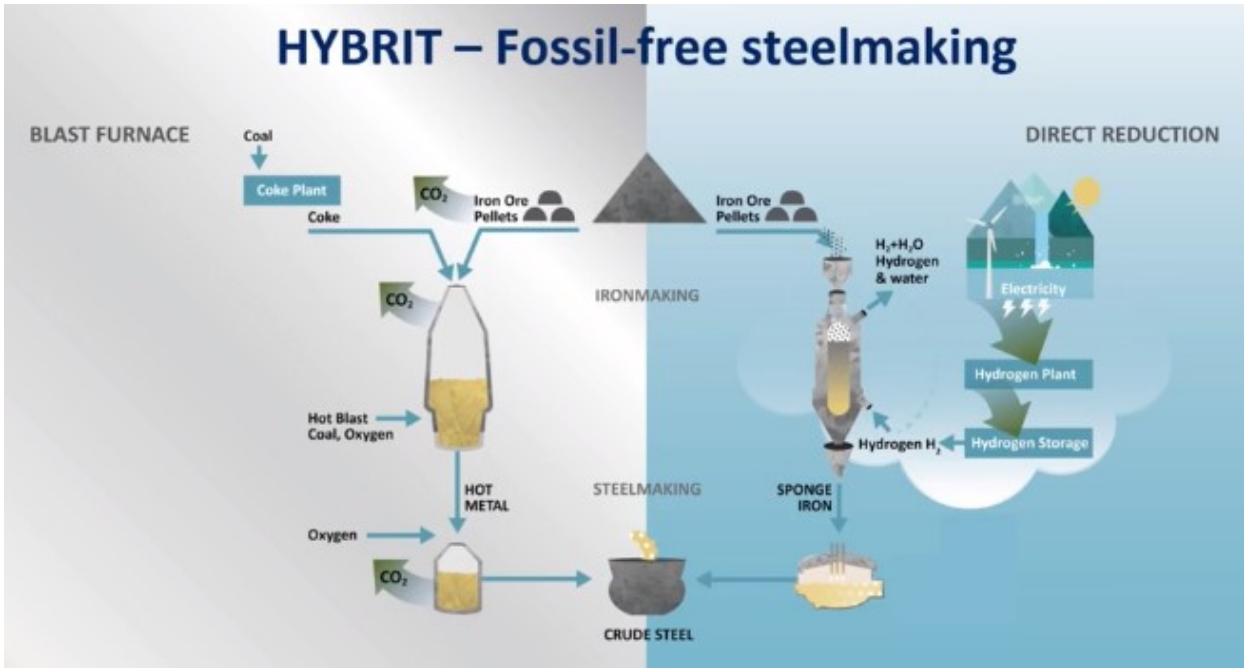
by John L. Roeder

On its website FourKites bills itself as "the #1 global supply chain visibility platform." On 9 March 2022 they hosted an online Global Supply Chain Sustainability Summit aired from The Netherlands. I was one of four thousand two hundred and twenty persons who accepted their invitation to participate in it. The focus was mostly on sustainability, albeit in the context of the global supply chain, especially the role of "logistics," which seems to be the global supply chain industry's way of referring to the movement of things.

This focus on sustainability was apparent from the beginning of the opening keynote, "Prototyping the World of Tomorrow," by Dutch artist and sustainability innovator Daan Roosegaarde. "If we cannot imagine a better future, we cannot create it" is the way he greeted us, before showing us a series of examples of sustainability: 1) the Van Gogh-Roosegaarde bicycle path, lit at night by lights which are energized by the sun during the day; 2) the addition of reflectors to buildings so that auto headlight reflections delineate them by night; 3) a sanitizing cone of 222 nm ultraviolet light, which sanitizes without inducing cancer; 4) fireworks called "sparks," made of naturally glowing material without adding to air pollution; and 5) switching off city lights to be able to see the stars and eliminate light pollution. "We can improve the world step by step if we invest in new ideas," Roosegaarde concluded.

Next on the program was a panel discussion on "Collaborating with Customs and Partners for a Greener Supply Chain." On participant was Donal Daly, whose background was artificial intelligence. He founded Future Planet to guide future sustainability growth as the result of his son's asking him about his concern for the future. "Nobody wants to see the planet burn," Daly said, also opining that "people are basically good." The main problem in achieving a sustainable transformation journey, he felt, was the lack of a platform infused with sustainability knowledge. A particular takeaway from what he had to say were his "9Rs of circularity" (alluding to the idea of a "circular economy," in which waste is eliminated): Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Repurpose, Recycle, Recover – designed, he said, to give people other things to think about before reducing.

