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Tobacco, Age Limits, and the Illicit Market

A Course for Ocean Science Research

Signals Intelligence and Bulk Data Collection

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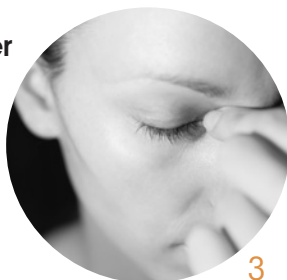
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Medical Misnomer

NEW NAME AND DIAGNOSTIC CRITERIA NEEDED FOR CHRONIC FATIGUE SYNDROME

I believe that the words “Chronic Fatigue” are the kiss of death. Who in this over-wrought, stress-driven society isn’t “fatigued” a good deal of the time? What people don’t get is that this fatigue for people like me keeps me in bed for days at a time and prevents me from doing everyday errands and even simple house tasks on some days.

— *Comment submitted to the study committee*

Myalgic Encephalomyelitis/Chronic Fatigue Syndrome (ME/CFS) is a disease that has sparked considerable public debate for years. Doctors are often skeptical about the condition or have difficulty diagnosing it. And those affected feel frustrated and dismissed, on top of the debilitating symptoms they experience. In fact, diagnosis has always been a problem; less than one-third of medical schools include ME/CFS-specific information in the curriculum. Sixty-seven percent to 77 percent of patients diagnosed with the disease said it took more than a year to receive a diagnosis; of these, about 29 percent said it took more than five years. Experts estimate that 84 percent to 91 percent of people with ME/CFS are undiagnosed, and as many as 2.5 million in the United States may suffer from the disease. In addition, the direct and indirect economic costs of ME/CFS to society have been estimated at \$17 billion to \$24 billion annually.

A recent report from the Academies concluded that ME/CFS is a legitimate, serious, and complex systemic disease that frequently and dramatically limits the activities of affected individuals. The study committee that authored the report recommended new diagnostic criteria that address the needs of health care providers, patients, and their caregivers.

“Diagnosing ME/CFS is often a challenge, and seeking and receiving a diagnosis can be frustrating due to the skepticism of health care providers about these patients and the serious nature of their disease,” said committee chair Ellen Wright Clayton. “The new diagnostic criteria will make it easier for clinicians to recognize and accurately diagnose patients

in a timely manner, as well as allow a large percentage of currently undiagnosed patients to receive appropriate care.”

If the diagnostic criteria are met following an appropriate history, physical examination, and medical work-up, physicians should diagnose ME/CFS, the committee said.

Diagnosis requires that a patient have three core symptoms:

- A substantial reduction or impairment in the ability to engage in pre-illness levels of activities that is accompanied by often profound fatigue of new or definite onset, not the result of ongoing excessive exertion and not substantially alleviated by rest
- The worsening of patients’ symptoms after any type of exertion — such as physical, cognitive, or emotional stress — known as post-exertional malaise
- Unrefreshing sleep

At least one of the two following manifestations is also required:

- Cognitive impairment
- The inability to remain upright with symptoms that improve when lying down — known as orthostatic intolerance

These symptoms should persist for at least six months and be present at least half the time with moderate, substantial, or severe intensity to distinguish ME/CFS from other diseases.

The committee, along with many ME/CFS researchers and patients, believe the term “chronic fatigue syndrome” perpetuates misunderstanding of the illness and dismissive attitudes from health care



providers and the public. The term “myalgic encephalomyelitis” was also deemed inappropriate by the committee, because myalgia, or muscle pain, is not a

core symptom of the disease, and because there is inconclusive evidence of brain inflammation in ME/CFS patients. It suggested renaming the disorder to Systemic Exertion Intolerance Disease (SEID), which captures the characteristic that any exertion can adversely affect several organ systems and other aspects of patients’ lives.

The committee also noted that more research on ME/CFS is needed — especially given the number of people affected — because too little is known about the causes, development, and progression of the disease, or about effective treatment. Future research could lead to findings that refine the diagnostic criteria and understanding of ME/CFS subtypes. A multidisciplinary group should re-examine the proposed criteria after five years or sooner if firm evidence supports the need for modification. — *Jennifer Walsh*

■ **Beyond Myalgic Encephalomyelitis/Chronic Fatigue Syndrome: Redefining an Illness.** Committee on the Diagnostic Criteria for Myalgic Encephalomyelitis/Chronic Fatigue Syndrome, Board on the Health of Select Populations, Institute of Medicine (2015, 304 pp.; ISBN 978-0-309-31689-7; available from the National Academies Press, tel. 1-800-624-6242; \$55.00 plus \$5.00 shipping for single copies; also on the Internet at <www.nap.edu/catalog/19012>).

The committee was chaired by **Ellen Wright Clayton**, Craig-Weaver Professor of Pediatrics and professor of law at Vanderbilt University, Nashville, Tenn. The study was sponsored by the Office on Women’s Health within the U.S. Department of Health and Human Services, National Institutes of Health, Centers for Disease Control and Prevention, U.S. Food and Drug Administration, Agency for Healthcare Research and Quality, and U.S. Social Security Administration.

WHITE POTATO

Should Be Allowed on the WIC List

Since the 2009 regulation that made cash value vouchers available to participants in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), the vouchers have been redeemable for fruits and vegetables so that participating women and children can obtain specific nutrients that might be lacking in their diets. The white potato has been excluded, however, as a vegetable eligible for purchase.

