

SCIENCE POLICY MATTERS: OBSERVATIONS FROM TWO YEARS IN WASHINGTON, D.C.

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In the fall of 2009, thanks to an extraordinary sequence of highly improbable events, I found myself in Washington, D.C., about to begin a Congressional Science & Engineering Fellowship*. Nearly two years later, I am still in Washington, continuing to explore the policy realm. Dr. Steven Garrett, who organized this special issue on scientists in public policy and service, invited me to write about my experiences last year as a Congressional Science & Engineering Fellow and this year as a Science & Technology Policy Fellow in the U.S. Department of State. Hopefully this series will be useful to readers who are curious about science policy and who are interested in learning about programs that help research scientists become involved in public policy. Additionally, we hope to convey how important it is for scientists and engineers to engage in policy. That involvement benefits both the scientific community and the U.S. public.

Although scientists and engineers have good reasons to take part in public policy and service, several barriers can hinder their engagement. Fortunately, scientific and technical professional societies have developed a set of initiatives, like the AAAS (American Association for the Advancement of Science) Science & Technology Policy Fellowships, to lower the barriers before them. I will discuss some of my observations and experiences as an S&T Policy Fellow, first in the legislative branch on Capitol Hill and then in the executive branch at the State Department. Finally, I will urge you, the reader, and your colleagues, to become more engaged in public policy and service. I will provide concrete actions you can take that vary in scope and commitment. Hopefully, one or more of these suggestions will resonate with your particular interest and background. To be sure, my experiences over the past two years have been challenging, and at times frustrating. But these two years have also been incredibly rewarding, and I now have a much greater appreciation for the value that scientists and engineers can bring to public policy and service.

Science for policy and policy for science

There are many excellent resources for those with an interest in science and technology policy.¹⁻¹⁴ During the summer orientation for the AAAS Science & Technology Policy Fellowships, we received several books, a thick binder of articles, and a series of lectures on the topic. We learned that science policy is generally thought to include two main concepts: science for policy, and policy for science. Often in this article I will use “science” as shorthand for science and tech-

*“As John Adams,
one of our country’s
Founders, would say, facts
are stubborn things.”*

nology, as well as for science, technology, engineering, and mathematics. In education policy circles, these are sometimes referred to as the STEM fields.

“Science for policy” refers to the use of scientific knowledge or technical expertise to address a policy issue. Many departments and agencies at all levels of government rely on staff or

contract scientists and engineers to provide the expertise necessary to design and inspect equipment and infrastructure, and to collect, distribute, and analyze data that both public and private entities use to make policy decisions. Policy-makers also view science and technology as a source for new or improved solutions to existing problems, and as a key driver of economic development. Science and technology are critical tools in the policy-making process.

“Policy for science” refers to the policies that public officials put in place to develop and sustain a productive scientific community and infrastructure. Officials who work on these policies must decide how to organize funding agencies and where to spend increasingly scarce resources. They must also consider the “human resources” needed to conduct science. These officials wrestle with difficult challenges: How do we encourage talented students from all backgrounds to enter science and engineering? How do we train them? Is our system sustainable? How do we decide which areas of science deserve the most support from taxpayers? Does our system encourage or hinder the transformation of discoveries and inventions into new products and services? How do we know if our policies are effective?

Policy for scientists and scientists for policy

For those of us who are or have been research scientists supported by a grant from the National Science Foundation, the National Institutes of Health, the Department of Defense, the Department of Energy, or any other federal, state, or local agency, the importance of maintaining a sound policy for science is self-evident. We rely on taxpayer support for our professional growth, for our scientific pursuits, and for our livelihood. Given that reality, one might expect that research scientists would be knowledgeable in the policy processes that govern grant-making in the various agencies that support science. There is also strong incentive for scientists to have a clear understanding of how their research relates to public policy goals, and to be adept at explaining that connection to public officials and the general public. Yet, very few of us know enough about policy to help us accomplish these objectives. In some scientific circles these aspects of our work may even be looked down upon.

U.S. scientists and engineers have an obvious incentive to push for sound policies for science. And one might expect that both science for policy and policy for science should be important to every American citizen. But most of us in the scientific community can think of examples in which scientific viewpoints are marginalized, disparaged, or ignored in public policy debates. In addition, while it is common for government officials to have a scientific or technical background in some countries, such as China,¹⁵ the same is not true in the U.S.