Another participant on that panel was Thomas Hörnfeldt, from the steel-producing SSAB Group in Sweden and Finland, which, he said, had an abundance of hydroelectric and nuclear power. Carbon dioxide emissions can be eliminated from power generation, he said, by changing the fuel. Eliminating them from industry requires changing the way steam is made. His company aims to produce fossil-free steel by 2026; but steelmaking completely without carbon dioxide would have to await 2045, because of the use of carbon in the form of coke to reduce the iron in ore in a chemical reaction which emits carbon dioxide. These carbon dioxide emissions would be eliminated from steel production by replacing carbon as a reducing agent by hydrogen made by solar electrolysis of water, as shown in the following visual which Hörnfeldt presented:



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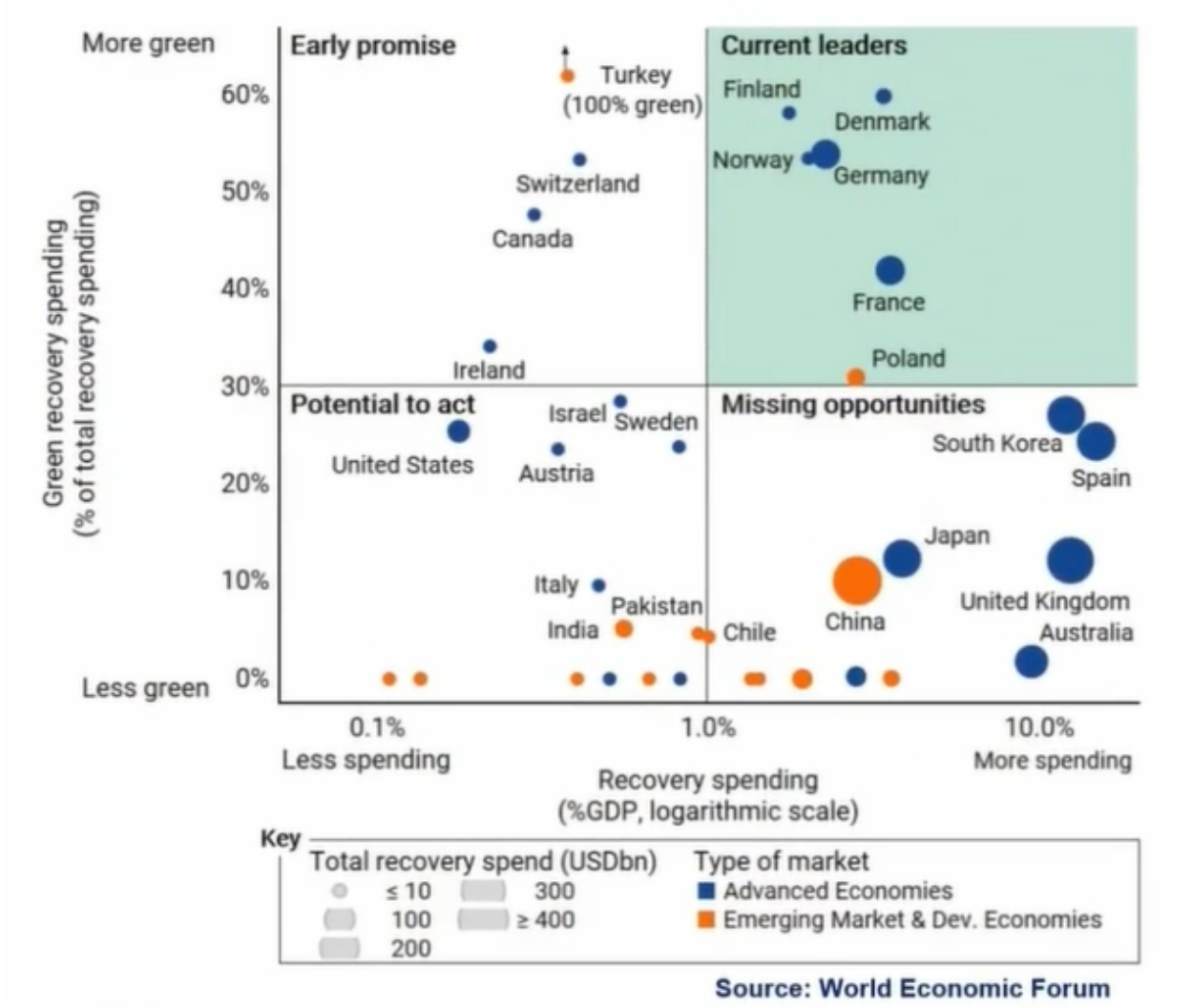
In the next panel presentation, "Crawl, Walk, Run: Developing Your Framework for Sustainability," Ylani DeNave of AB InBev had occasion to refer to three of Daly's 9Rs in assessing how to reduce greenhouse gas emissions from the operation of AB InBev's 200 breweries worldwide: 12.5% from agriculture, 5.1% from processing ingredients, 38.1% from packaging, 12.3% from brewing, 9.4% from logistics, 20.2% from cooling, and 2.4% from end-of-product life. The goal is to eliminate greenhouse gas emissions from brewing operations by 2030 (through Reduction, Replacement, and Rethinking) and all greenhouse gas emissions by 2040 (by, among other things, using hydrogen to fuel delivery trucks).