WIC requires that the program's food package align with the current Dietary Guidelines for Americans, which are revised every five years. Based on the 2010 Dietary Guidelines, USDA should allow the purchase of white potatoes with the voucher, according to a recent Academies report. A change in the guidelines from 2005 to 2010 increased the recommended amounts of starchy vegetables from 2.5 cups to 3.5 cups per week for children and from 3 cups to 5 cups per week for women. On average, however, children and women are only eating about 64 percent and 56 percent, respectively, of the recommended amounts. In fact, WIC participants' intakes of all vegetable subgroups could be improved, determined the study committee that wrote the report.

For low-income children, consumption of vitamin D, calcium, potassium, and fiber fall short, and for low-income women, intakes of seven nutrients — vitamins C and D, calcium, potassium, iron, folate, and dietary fiber — need substantial improvement. White potatoes are particularly high in potassium, so eating the



recommended amounts of them may help reduce shortfalls of potassium in the diets of both children and women. Also, allowing the purchase of white potatoes would offer WIC participants more ways to meet their preferences — or at minimum would likely not reduce them.

In 2006, the Institute of Medicine issued the report *WIC Food Packages: A Time for Change*, which used the 2005 Dietary Guidelines to conclude that white potatoes should be excluded as a WIC-eligible vegetable. However the basis for their exclusion no longer applies, the committee said, because the 2010 recommendations for starchy vegetables increased. If relevant changes occur to the 2015 Dietary Guidelines, the latest recommendation should be re-evaluated. — *Jennifer Walsh*

■ Review of WIC Food Packages: An Evaluation of White Potatoes in the Cash Value Voucher — Letter Report. Committee to Review WIC Food Packages, Food and Nutrition Board, Institute of Medicine (2015, 100 pp.; ISBN 978-0-309-33924-7; available from the National Academies Press, tel. 1-800-624-6242; \$40.00 plus \$5.00 shipping for single copies; also on the Internet at <www.nap.edu/catalog/20221>).

The committee was chaired by **Kathleen M. Rasmussen**, professor of nutrition in the division of nutritional sciences at Cornell University, Ithaca, N.Y. The study was sponsored by the U.S. Department of Agriculture.



The U.S. Tobacco Trade

Reports Examine Age Regulations and the Illicit Market

Over the past 50 years, tobacco control in the United States has led to an estimated 8 million fewer premature deaths. However, tobacco use continues to significantly affect public health, and more than 40 million Americans still smoke.

In 2009, the Family Smoking Prevention and Tobacco Control Act granted the U.S. Food and Drug Administration broad authorities over tobacco products, though it prohibited FDA from establishing a nationwide minimum age of legal access (MLA). It also directed FDA to convene a panel of experts to conduct a study on the

public health implications of raising the MLA above 18 years of age.

At FDA's request, an Academies committee conducted this study, which found that raising the minimum age for purchasing tobacco products to 21 likely would have a substantial impact on reducing the initiation of tobacco use — defined as having smoked 100 cigarettes — even more than raising it to 19 would. The added effect of raising the minimum age beyond age 21 to age 25 would probably be considerably smaller. Underage users rely primarily on social sources — friends and relatives — to get tobacco. Between ages 15 and 17, mobility increases with driving privileges, and social networks and potential sources of tobacco start to increase as some adolescents take on part-time jobs with co-workers who may be over the MLA. Therefore, increasing the

MLA only to 19 may not change social sources substantially, but raising the MLA to 21 is likely to have a considerable impact on initiation for this age group.

If the MLA were raised now, by 2100 there would be approximately a 3 percent decrease in smoking prevalence for an MLA of 19, a 12 percent decrease for an MLA of 21, and a 16 percent decrease for an MLA of 25, the report says. In terms of direct health effects, if the MLA were raised now to age 21 nationwide, there would be approximately 249,000 fewer premature deaths, 45,000 fewer deaths from lung cancer, and 4.2 million fewer years of life lost among the cohort of people born between 2000 and 2019.

Another recent Academies study requested by the FDA looks at a different aspect of the tobacco trade — understanding the U.S. illicit tobacco market and what we can learn from other countries' efforts to decrease illicit sales.

Currently, the U.S. illicit tobacco market consists primarily of bootlegging from Native American reservations and low-tax states, such as Virginia, to high-tax states, such as New York, where illicit sales may constitute as much as 45 percent of all tobacco sales. Bootlegging is the legal purchase of cigarettes in one jurisdiction and their resale in another, without the payment of applicable taxes or duties in the jurisdictions where they are resold.

Other countries' adoption of comprehensive interventions show that it is possible to reduce the size of the illicit tobacco market through tobacco-specific enforcement resources and collaboration across jurisdictions. For example, Spain reduced the illicit share of its market from 15 percent in 1995



to 2 percent in 2001 through licensing and control measures, enforcement efforts, and legal agreements.

In order to better understand the nature of the tobacco market in the U.S. and the ways it may evolve in the future, additional research and data are needed across a broad range of areas, such as an examination of how smokers respond to the permanent loss of specific product features they previously found desirable, and the relationship between e-cigarette use and the use of conventional tobacco products.