Thus we can identify two deficiencies in scientists' personal engagement with public policy: too few researchers have sufficient understanding of and comfort with the public policy process, and too few of those with backgrounds in science and engineering play an active role in developing public policy and communicating the importance of science to the public. The Science & Technology Policy Fellowships are designed to address these problems. These fellowships immerse PhD scientists and professional engineers in the policy arena, with the goal that the scientist either returns to a career in research with a much stronger understanding of policy, or that the scientist shifts to a career in policy or public service and brings a technical background and scientific viewpoint to a government agency or a private or nonprofit organization involved in policy.

Science & Technology Policy Fellowships

The Science & Technology Policy Fellowships started in 1973 as a partnership of five scientific and engineering societies sponsoring seven Fellows serving in Congressional offices¹⁶ in what are formally known as the Congressional Science & Engineering Fellowships® (referred to as Congressional Fellows). Since that time it has grown considerably, as has the need for technical expertise and scientific analysis in federal policy development and implementation. AAAS now partners with nearly thirty professional scientific and engineering societies¹⁷ who support the Fellowships, and more than 2,300 Fellows have participated in the program. The 2010-2011 Science & Technology Policy Fellowship class includes 208 yearlong Fellows, 28 serving in Congress and 180 serving in 20 federal agencies, departments, and units. Many alumni from the program have gone on to serve in government agencies and institutions at all levels. Some of the more high profile alums include Rush Holt, a 1982-1983 Congressional Fellow sponsored by the American Physical Society, who serves in the House of Representatives (and spends his free time beating supercomputers at Jeopardy¹⁸); Kerri-Ann Jones, a 1985-1986 AAAS Science & Technology Policy Fellow in the executive branch at USAID (U.S. Agency for International Development), who currently serves as the Assistant Secretary for Oceans, International Environmental, and Scientific Affairs in the U.S. Department of State; and Gregory Jaczko, a 1999-2000 Congressional Fellow sponsored by the American Institute of Physics, who is the chairman of the U.S. Nuclear Regulatory Commission.

Scientists and engineers who are interested in the AAAS Science & Technology Policy Fellowships can apply for up to two of four program areas. Three of these place Fellows in

executive branch agencies: Diplomacy, Security and Development; Health, Education and Human Services; Energy, Environment and Agriculture. The Congressional program area places Fellows in congressional offices and committees. Applicants can also apply separately for fellowships through AAAS's partner societies, as long as they meet the society's requirements. The application process is designed to help both the applicant and the review panel determine if the Fellowship will be a good fit. The first stage of the process is a written application with several essays. To be selected for an interview, the applicant must produce evidence of a strong scientific background. No previous experience in policy or government is necessary, although the written statements must explain why the candidate's background has prepared him or her for the specific fellowship program area, as well as what the applicant hopes to gain from the fellowship year. Finally, the essays must include experiences that point to an interest public service.

If selected for the next stage in the process, the candidate is invited for a short (thirty minute) interview, and receives instructions for preparing a one-page memo on a topic related to the Fellowship area. The memo is quite different from the writing style familiar to most scientists: it is very short, it must be understandable to a policy-maker who is well-educated but not a subject-matter expert and it must end with a clear recommendation to take a specific action. Writing the memo and preparing for the interview can be stressful, but it is excellent preparation for work in the policy arena. A friend of mine who is a current Fellow at the State Department put it well: if you begin to enjoy the process of researching, writing, and presenting a memo on a policy topic, then you are probably a good match for the fellowship. If that process makes you feel increasingly ill, then working in Congress or a federal agency would probably not be much fun for you.

AAAS notifies candidates whether they are designated as finalists within a week of their interview. The next step for the three executive branch program areas is the placement process. During placement, finalists spend a week in Washington interviewing with offices at the agencies that fall under the finalist's fellowship area. In some ways matching with an office for placement is similar to finding an advisor in graduate school. Some Fellows know exactly where they want to go, and others are interested in a variety of different offices in several agencies. Similarly, some offices are looking for a Fellow with a particular background, such as experience in a certain region of the world, or expertise in a certain scientific field, while other offices are looking for someone with a broad scientific background who can contribute an analytical point of view. All offices look for Fellows who can communicate effectively. By the end of the spring, Fellows in the executive branch typically know where they will be in the Fall. Congressional Fellows go through a separate placement process that starts in mid-September.