On the same panel, Paul Avampato, International Head of Logistics for Laundry and Home Care for Henkel (which also provides adhesive technology and beauty care) reported 50% reduction in carbon dioxide emissions and 28% reduction in water used by his company since 2010, also an 18% increase in recycled plastic.

Bart De Muyack of Gartner gave a comprehensive presentation on "State of Sustainability in Supply Chain." He began by listing three 2022 sustainability trends: 1) responding to climate change, 2) resource preservation and availability, and 3) the strategic application of technology.

He then presented the following visual, which categorized countries by their percentage of green recovery spending *vs.* their recovery spending as percentage of GDP:



Source: World Economic Forum

Sustainability in the supply chain is driven by four parties: consumers, governments, shippers, and carriers, De Muynck said. To foster it, the Global Logistics Emissions Council was established in 2014, and in 2023 the European Green Deal is implementing its Corporate Sustainability Reporting Directive, he added. He went on to list the benefits of sustainability in the supply chain: 1) improving brand image, 2) reducing greenhouse gas emissions, 3) reducing local environmental impact, 4)

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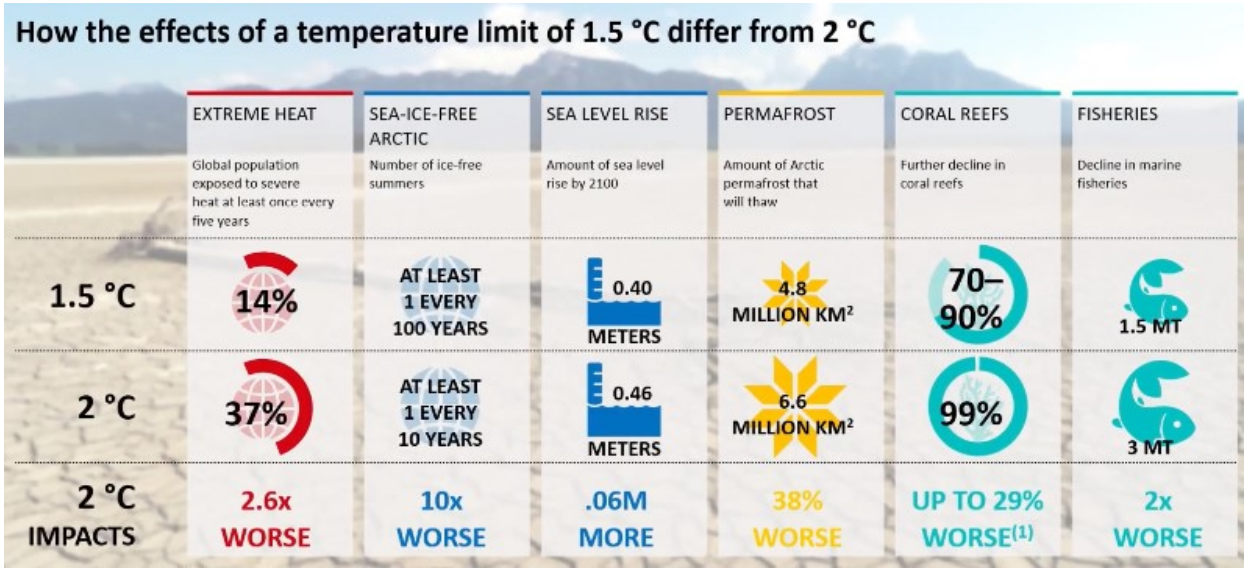
improving profitability, 5) winning or retaining business, and 6) reducing transportation fuel cost.

De Muynck highlighted this last benefit, noting that transportation is a big greenhouse emitter but that reductions in those emissions had not paralleled reductions in other sectors. Road transportation accounted for 71% of emissions from transportation, he added, but this mode of transportation is decarbonizing more rapidly than other modes. Autonomous electric trucks are more efficient than human-driven trucks, he stated (one of his photos showed an electric truck, drawing its electricity from overhead wires), and electric vehicles are increasing for the first mile, middle mile, and last mile. Moreover, the last mile could be delivered by robots or delivery bikes.