— Dana Korsen

■ **Public Health Implications of Raising the Minimum Age of Legal Access to Tobacco Products.** Committee on the Public Health Implications of Raising the Minimum Age for Purchasing Tobacco Products, Board on Population Health and Public Health Practice, Institute of Medicine (2015, 360 pp.; ISBN 978-0-309-31624-8). The committee was chaired by **Richard J. Bonnie**, Harrison Foundation Professor of Medicine and Law and director of the Institute of Law, Psychiatry, and Public Policy, University of Virginia, Charlottesville.

■ **Understanding the U.S. Illicit Tobacco Market: Characteristics, Policy Context, and Lessons From International Experiences.** Committee on the Illicit Tobacco Market: Collection and Analysis of the International Experience; Committee on Law and Justice, Division of Behavioral and Social Sciences and Education; and Board on Population Health and Public Health Practice, Institute of Medicine (2015, 260 pp.; ISBN 978-0-309-31712-2). The committee was chaired by **Peter Reuter**, professor, School of Public Policy and department of criminology, University of Maryland, College Park.

Both studies were funded by the U.S. Food and Drug Administration, and are available from the National Academies Press, tel. 1-800-624-6242 or on the Internet at <www.nap.edu>.



The Postdoctoral Experience

Ideally, a job as a postdoctoral researcher looks something like this:

Under the mentorship of a principal investigator, a recent Ph.D. recipient receives additional scientific training — learning new research techniques, gaining access to professional networks, accruing publications of their work, and learning grantsmanship and other vital tools of the trade. After a short period of time, this person transitions into a tenure-track faculty position or another full-time research position.

For most U.S. postdocs, however, reality is far different from this ideal. Many stay for years in low-paying positions that offer little mentoring or training, hoping for tenure-track positions that for most are unlikely to materialize. While the number of postdoctoral researchers has surged in recent decades, the number of research faculty positions into which junior researchers can hope to move has not kept pace.

The result is a system that has created expectations for academic career advancement that cannot be met, says a recent report from the Academies. It recommends reforms — both to improve the postdoctoral experience for those whose career paths require it, and to help more students explore science-related career paths for which postdoctoral training is unnecessary.

Postdoctoral positions need to have mentoring and training at their center, the report emphasizes. The title “postdoctoral researcher” should be applied only to those who are receiving significant advanced training in research, and funding agencies should

require evidence of this training. In addition, host institutions and funders both should offer training programs for mentors and evaluate their performance.

Current salaries for postdoctoral researchers are low, the report says. The committee that wrote the report examined five different approaches for determining an appropriate minimum salary, and all of them suggest an amount of \$50,000 or more. The National Institutes of Health should raise the National Research Service postdoctoral award — which has become the de facto standard for postdoctoral salaries at many universities — to \$50,000 and adjust it annually for inflation.

No one should spend more than five years total in postdoctoral positions, the report adds. Host institutions should maintain a record of how long a postdoctoral researcher remains in a position and provide that information to funding agencies as part of grant proposals. And given the shortage of tenure-track research jobs that actually require postdoctoral training, host institutions and mentors should make students aware of the wide variety of career paths available for Ph.D. recipients. — *Sara Frueh*

■ **The Postdoctoral Experience Revisited.** Committee to Review the State of Postdoctoral Experience in Scientists and Engineers; Committee on Science, Engineering, and Public Policy; National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (2014, 122 pp.; ISBN 978-0-309-31446-6; available from the National Academies Press, tel. 1-800-624-6242; \$49.95 plus \$5.00 shipping for single copies; also on the Internet at <www.nap.edu/catalog/18982>).

The study was chaired by **Gregory A. Petsko**, Arthur J. Mahon Professor of Neurology and Neuroscience, Weill Cornell Medical College, and Gyula and Katica Tauber Professor of Biochemistry and Chemistry Emeritus, Brandeis University. The study was sponsored by the Presidents' Committee of the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine; the Alfred P. Sloan Foundation; and the Burroughs Wellcome Fund.



CLIMATE INTERVENTION

Manipulating the Climate Through Certain Technologies **Not Viable at Present**

The mounting evidence indicating that our climate is changing rapidly — and pointing to human activity as the culprit — has prompted scientists to begin asking whether humans can also prevent its worst impacts.

One set of options that has recently gained traction is known as “geo-engineering,” or purposefully manipulating the climate to halt certain effects of climate change. Two proposed classes of techniques in particular have received the most attention: removing carbon dioxide from the atmosphere — which addresses the root cause of climate change

— and reflecting sunlight back to space to cool the Earth.

After reviewing these methods for technological readiness, cost, and risk, an Academies committee concluded that neither is currently ready for large-scale deployment, and that mitigation by reducing carbon emissions together with adaptation is still the safest, most effective way to ease the impacts of climate change.

The committee also said that the term “geoengineering” implies having precise control over the climate and instead preferred the term “climate intervention” to more accurately convey that these technologies could modify the climate in different ways to lessen the impacts of climate change.

The two types of intervention strategies differ in almost every aspect. Carbon

dioxide removal is currently prohibitively expensive and would only produce modest effects on the climate over decades; using aerosols to block sunlight — known as albedo modification — is relatively inexpensive and could have a substantial impact within a short time. Carbon dioxide removal would likely require cooperation among many countries, and its risks are minimal and generally well-characterized, while albedo modification could be implemented suddenly and unilaterally, but it likely presents serious risks, known and unknown. These differences led the committee to evaluate the strategies separately and recommend different paths forward for each set of techniques.