Navigating a cultural divide

Before the Fellows head off to their respective placements, AAAS organizes a valuable two-week orientation period in early September. The orientation serves several



Fig. 1. The 2009-2010 AAAS Science & Technology Policy Fellowship class. Photo by Matt Spangler.

purposes: it is a chance for Fellows to get to know each other and their new surroundings in Washington (Figure 1); it provides a short but intense overview of the federal government and its institutions; and it gives new Fellows an opportunity to learn what to expect during the coming year.

One of the major topics covered during orientation is the contrasting (and often conflicting) cultures of the science and policy realms. I have had the pleasure of taking part in orientation twice, first as a Congressional Fellow, and later as a Diplomacy, Security, and Development Fellow. I found that my appreciation for the wisdom contained in these sessions grew tremendously after my intervening Congressional experience. As the orientation speakers emphasized, scientists and policy-makers come from fundamentally different worlds. They have different values, they use different tools, and they describe their worlds using very different languages. One phrase that stuck with me is that scientists are used to solving problems, while policy-makers must spend their time resolving issues. The organization and function of some bureaucratic structures may seem maddeningly inefficient and incomprehensible from an engineer's perspective, but they can become understandable when viewed through the lens of political consideration.

Dr. Stephen Nelson, Senior Advisor on Science and Technology Policy at AAAS, told us that to operate effectively in this new environment, scientists need to appreciate and adapt to it. They need to empathize with the policy-makers, who must make decisions in a low-information environment, in which the goals are often unclear and the policy tools poorly understood. At the same time, Dr. Nelson urged scientists to not just deliver more and better information to policy officials and decision-makers, but to work to change the very nature of decision-making. Dr. Nelson also cautioned us to be patient with our new offices and with ourselves, and to have realistic expectations.

Another memorable seminar during orientation for the Congressional Fellows was a morning that we spent at the

Library of Congress with staff from the Congressional Research Service. There, Judy Schneider, who helped write the book on how Congress works,¹⁹ drilled into our minds that politics, procedure, and policy—in that order—determine actions in Congress. This lesson can be difficult to learn, especially for scientists. It may not make seemingly irrational decisions less frustrating, but keeping “politics, procedure, policy” in mind when reading about events in Washington at least makes things seem more comprehensible.

Life on the Hill

After AAAS orientation, Executive Branch Fellows go to their offices for a short agency-specific orientation, and then begin work. Congressional Fellows must first find placement in a Congressional office, which is another learning experience that prepares them for their year on Capitol Hill. At the beginning of placement, the Fellows receive a list of offices that are interested in having a Fellow (for the 2009-2010 class, the list included more than 70 placement opportunities), and those offices receive a list of the Fellows and their policy interests (there were 32 Fellows in the 2009-2010 class). Fellows can place in a personal office or a committee, and can work in either the “House” (the House of Representatives) or the Senate. Placement can be a chaotic and intense experience, but it is a once-in-a-lifetime opportunity to meet and talk policy with Congressional staff from a wide range of political backgrounds. It is also ideal practice for the next year; the placement process requires lots of preparation, quick decision-making with incomplete information, and above all, a clear sense of your own personality and priorities. I decided to interview with both personal and committee offices on both the House and Senate side.

Over the summer I did some reading on various members of Congress and, was impressed by Senator Jeff Bingaman's work in areas that were of great interest me, including education, health care, energy, and science policy. I



Fig. 2. The author took part in Senator Bingaman's annual Student Leadership Institutes in New Mexico in February, 2010. This discussion focused on the costs, causes, and potential solutions to high drop-out rates in New Mexico.

learned that Senator Bingaman, the senior Senator from New Mexico, serves on several key committees for those issues: he is Chair of the Energy and Natural Resources Committee, he is on the Finance Committee (and chairs the Finance Subcommittee on Energy, Natural Resources, and Infrastructure), and he serves on the Health, Education, Labor, and Pensions Committee.²⁰ During placement I discovered that his staff included a fair number of former Science & Technology Policy Fellows as well as other scientists who made their way into the policy realm. Most importantly, I learned that he set the tone for an incredibly talented and down-to-earth team. When his office offered me a spot on his education team, I was very excited and felt tremendously fortunate. Little did I know at that time how lucky I was to receive that offer; my wife is a Senate staffer whom I met that year.