At another panel presentation, "The Road (or Rail, or Ship) to Sustainable Logistics Operations," Johnny Ivanyi of Bayer presented a 2030 goal of "climate neutrality," but it called for only 12% reduction in emissions from transportation, which accounts for 82% of their emissions. Tabita Verberg reported that Dow aims to cut their greenhouse gas emissions back to the 2006 level by 2025 and *aspires* to be carbon-neutral by 2050. Other speakers indicated that their companies are just getting started. As Mark Binns from the Hoyer Group said in the panel discussion of "Sustainability That Works. Practical Lessons from the Carrier Community," "People are willing, but don't know how." But in the "Supply Chain Tech Power Panel on Sustainability," which spent a lot of time discussing how to overcome barriers to sharing data, discussants Stanton Thomas of o9 Solutions, Inc., Erik Lund of SONY Network Communications Europe, and Francesca Poggioli of GS1were generally optimistic about dealing with climate change, Poggioli and Thomas because of the intensity of concern about it, Lund because companies see it as good for business. Dr. Nick Vyas, moderator of this panel, stated that "Sustainability is not an option."

The final keynote presentation, by Florian Schwartz of Deutsche Post DHL, "Sustainability at Massive Scale: DHL's Journey to Net Zero," was very substantive. Schwartz divided his presentation into six sections, as follows:

Humankind's Impact on Our Planet. Schwartz opened by saying that "our planet has a fever," and presented the following visual to show how the consequences differed for a temperature increase of 1.5°C and 2°C:



"The planet doesn't need us," he said, "but we need our planet."

The world emitted 49.4 billion tons of carbon dioxide equivalent in 2019, Schwartz went on – 18.4% from agriculture, forestry, and land use; 3.2% from waste; 5.3% from industry; and 73.2% from energy used. The breakdown from energy use is 24.2% from industry; 17.5% from buildings (10.9% residential, 6.6% commercial); and 16.2% from transportation (11.9% on the road, 1.9% from aviation, 1.7% from shipping). He then listed the emissions from countries in the European Union (EU), the top six being 809.799 megatons from Germany, 453.101 from the UK, 442.995 from France, 418.281 from Italy, 390.745 from Poland, and 314.529 from Spain. All the other EU countries emit less than 200 megatons, and Schwartz reported that DHL is between Croatia and Slovakia at 33.2 megatons.

Logistics Emissions and DPDHL's Share. DHL's emissions are 23.9% from internal operations, 0.6% from

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electricity (a small percentage because most of their electricity is "green"), and 75.5% from work with suppliers. By transportation mode they break down to 66.0% by air, 22.0% by road, 10.0% by sea, and 2.0% from buildings.

DPDHL's Roadmap to Net Zero. Schwartz reported that DHL has done the following so far: 1) achieved the goal to increase carbon efficiency relative to 2007 by 10% by 2010, two years ahead of schedule; 2) started a fleet of electric vehicles in 2015; 3) improved carbon efficiency relative to 2007 by 30% by 2016; 4) brought out a new sustainability roadmap in 2021, addressing all three areas of sustainability (environment, safety, and governance). Their goal is to reduce greenhouse gas emissions to 29 megatons by 2030 (which would otherwise be expected to increase to 46 megatons), through investing 7 billion Euros to achieve the use of more than 30% sustainable aviation fuels, 60% electrification of last mile delivery and more than 30% sustainable fuels on the road, carbon-neutral design in buildings, and increased use of sustainable marine fuels. To reduce this to zero by 2050 requires newer clean fuels in addition to the greater efficiencies already achieved, initially with biofuels but eventually with electricity and synthetic and hydrogen fuels.

Examples of Products and Pilots. Schwartz reported that DHL's GOGREEN Product and Solution Portfolio consists of 1) Clean Fuel and Technology, 2) Offsetting, 3) Efficiency, and 4) Circular Economy. Among the technologies for air travel are sustainable aviation fuels, which reduce emissions by 70-80%, and electric planes for short hauls.

Netherlands Deep Dive. Among the innovations DHL has introduced into The Netherlands described by Schwartz are Cargo Bikes for inner city deliveries (The Chariot-NL, T-TRIKE-JP, and eCargo-Cycle) and electric vehicles for the last mile (up to 100% by 2005). Schwartz also cited 20 standard technologies toward making DHL facilities carbon-neutral, coupled with 15 advanced technologies.