Because cost and technological immaturity are the major obstacles facing carbon dioxide removal, increased investment in research and development could help develop techniques that are efficient and affordable, as well as enable better understanding of the risks that do exist, such as how ocean iron fertilization, which raises the rate of CO₂ absorption by ocean plant life, could affect marine ecology.

Albedo modification, on the other hand, raises serious social, political, and ethical concerns. Many of the natural processes most relevant to albedo modification, such as the formation of clouds and aerosols in the atmosphere, are among the most difficult components of the climate system to model and monitor, making it challenging to predict the effects of this intervention on weather, climate, or other Earth systems. Furthermore, albedo modification doesn't counteract the rising concentration of greenhouse gases in the atmosphere, so it wouldn't resolve related

climate change issues such as ocean acidification. If deployed in the absence of efforts to reduce carbon emissions, albedo modification would have to continue perpetually; a sudden termination would reintroduce all of the problems associated with a warming climate.

The committee recommended against using albedo modification at this time, but additional research to better understand these uncertainties is needed in the event that deployment becomes a necessary climate response in the future or if a lone actor pursues the technology. Much of the required research overlaps with basic climate research.

Any research, including potential small-scale field experiments, should be subject to a deliberative process, which should involve a broad set of stakeholders to examine what types of governance models are needed beyond those already in place, and what research would require such oversight based on its expected environmental impact and other potential direct and indirect effects. — *Lauren Rugani*

■ ***Climate Intervention: Carbon Dioxide Removal and Reliable Sequestration***

■ ***Climate Intervention: Reflecting Sunlight to Cool Earth***

Committee on Geoengineering Climate: Technical Evaluation and Discussion of Impacts, Board on Atmospheric Sciences and Climate and Ocean Studies Board, Division on Earth and Life Studies. The committee was chaired by **Marcia McNutt**, editor-in-chief at Science and former director of the U.S. Geological Survey. The study was funded by the National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, U.S. Department of Energy, the intelligence community, and the National Academy of Sciences.

Both reports are available from the National Academies Press, tel. 1-800-624-6242 or on the Internet at <www.nap.edu>.

Sea Change

The National Science Foundation is the primary funder of basic ocean science research, spanning physical, chemical, and biological oceanography and marine geology and geophysics. In addition to research that advances understanding of the ocean, NSF supports the ocean research infrastructure, such as the academic research fleet, scientific ocean drilling, and the Ocean Observatories Initiative.

As new technologies and capabilities transform the ability of scientists to study the complex and dynamic ocean system, NSF asked the Academies to establish research priorities for the next decade and identify strategic investments that are necessary to achieve those goals.

The study committee solicited input from the broader ocean sciences community and, after sorting topics into high-level scientific questions, applied four criteria to determine the top research priorities: transformative research potential, societal impact, readiness, and partnership potential.

The process yielded eight priorities representing integrative research areas, including rate and impacts of sea-level rise, effects of climate change on marine ecosystems, greater understanding of marine food webs, better approaches for forecasting hazards such as mega-earthquakes and tsunamis, and exploration of the seafloor environment. Because each of the priority areas crosses disciplines, the report emphasizes that it is important that investigators do not encounter barriers to obtaining funding for interdisciplinary research.

The report found that the fleet of academic research vessels was most closely

SETTING THE COURSE FOR THE NEXT DECADE OF OCEAN SCIENCE RESEARCH

aligned with the new priorities and was critical to effectively address the decadal priorities. Scientific ocean drilling facilities were critical for addressing some of the priorities, and the Ocean

Observatories Initiative, which has yet to become fully operational, was less aligned with the priorities. Together, this infrastructure accounts for more than 50 percent of the total budget for ocean sciences within NSF, and the operation and maintenance costs continue to rise.

In the face of flat or declining budgets, growing infrastructure costs mean less money for core research and investigator support. The report says that the Division of Ocean Sciences at NSF should initiate an immediate 10 percent reduction in major infrastructure costs in the next fiscal year, followed by an additional 10 percent to 20 percent decrease over the next five years. These cost savings should be applied directly to strengthening core science programs, investing in technology development, and funding partnerships to address the decadal science priorities. — *Lauren Rugani*

■ **Sea Change: 2015-2025 Decadal Survey of Ocean Sciences.** Committee on Guidance for NSF on National Ocean Science Research Priorities: Decadal Survey of Ocean Sciences, Ocean Studies Board, Division on Earth and Life Studies (2015, 98 pp.; ISBN 978-0-309-36688-5; available from the National Academies Press, tel. 1-800-624-6242; \$44.00 plus \$5.00 shipping for single copies; also on the Internet at <www.nap.edu/catalog/21655>).

The committee was co-chaired by **Shirley Pomponi**, executive director of the NOAA Cooperative Institute for Ocean Exploration, Research, and Technology at Harbor Branch Oceanographic Institute-Florida Atlantic University, and **David W. Titley**, director of the Center for Solutions to Weather and Climate Risk at Pennsylvania State University. The study was funded by the National Science Foundation.