Just before orientation, a former Fellow told me that the first several months on the Hill were like getting shot out of a canon. I found that to be a good description. It was thrilling, terrifying, exhausting, and exhilarating all at once. The pace of work on the Hill can be beyond frenetic, especially if the issue you are working on has hit the front page of the *Washington Post* and the *New York Times*. More commonly, the pace in the Senate is "hurry up and wait." While I did not work on the big issue of the year (health care), being in an environment with that much intensity can be both addictive and overwhelming.

I assisted Senator Bingaman's Senior Education Counsel on a wide range of education issues (Figure 2). While the primary education issues that I covered were science education and education technology, I also learned about rural education issues, workforce development, Native American educa-

tion, early childhood development, K-12 policy, and higher education. Almost all of my day-to-day work in the office involved communication: writing memos to brief our staff and Senator Bingaman, working on speeches and letters, taking meetings with constituents from New Mexico, attending briefings on and off the Hill, reviewing legislative language with staff from other offices, and reading and writing lots of email.

For example, meetings with constituents from the state and with interest groups in Washington served several purposes. Lobbyists would seek information on the Senator's position on an issue, or would ask the Senator to take a certain position on a bill which had been introduced, or to support (or oppose) funding for a particular program. Our job as staffers was to gather information on the request, summarize it into a few bullet points, and brief senior staff either verbally or in writing. Perhaps more commonly, these meetings were a chance for both staffers and lobbyists to learn news about bills that might be moving forward in House or Senate committees, or about how various interest groups might be reacting to the latest development in a given issue area. As you likely know, the term "lobbyist" can have a negative connotation. However, that term includes anyone who asks a member of Congress to take a position on a given issue, including a scientist who argues for improved standards in education or funding to support basic research. I quickly learned that effective lobbyists shared some common traits. Above all, they were expert on the issue that they covered, and could quickly and concisely deliver their message—meetings on the Hill rarely last more than 30 minutes. They could produce the arguments for and against their position, and they treated staff with respect and courtesy regardless of

the party or position that they might be arguing for or against. Staffers tended to appreciate these lobbyists, who appeared to operate from the assumption that their position would “win” if all sides had the most complete information possible.

When I first began as a Fellow, preparing for meetings with lobbyists, for discussions with other Congressional offices and committees, and for internal briefings seemed an impossible task. The issue area I covered, education, included everything from early childhood development to graduate research and education policy. What was more, understanding a given proposal required some knowledge of a complex web of federal, state, and local laws and regulations. And I had it easy; Fellows and staffers who worked in the House rather than the Senate typically covered many issues. How on earth did they manage? Fortunately, Congressional staffers can call on a considerable resource, the Congressional Research Service. The Congressional Research Service consists of a team of researchers from a variety of academic and professional fields with great depth in a given issue or sub-issue. In addition, outside experts are typically quite willing, and often even flattered, to receive a call or email from a Congressional office seeking advice or input on an issue. As I learned, the job of a staffer is not to analyze a problem and develop a new solution. Typically, many technical solutions to a given problem being considered by Congress already exist. The difficulties lie in identifying the trade-offs involved in these solutions, and in developing the political support necessary to nudge policy in a certain direction. In this way, the job of a staffer is quite different from the job of a research scientist. I rarely if ever made direct use of my scientific background (my research was interdisciplinary, involving physics, applied math, and biomedical engineering), but I could speak from experience about how science and higher education policies impact research and education in universities. I also found that being able to translate the language of scientists made it much easier to communicate with constituents and advocates on science education issues. Most importantly, the analytical perspective that I brought fit very well with the approach of Senator Bingaman and his staff.

Science diplomacy

The Congressional Fellowship lasts for only one year, with no renewal, while Fellows in the three executive branch areas can renew for a second year. Fellows can re-apply in another fellowship area (as long as a Fellow serves no more than three years in total). Last spring I went through the application process again, and this year I am a Science & Technology Policy Fellow in the State Department, working in the Office of Public Diplomacy and Public Affairs, within the Bureau of African Affairs.