Outlook and Closing Thoughts. In addition to highlighting what he hoped people would take away from his presentation, Schwartz also emphasized the importance of collecting data. It's important, he said, not only to optimize the provider's operation but also to provide assurance to customers.

After the Summit I learned that, in a gesture toward sustainability, FourKites had planted 4220 trees in British Columbia, not only in my name but also in the names of the other 4219 participants.

New Tech for zero-C

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Energy Conservation is an ingredient in everybody's portfolio to restrict emission of greenhouse gases, because energy that isn't used doesn't lead to any greenhouse gas emissions.

A 28 January 2022 report from *Physics Today* describes a transparent window covering made of tungsten-doped vanadium dioxide which acts as a metal absorbing infrared radiation from the Sun at high outside temperatures and acts as an insulator admitting infrared radiation from the Sun at low outside temperatures. The transition temperature is determined by the amount of tungsten doping.

Carbon Capture is a direct way to reduce carbon dioxide emissions, but technologies thus far have used lots of energy and cost lots of money.

A 7 February 2022 report from *Physics Today* described a zinc-based metal organic framework whose pores selectively absorb carbon dioxide over water when the relative humidity is less than 40%. It can discharge carbon dioxide upon heating and be reused and is less costly and energy intensive than chemical solvents.

According to an article by Akshat Rathi in the 2 February 2022 issue of *Bloomberg Green*, Bill Gates's Breakthrough Energy Venture has contributed to the $80 million raised by MIT spinoff Verdox, whose lab results show promise for a method capturing carbon dioxide from the air which uses 70% less energy than current Direct Air Capture technology.

REVIEWS

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ing students how to calculate derivatives and integrals manually, he would have them learn to do so digitally and use the remaining time learning how to use derivatives and integrals to solve problems. Among other important mathematics topics he cites are probability and statistics, programming, financial literacy, data analytics, decision analysis, and algorithm structuring.

"Doing Better Things." This is what we should be doing instead, and Dintersmith found examples in such diverse locations as the states of VT, NH, WA and ID; Newark, NJ; Albemarle County, VA; and Eminence, KY.

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Top Five Science Stories

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text are related as well. Bitcoin holds no intrinsic value whatsoever; bitcoin makes nothing; it is also wasteful of precious energy. Kaku's point is clear, any purposeless speculation is actually a poor choice for excess wealth to generate profits from. And as an empty "thing," bitcoin holds little actual value so when the price drops suddenly, as it will, bitcoin may really become worthless. Is gambling on bitcoin any different than gambling in Atlantic City? Kaku feels they are the same. I tend to agree.

TEACHERS CLEARINGHOUSE FOR SCIENCE AND SOCIETY EDUCATION, INC.
17 Honeyflower Lane
West Windsor, NJ 08550-2418

John D. White
1936-2022

When I became a Resource Agent for the New York Energy Education Project in 1983, one of my fellow Resource Agents deeply impressed me by his historical knowledge of the role of technology. It didn't take me long to learn that his name was John White, and that he taught history at West Islip High School on Long Island. When Carolyn Graham, one of the Project directors, moved from the Project to the New York State Education Department, John and I were named as two of the four Project Associates, which meant that we assisted the remaining director, RoseAnne Fogarty, by helping the other Resource Agents in our districts (his being Long Island, mine being New York City) present workshops.

I also enlisted John White as the Technology Correspondent for this *Newsletter*, and he fulfilled that role by writing occasional stories (many of them on the front page) and reviewing many books. When the New York Power Authority asked me to organize a team of four to present summer weeklong workshops on science, technology, and society at Purchase College in the 1990s, I suggested inviting teams comprised of a science teacher, social science teacher, and technology teacher from the same school or district to develop an interdisciplinary curriculum they could implement in the following year. Wanting to model the team of presenters like the teams of teachers we were inviting, I found John to be the obvious choice to be the social science teacher on the presenting team.

Because he and I lived farther from Purchase College than the other two members of the team, we stayed at the nearby Crown Plaza in White Plains, and having this additional time together further deepened our friendship. After dinner we delighted in solving the crossword puzzles in *The New York Times* (which we bought) and *USA Today* (which was complimentary and dubbed by John as "news lite"). I later was able to visit John at his home in Islip, where he was an involved member of the Arts Council and Historical Society, after presenting a workshop at nearby Stony Brook University.

I knew something was amiss when I received an email from John this spring that, because his eyes were failing him, it was to be his last email message. But, before I could call him the following weekend, I received the news that he had passed – on 27 April. I feel that I have lost a very dear friend, but he has left me a wonderful collection of memories.

- John L. Roeder