THE FUTURE OF Manufacturing

Strengthening Innovation, Productivity, and Workforce Training in the U.S.

Globalization, technological advances, and changing business practices are dramatically transforming manufacturing. While technological developments offer companies new ways to understand customers' needs and in turn increase demand for their products, automation and streamlined operations will increasingly supplant workers in a variety of occupations. By some estimates, almost 50 percent of U.S. jobs will be disrupted as a result of the factors changing manufacturing. For example, an automobile plant can now be run by one-third as many people as were needed in 1965 due to advances in automation and computer-aided design, engineering, and production, yet the quality, sophistication, and timely delivery of vehicles have dramatically improved.

With reduced demand for production workers, total U.S. manufacturing employment dropped from approximately 19 million in 1980 to 11.5 million in 2010,

according to the Bureau of Labor Statistics. These job losses were concentrated in the portion of the manufacturing workforce without a high school diploma.

To help ensure that the U.S. thrives amid these global changes and remains a leading environment for innovation, U.S. companies, government, and educators should collaborate to confront workforce challenges and improve productivity, says a recent report from the National Academy of Engineering. Specifically, they must strengthen workforce training and improve innovation to make sure manufacturers are “making value” for customers. Making value is the process of



using ingenuity to convert resources into goods, services, or processes that create solutions, serving the welfare of humanity and the needs of society.

Businesses should establish training programs to prepare workers for modernized operations and invest in the education of their low- and middle-skilled workforce, as well as implement programs to attract and retain diverse workers with respect to gender, race, and socio-economic background because this diversity improves a team's innovation performance. Businesses, local school districts, workforce organizations, community colleges, and universities should form partnerships to help students graduate from high school, earn an associate's or bachelor's degree, and take part in continuing education and training programs in the workplace.

The report also says that Congress and state legislatures should create tax credits or other incentives for businesses to invest and be involved in education programs that provide students and displaced workers with the knowledge and skills needed for higher-paying careers.

Companies also need to find new ways to make value, the report says. For instance, when the rise of digital photography changed the value of film, Fujifilm harnessed its expertise working with the antioxidant chemicals used in photography to develop antioxidants for cosmetics and optical films for use in flat-panel screens. Although Fujifilm for decades created film and the materials to develop photographs, this now accounts for a small percentage of its sales.

Businesses, economic development organizations, educational institutions, research organizations, as well as federal, state, and

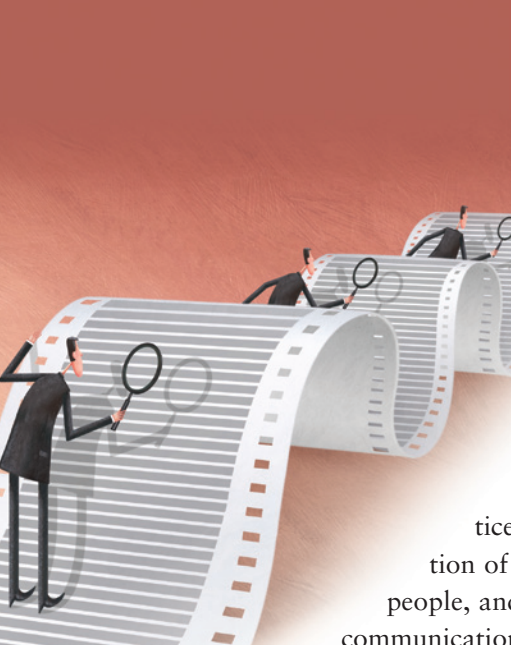
local governments all have important roles to play to guarantee that U.S. manufacturing strengthens its capacity for innovation. The report offers several recommendations as a blueprint for action.

To foster the creation of new businesses and to connect entrepreneurs with the individuals, investors, tools, and institutions in their region and around the world that they need to help their businesses grow, metro area and state governments, industry, higher education, investors, and economic development organizations should unite to create local innovation networks.

Manufacturing can no longer be considered as something separate from the value chain — the system of research and development, product design, software development and integration, and lifecycle service activities performed to deliver a product or service to market. Businesses focusing on the entire system help make value for their customers and are less likely to be disrupted by new technologies or increased competition from emerging economies around the world. — *Dana Korsen*

■ ***Making Value for America: Embracing the Future of Manufacturing, Technology, and Work.*** Committee on Foundational Best Practices for Making Value for America, National Academy of Engineering (2015, 144 pp.; ISBN 978-0-309-32653-7; available from National Academies Press, tel. 1-800-624-6242; \$46.00 plus \$5.00 shipping for single copies; also on the Internet at <www.nap.edu/catalog/19483>).

The study committee was chaired by **Nicholas Donofrio**, former executive vice president of innovation and technology, IBM. The study was funded by NAE along with Gordon E. Moore, Robert A. Pritzker and the Robert Pritzker Family Foundation, Jonathan J. Rubinstein, Edward Horton, and by a number of U.S. companies — Boeing, Cummins, IBM, Qualcomm, Rockwell Collins, and Xerox.



BULK COLLECTION OF SIGNALS INTELLIGENCE

Last year, President Obama issued Presidential Policy Directive 28, which called for an evaluation of U.S. signals intelligence practices — specifically the collection of communications between people, and information about those communications, such as the time and length of a phone call. It had come to light that the U.S. government was collecting such data in bulk, including information about individuals who were not subjects of intelligence investigations, raising concerns about the trade-off between national security and civil liberties.