As one might expect, the pace at the State Department is rapid and event-driven. The organization of the State Department is complex. Roughly speaking, it is organized into a matrix of bureaus. On one axis are the “regional bureaus” that cover large regions of the world, such as the Western Hemisphere, East Asia, and Sub-Saharan Africa. On the other axis are the functional bureaus, for example, the

Bureau of Economic, Energy, and Business Affairs; the Bureau of Democracy, Human Rights, and Labor; and the Bureau of Oceans and International Environmental and Scientific Affairs. Secretary Clinton has ordered a re-organization of the State Department under the *Quadrennial Diplomacy and Development Review*.²²

My office is in a regional bureau (the Bureau of African Affairs), and has functional responsibility. The mission of our office is to inform and engage the American public on U.S. policy in Sub-Saharan Africa (which is referred to as “public affairs”), and to inform and engage publics in Sub-Saharan Africa on issues that are important to the U.S. government (“public diplomacy”).

Our office sought a Science & Technology Policy Fellow because of the great interest throughout the State Department in science diplomacy. This interest comes directly from the top, so to speak. On several occasions, both President Obama and Secretary Clinton have described how science plays a key role in the administration’s diplomacy and development strategy. The President’s 2009 Cairo speech²¹ is perhaps the best known example. “Science diplomacy” often refers to three main ideas. The first is diplomacy for science (you may be noticing a pattern here), the bi-lateral or multi-lateral agreements needed to conduct an international scientific project. The second, science for diplomacy, is perhaps more interesting from the policy perspective. Science for diplomacy refers to using science as a basis for engagement, especially with countries in which bilateral relations with the U.S. are challenging. Perhaps the most well-known example of science diplomacy comes from the Cold War, when interaction between U.S. and Soviet scientists was one of the only channels of communication in an otherwise hostile relationship.

Our office is most interested in the third aspect of science diplomacy, which is science outreach directly to foreign publics. Even in countries that view America with a high degree of distrust, science is one area in which the U.S. is almost universally admired. In Sub-Saharan Africa, where the U.S. enjoys relatively good relations, many of our Embassies and Consulates use science outreach as a key tool in public diplomacy. Because of the obvious connection that science and technology have to other important policy issues such as health, education, and economic development, science outreach can be a good mechanism for engaging with a variety of sectors within a country. Science outreach is also an excellent way to connect with young people in Africa, which is the top priority for our office. Given recent events in North Africa, governments on the rest of continent have a clear incentive to listen to and learn from their young people, rather than continue to ignore the needs and opinions of the next generation.

Initially, my job in the office was to cover anything and everything science-related. However, the leadership in our office has commented to me that perhaps my most valuable contribution is my ability to offer an analytical and data-driven perspective. I am fortunate to work in an office that has a real desire to bring data into conversations that have nothing to do with science outreach. I am also lucky to work with



Fig. 3. The Mae Jemison Science Reading Room is a rich environment for students in Mamelodi Township, just outside of Pretoria, South Africa. For many students, the Reading Room is the only place where they can learn about science and technology; their enthusiasm for science is palpable! The Mae Jemison Reading Room is a partnership between the U.S. Embassy in Pretoria, the University of Pretoria, and Mamelodi Township.

friendly and patient colleagues who have helped me navigate the complex State Department structure and culture.