The directive instructed the Office of the Director of National Intelligence to produce a report that assessed the feasibility of creating software that would allow the intelligence community to more easily conduct targeted data collection rather than bulk collection. In turn, ODNI asked the Academies for input to assist in preparing its response to the president.

A key value of bulk data collection is having a record of past communications that could be useful in future investigations, an attribute that cannot fully be replicated by software, the Academies' report says. Curtailing bulk data collection would mean that some information is necessarily lost, but this doesn't imply that bulk data collection must continue. While the report doesn't recommend whether bulk data collection should continue, it did find that technological alternatives could improve targeted collection or control how collected data is used.

New approaches to targeted data collection could increase the relevance of

current information to future investigations, for example by rapidly updating filtering criteria to include new targets as they are discovered. And as an alternative to curbing the bulk collection of data, automated controls could be applied to how data is used to help protect individuals' privacy. The report identified three key technical elements required to control the use of data: isolating the bulk data so that it can be accessed only in specific ways; restricting the types of queries that can be made against the stored data; and auditing the queries that have been made. How these controls work can be made public without revealing sensitive data, so outside inspectors can verify that the procedures adequately protect privacy.

Some of the necessary technologies to enhance targeted collection or improve automated controls require further research and development, and many could feasibly be deployed within the next five years. However, the report says that the ultimate decision to use any technology is a policy question that requires determining whether increased effectiveness and transparency are worth the cost in equipment, labor, and potential interference with the intelligence mission. — *Lauren Rugani*

■ **Bulk Collection of Signals Intelligence: Technical Options.** Committee on Responding to Section 5(d) of Presidential Policy Directive 28: The Feasibility of Software to Provide Alternatives to Bulk Signals Intelligence Collection, Computer Science and Telecommunications Board, Division on Engineering and Physical Sciences (2015, 124 pp.; ISBN 978-0-309-32520-2; available from National Academies Press, tel. 1-800-624-6242; \$44.00 plus \$5.00 shipping for single copies; also on the Internet at <www.nap.edu/catalog/19414>).

The committee was chaired by **Robert F. Sproull**, former director of Oracle's Sun Labs. The study was funded by the Office of the Director for National Intelligence.



Ambassadors for Science and Engineering

Pittsburgh Program Brings Expertise and Evidence to Local Decision Making

The Academies have a long history of offering evidence-based advice to policymakers on a national level, but for the past three years, they have been piloting a new way to help scientists and engineers connect with policymakers and other opinion leaders at the local level. The Science & Engineering Ambassadors program has enlisted experts in Pittsburgh to reach out to local opinion leaders and help them understand energy issues, with the goal of informing community decision making. The broader hope is to develop a model that can work in a variety of communities around a range of topics.

Selected in 2011 from a group of 15 cities, Pittsburgh had the right raw ingredients for the pilot site. It offers the benefits of both a big and a small city, says Barbara Granito, a Pittsburgh resident and former Wall Street Journal editor who chairs the program's advisory board and serves as executive adviser. "People know one another, and because of that, they're inclined

to collaborate. You also have world-class research labs and universities." The city is also in the middle of a huge transformation. "They are successfully reinventing themselves from an old steel and coal economy to a new one based on medicine, technology, research, advanced manufacturing, and sustainable development," says Granito. "There is high local pride. The idea of inventing a national model is very appealing to Pittsburgh."

The program is beginning with a focus on one topic: energy. In 2012, 26 ambassadors — all of them energy experts in the Pittsburgh community — were selected to participate in the program. Half were senior-level scientists and engineers, and each was invited to bring a younger colleague or graduate student into the program. The senior-level ambassadors, representing academia, industry, and government, were carefully vetted for their professional reputations, proven interest in outreach, and natural aptitude and enthusiasm for communication.

Reaching Unique Audiences

Through the program, the ambassadors have engaged several types of audiences, all with the goal of increasing knowledge about energy. One audience is students; the program worked with the University of Pittsburgh and Carnegie Mellon University to create a joint honors class that offered



undergraduates the chance to learn about both energy and science communication. The ambassadors have also led multiple events for general audiences, such as a three-session series on energy and climate that engaged citizens last fall.

But the program's primary audience is more focused — and one that not many programs attempt to reach, says Jessica Sickler, an external evaluator who has followed the program from its beginnings. "What makes it unique is that it's trying to reach community decision makers. The goal is to bring science to bear to influence decisions."

Over the fall and winter of 2014-2015, for example, the program worked with the Allegheny Conference on Community Development to create the Grid Academy, a four-session series of presentations and

discussions to help local leaders learn more about the electrical grid — how it works, its economic aspects, the threats it faces, and its possible future. A group of more than two dozen local policymakers and business and nonprofit leaders attended the sessions. As a follow-up, the Allegheny Conference will work with these leaders to

produce a white paper on issues facing the region's electrical grid. In addition, several science ambassadors are serving as expert resources for Sustainable Pittsburgh, a group working with a number of partners in the Pittsburgh area to develop a regional energy strategy.