One of the highlights of my year has been a trip to South Africa and Botswana. I traveled with the officer who covers all State Department public diplomacy activities in southern Africa. The goals of the trip were threefold: to learn about South Africa and Botswana and the goals and activities of U.S. Missions there; to report back to the office on Embassy and Consulate outreach goals and plans, as well as any problems or issues they are facing; and to conduct public outreach events. We spent roughly a third of our time meeting with Embassy and Consulate staff. The rest of the time was spent meeting external groups, and taking part in several science outreach events. In Pretoria, we met with teachers and students at the African Leadership Academy,²³ which is an ambitious initiative to develop the next generation of leaders in Africa, and visited the Mae Jemison Science Reading Room,²⁴ which is a partnership between the U.S. Embassy in Pretoria, the University of Pretoria, and the Mamelodi Township (Figure 3). In Johannesburg, I led a discussion on science education policy in the U.S. and South Africa with K-12 science educators and university faculty. That discussion was a good example of how science outreach can help U.S. Missions advance their policy goals. Helping South Africa improve its education system is a top U.S. Mission policy objective. While my few hours there obviously did not have much impact on student achievement, the U.S. Consulate in Johannesburg was able to use my visit to develop and strengthen Consulate relationships with the university, an important and influential education policy stakeholder in South Africa. In Cape Town, I met with students at the African Institute for Mathematical Sciences,²⁵ and later with students at several local high schools that focus on science and technology, one of which has a virtual exchange program with a high school in Los Angeles. Finally, in Gaborone, I met with faculty leaders at the local university and led two roundtable discussions on climate change (Figure 4), one with uni-

versity students and another with local, non-governmental environmental organizations.

I have very much enjoyed my experience this year in the State Department. I plan to renew the Fellowship for one more year, after which I will decide what path to take next. Perhaps the most important lesson I have learned over the last several years is that it is impossible to predict the future. That said, my experiences as a Science & Technology Policy Fellow have been transformative, and I expect to continue to work on policy-related issues, whether in the public or private sector, after my Fellowship ends.

America needs scientists in policy

Applying the scientific method to complex policy issues is not always realistic (try to imagine a controlled experiment on an ensemble of State Departments). Yet scientists can bring an analytical and data-driven perspective that can significantly improve the policy-making process. Unfortunately, including a scientific perspective as one of several points of view in policy development is not as common as it should be, and this deficiency has consequences. As John Adams, one of our country's Founders, would say, facts are stubborn things. When our elected officials ignore empirical facts and scientific evidence, it is not just the science community that feels the impact; eventually all of society suffers.

It is not realistic for scientific principles to be the primary driver behind public policy decisions. Nor would that be desirable; public policy is a tool by which a given society organizes itself, and that policy must in some way reflect that society's values. As Richard Feynman argues in *The Meaning of it All: Thoughts of a Citizen-scientist*,²⁶ a thought-provoking set of lectures on science and its role in society, ethical values lie outside the scientific realm (Feynman acknowledges that this assertion may be controversial to some. His lectures, and his defense of this position, are worth reading). However, science can identify policy options, and can forecast potential



Fig. 4. The author met with environmental civil society organizations at the U.S. Embassy in Gaborone, Botswana to discuss climate change and the COP-17 climate negotiations that will be held in Durban, South Africa at the end of 2011.

implications of those options. Scientists can also contribute an analytical problem-solving approach and a way of thinking about the world that can be a valuable addition to any decision-making process.

What you can do

My glimpse into how federal agencies and Congress operate has been brief and narrow, and my understanding of how our government works is certainly quite limited. Yet I can see that there is a tremendous need for a scientific perspective in government, even (or perhaps especially) in agencies or issue areas that may not directly relate to science. I also have a great appreciation for the extent to which scientific researchers rely on wise policies to support their profession. Thus, there is plenty of motivation, both altruistic and self-interested, for scientists and engineers to be involved in public policy and service.

An extended stay in the policy realm will not be a good fit for most scientists, and that is a good thing. We need our scientists to do science. But there are several important ways in which scientists and engineers with nearly any combination of interest and background can get involved in policy and public service. The list below is by no means exhaustive, but hopefully it will help you come up with a good idea—act on it!

1. Work in policy. If you have the interest, consider applying for a Science & Technology Policy Fellowship, or pursue other opportunities to serve for a year or two in government. AAAS provides excellent information on policy fellowship opportunities²⁷ and its other science policy efforts²⁸ through its website. If you find yourself drawn to policy discussions and catch yourself listening to the Sunday morning political news programs or C-SPAN, a Science & Technical Policy Fellowship will almost certainly be an amazing experience for you. It can be a good fit for scientists at career transition points, such as after a postdoc, as well as for established researchers who are interested in something different for their next sabbatical experience. You can also offer valuable policy insight at the state and local level; in the U.S., policies developed by state and local governments can have tremendous impact, particularly in education. Dr. Greg Swift's essay on his experiences helping to write New Mexico's state science standards is a wonderful example of how scientists can engage in policy development in ways that have immediate and significant impact on communities. (It appears in this issue of *Acoustics Today*.) You can also serve in your local government, such as on a school board or in another capacity.

2. Talk to your elected representatives. Meet with staff in your Senator's and Representative's local office. If you are in the Washington area for a conference, take some time to meet with staff on Capitol Hill. When you speak to staff, keep your conversation focused on policy. It can be difficult to resist the temptation to delve into the details of your work, but you will have a more productive conversation if you can help them understand why the issue you care about is important to their state or district. If you disagree with their position, try to understand why they are taking it, and be con-

structive in your opposition. Be realistic about the outcome of the meeting; passing legislation is enormously complicated and progress is typically slow. Finally, seek their advice; ask them what they think you should do to help advance your issue. There might be local strategies that you can pursue that will produce quicker results. You will be speaking to someone who is bright, energetic, and who likely has a strong network of contacts in your state or district that might prove to be useful.

3. Develop opportunities in your institution. For scientists at universities, one of the most important ways to impact policy is to provide opportunities for students to learn about and engage in science policy and science communication. Investigate your institution's career services offerings, and encourage your career services office to provide students with information on policy careers and science policy fellowships. As you design your course curricula, think broadly about the types of careers that might benefit from the skills and knowledge that you are teaching. Build science communication into all of your department courses, and consider offering seminars or courses on communicating science to non-scientists.

4. Contribute to effective outreach. Agencies are increasingly encouraging scientists who receive federal support to conduct outreach. As that trend moves from "encouraging" to "requiring," researchers have felt more pressure to develop outreach programs. Understandably, that pressure can be frustrating. A good friend who is also a recent university faculty hire has been wrestling with this issue. As he said to me, there is no doubt that scientists and engineers have a responsibility to inform the public about the impact of their research and to inspire and encourage the next generation of scientists. Yet although he personally enjoys working with schools, he is torn about the most effective way for professors to engage in K-12 outreach while making the most efficient use of taxpayer dollars. As he pointed out, most scientists are good at research, and may not be as talented teaching elementary school students.

We thought of two ways that a scientist could approach this issue. The first suggestion is to talk to your funding agencies and your elected officials, and offer constructive suggestions about how your funding agency could change its policy to make the most efficient use of both taxpayer funds and scientists' time and effort. The second suggestion is for science and engineering faculty to design outreach programs that are as effective as possible given the requirements of the funding agency. For example, rather than try to develop an outreach program or science education research project from scratch, my friend pointed out that science education outreach efforts and centers already exist in many universities. A good strategy might be to learn more about how you can best contribute to these existing efforts on your campus or in a nearby institution. Rather than teach middle school classes, you might be better suited to developing science kits, to contributing to curriculum design, or to providing advice and equipment to help set up a lab. For example, one of the authors in this series, Dr. Garrett, has developed an acoustic laser kit for middle- and high-school students.²⁹ Or, you might help

recruit colleagues in academia, industry, or government who can talk about the variety of career options for a person with a science or engineering degree.

5. Get informed. At the very least, learn about the science-policy interface now, with the expectation that you might find the time to become more active in the future. Join organizations like AAAS that work in this interface and/or subscribe to magazines such as *Issues in Science and Technology*³⁰ or *Foreign Affairs*³¹ that explore these issues and see what grabs your attention!

We hope that the articles in this issue have shed some light on science policy, and that the series has given you some good ideas about how you can engage in public policy and service. As a scientist, you have a lot to contribute, and your effort can make a difference. Once you find a way to get involved that matches your interest and background, I am confident that you will find the experience deeply rewarding.**AT**

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An advertisement for Odeon Room Acoustics Software. On the left, a black background contains the Odeon logo (a stylized 'O' with concentric arcs) and the text 'ROOM ACOUSTICS SOFTWARE'. Below this, it says 'The **Formula 1** in Room Acoustics now handles array loudspeakers and clusters.' and the website 'www.odeon.dk'. On the right, a 3D architectural rendering of a modern interior space with blue and white walls and red decorative elements is shown. In the foreground, a man wearing a headset is sitting at a desk, working on a computer with a monitor displaying a colorful sunset scene.