"I think the program has made a difference in how the region views issues surrounding energy," says Gregory Reed, director of the University of

Pittsburgh's Center for Energy and among the program's first ambassadors. He points not just to an improved dialogue about the issue but also to the connections that have been sparked among different parts of the community. "There have been unpredicted outcomes, in terms of people coming together and creating opportunities where they didn't exist before." Reed himself is now working with the city of Pittsburgh to develop an energy strategy for the city's downtown — a collaboration he would not have foreseen before the program.

Building Better Communicators

To connect with local leaders and other groups, the program's scientists and engineers need to be able to convey what they know clearly and effectively, so a key



part of the program is giving the ambassadors intensive communication training. Workshops led by experts in science communication have trained the participants to draw on stories and examples to ground explanations, for example, and how to use visual aids effectively.

The scientists and engineers completed the training feeling far more prepared to engage with the public, they reported. And the benefits extended beyond the program; when evaluators checked in with the ambassadors later, all of them said they had used what they had learned in some way outside of the program. To build on this foundation, the program provides individual coaching before events and plans to hire a communications coach. “We also want to map the trainings more closely to the events so the ambassadors can put what they learn into practice right away,” says Terrell Smith, who supervised the program for the Academies.

Communicating effectively also means engaging local leaders in the right way. The program found that while general audiences may prefer the traditional lecture-and-Q&A format, local leaders want more of an interactive dialogue. These are highly competent civil servants, says Sickler, and the “deficit” model of science communication — “You lack something that we will provide” — doesn’t work. “It’s important to approach them as partners and honor the expertise they bring to the table.”

Future Directions

Plans are underway to recruit additional ambassadors in Pittsburgh, using the opportunity to broaden the cadre’s subject-area expertise — possibly transportation, water, health, decision science, and other areas. The program is also working to develop funding approaches that can make it sustainable in Pittsburgh for the long haul.

In addition, program leaders are weighing whether it’s time to expand the model to other cities — but not in an identical, cookie-cutter way. “Success in Pittsburgh and other cities depends on meeting a local need and fitting into a local agenda,” said Sam Taylor, who directs the program on the ground in Pittsburgh. That may mean focusing on issues other than energy or engaging community leaders in different ways.

“This program has demonstrated that scientists and engineers can be successfully woven into decision making in ways that truly benefit local communities if they use best practices in communication — listening to the needs of citizens and engaging with them in ways that uncover the relevance of the science to solving community problems,” says Barbara Kline Pope, executive director of the Office of Communications, which oversees this program for the Academies. “We are eager to identify the next city that will embrace this model.” — *Sara Frueh*

More information on the program is available at scienceambassadors.org.



ARAB-AMERICAN

A Unique Opportunity for Building Scientific Bridges

For over 25 years, the Academies have brought together outstanding young scientists to discuss cutting-edge research and spark collaborations. The Kavli Frontiers of Science first staked out the territory in 1989, gathering early-career scientists from the U.S. to discuss scientific advances in many disciplines. Its success inspired many variations — including an ongoing Frontiers of Engineering program — and international expansion, giving rise to bilateral projects with Germany, China, Japan, and India, among others.

The most recent program in this vein, created in 2011, is in many ways even more complex and geographically ambitious than its forerunners. The Arab-American Frontiers of Science, Engineering, and Medicine program connects competitively chosen young scientists, engineers, and medical professionals from the U.S. with their counterparts in the 21 countries of the Arab League.

The Arab world is far from monolithic, and Dalal Najib, who manages the program for the Academies, says that finding ways to engage the whole region at once has been interesting and challenging. “These countries vary tremendously in terms of economic development, scientific literacy, and overall stability,” she says. “The region includes Gulf countries such as the UAE, Qatar, and Saudi Arabia, which have world-class centers of excellence in science and technology. We also have Egypt, Lebanon, and Jordan, with their long-standing universities and critical mass of well-respected researchers, francophone North Africa with strong ties to Europe, and countries in the Sahel like Djibouti, Sudan, and Mauritania.” Despite their diversity, these countries are dealing with similar issues such as water scarcity, food insecurity, and the need for new sources of energy, and they share the same language, providing a solid base for collaborative work.

Many of the nations also share the experience of post-Arab-spring political conflict — turmoil that makes the program’s efforts to develop connections even more important, says Najib. “Right now most institutions see the current situation as a deterrent to working with the Arab world, but it’s more imperative than ever to engage with these young scientists, who are below the political radar and who are trying their best to make their countries better.”

One of the program’s aims is to enhance scientific dialogue across the region and across disciplines, with the goal of spurring better research and applications. At the heart of this effort are symposia where young scientists from across the Arab

FRONTIERS PROGRAM

world and from the U.S. discuss their research and plant the seeds of collaboration. The first symposium was held in Kuwait in 2011 and the second in Oman in 2014; a third will be held in Saudi Arabia at the King Abdullah University of Science and Technology in December 2015.

At each symposium, the participants display their research on posters, giving one-minute explanatory “flash talks” — an exercise that gives them training in communication, Najib says. In addition, there are plenary sessions around the conference’s themes. The Oman conference explored research on water, energy, and food security, for example, while the upcoming symposium in Saudi Arabia will focus on sensing technologies and their applications. Because another of the program’s goals is to empower early-career scientists to take on leadership roles, the symposia are organized and the speakers chosen by the young scientists themselves, under the guidance of a committee of senior researchers.

The symposia not only help connect Arab scientists but also serve as one of the few avenues for American scientists to connect with their colleagues in the Middle East and Northern Africa. “For me, this was a transformative experience,” said Scott Baker of the Pacific Northwest National Laboratory, after speaking at the first Frontiers symposium. “I am still assimilating all of the scientific and cultural information I picked up and have some ideas about future areas where I might take our group’s research.”

Often, the connections made at the symposia don’t end there. Another element of the program, the Arab-American Fellowships, enables researchers to continue



to collaborate. After each symposium, 10 seed grants are awarded to pairs of researchers to enable them to collaborate on areas of common interest identified at the meetings. A researcher from Yemen and another from Lebanon are working together on novel ways to remove pharmaceutical pollutants from water, for example. Another team pairing from Tunisia and the U.S. are working together on STEM career-building curricula for Tunisian scientists.

— Sara Frueh

Additional information is available online at sites.nationalacademies.org/PGA/dsc/AAFrontiers/index.htm.



Inspiring a New Generation of Engineers

Many may recall the popular action-adventure TV series from the late '80s and early '90s that featured fictional government agent Angus MacGyver, who resourcefully used his engineering skills and everyday materials, often duct tape and a Swiss Army knife, to resolve sticky situations in each episode. Lee Zlotoff, the creator of the “MacGyver” series, joined the National Academy of Engineering and University of Southern California’s Viterbi School of Engineering in asking, “Can you out-MacGyver MacGyver?”

Launched in February at an event held during National Engineers Week, “The Next MacGyver” is a worldwide crowdsourcing competition seeking ideas for a scripted television show featuring a female engineer as the lead character. With the share of engineering bachelor’s degrees earned by women in the U.S. in the last decade at just 19 percent, the project partners hope to change this trend. The principal goal of the competition is to inspire young people, especially girls, to pursue educations and careers in engineering, much like “MacGyver” and “CSI: Crime Scene Investigation” increased interest in engineering and forensic science careers.

“I literally could not tell you how many times people have come up to me and said ‘I became an engineer or I went

into the sciences because of MacGyver,’” said Zlotoff.

The contest received about 1,800 submissions, from which five winners will be chosen. Each winner will receive \$5,000 and be paired with Hollywood mentors who will help them to develop the female character and an engaging pilot script, and ultimately create viable concept packages for pitching to a network or distributor by the end of this year. Among the mentors are CEO and founder of Revelations Entertainment Lori McCreary, who is currently the executive producer of “Madam Secretary” on CBS; actress America Ferrera, best known for her leading role as Betty Suarez on the comedy-drama series “Ugly Betty” on ABC; Anthony E. Zuiker, creator and executive producer of the CSI franchise; and Roberto Orci, screenwriter and film and television producer, whose hit movies include “Star Trek” and “Transformers.”

“We could not be more pleased to have some of Hollywood’s top talent donating their time to develop compelling women engineer characters and bring them to life on the screen,” said NAE President C.D. Mote Jr. “This contest provides a rare opportunity to tell a story of engineering and engineers that people practically never see.” — *Dana Korsen*

This project is sponsored by the United Engineering Foundation. More information is available online at www.thenextmacgyver.com. A video of the contest launch event can be viewed online.

Prime Minister of Japan Speaks at NAS

National Academy of Sciences President Ralph J. Cicerone hosted Japanese Prime Minister Shinzo Abe at a breakfast meeting on April 30 with several U.S. leaders in the fields of science, engineering, and medicine. The meeting was co-hosted by Koji Omi, founder and chairman of the Science and Technology in Society (STS) forum, which holds a global conference of researchers, policymakers, and business leaders each year in Kyoto, Japan.

“Japan should take advantage of its high level of science and technology to promote peace and prosperity, especially peace based on the principle of international cooperation,” Abe told the gathering, adding that he believed innovation was the key to using science and technology to improve society. “I am looking forward to hearing your thoughts on how U.S.-Japan cooperation in science and technology can expand and deliver benefits [to society],” he said.

In welcoming the prime minister, Cicerone echoed the global nature of today’s research enterprise and the need for international cooperation to seek solutions to the world’s most pressing problems. He remarked on many areas of cooperation between the NAS and researchers in Japan, including the STS forum. In particular, he highlighted the Radiation Effects Research Foundation, a decades-long partnership with Japan to study the long-term health effects of atomic bomb survivors. In

addition, he noted the recent collaboration with the Science Council of Japan and the science academies of the other G7 countries on joint statements intended to call attention to certain science, technology, and health issues during the June G7 summit in Germany. Cicerone also acknowledged the cooperation that an Academies committee received from the Japanese gov-



ernment during its study of the Fukushima nuclear accident.

“These are the kinds of collaborations that are so critical — not just for advancing science but for addressing our mutual interests in creating a better world,” Cicerone said to Abe. “Mr. Prime Minister, we are looking forward to continuing our work with Japan’s scientists, engineers, physicians, and other experts in the future.”

Among the other attendees at the meeting were U.S. Secretary of Energy Ernest Moniz, National Science Foundation Director France A. Córdova, National Institutes of Health Director Francis S. Collins, and White House Office of Science and Technology Director John P. Holdren, as well as National Academy of Engineering Chair Charles O. Holliday Jr.
— *William Kearney*

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