STEPPING UP TO THE TABLE: A FEW THOUGHTS ON THE ROLE OF SCIENTISTS IN THE POLICY-MAKING PROCESS

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This is an interesting time, if you will permit me such an understatement. For the nearly seven years I've been on Congressional staff, starting as an American Institute of Physics Congressional Fellow in 2004, I have sincerely believed that, with few exceptions, Members of Congress and their staff strongly support science, respect the scientific enterprise and its practitioners, and believe there is a federal role in supporting scientific research. (It turns out the public is more positive about "scientific research" than it is about "basic research" or even "advanced research.") The exceptions have been high-profile perhaps, but they have been few and far between.

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Of course it is never so black and white. For example, there is a segment of lawmakers who are admittedly selective in their support for science—happy to fund physics and computer science, for example, but in search of opportunities to reduce federal support for social sciences. I see that as a challenge to the social scientists to make their case better and to the rest of you to step in and voice your support for this valuable area of research. There are others who believe that the federal government has no business supporting "applied research" and "development"—that those endeavors are the purview of the private sector alone. I have come to understand that the scientific community itself does not make this same clear distinction between "basic" and "applied" research as does the Office of Management and Budget (OMB). To further muddy the debate, the private sector uses yet another set of definitions for "basic" and "applied." Nevertheless, the definitions handed down by OMB guide federal budget decisions and set the tone for ideological divisions about the proper role of government in supporting research.

So I do my best to resist over-generalizing anything. However, if it is reasonable to generalize at all, I would offer that the challenge to building support for research funding across all disciplines and missions has not been willful dismissal of the importance of these research investments to our society, but rather that most Members of Congress don't prioritize science above other concerns and interests. Members care about what their constituents care about, and they have to explain their funding decisions back home. At the moment, the number one priority for most Americans is jobs. You and I might have no doubt that investment in science and technology now lead to job creation in the future. There are various estimates about the critical importance of research investments to our nation's economic growth and they all validate what we take as a given. But drawing a straight line between investments in scientific research and job creation is really hard to do, and even if we could do it better, it still wouldn't address today's job creation needs. Notwithstanding the President's recent State of the Union address, with the short attention span built into our electoral system and the pressing needs of today dominating the debates, science funding just doesn't make for good politics.

What about incorporating science into broader policy decisions? I take it as a given, and not inherently a negative, that science has just one seat at the policymaking table. And I accept that there are some lawmakers who willfully ignore the science because it contradicts ideologically or politically driven positions. That's nothing new. What concerns me much more is the subset of lawmakers who are open to incorporating the science, but do not understand what the science does or does not mean, or what the technology is or is not capable of. They are not scientists, nor are their staff. But more to the point, most of them never developed basic science literacy. And that's not something even most highly intelligent and educated people can learn on the job, especially people whose attention is pulled in a hundred different directions every day. The lack of basic literacy, the lack of understanding of the scientific process, the often visible discomfort at talking about science, is a failure of course of our education system. We succeed, if anything, in beating any love for science out of the majority of our students from a young age. So how do you compensate for that, short of fixing the education system and waiting around for the next generation to enter government?

I do not pretend to have all of the answers. There are some very smart people who have spent decades in Washington and are still regularly questioning and reassessing their efforts. Nevertheless, I believe there are some basic principles that we all agree on. First, scientists and those who represent scientific consensus in Washington policy debates must learn how to communicate effectively with policy makers. That's not easy. Scientists are rarely trained to communicate to non-technical audiences. Furthermore, scientists have a hard time understanding the non-linear process and culture of politics that help drive decision-making in Washington. But science and engineering disciplinary and professional societies as well as many other science-related groups and coalitions play an important role in building the bridge between these disparate worlds. They help to educate policy makers about the scientific enterprise, and about the scientific and technical elements of a given issue. They also help to educate the scientific community about how policy is made, and how scientists can effectively communicate their relevant scientific findings and ideas to policy makers. To a much lesser, or perhaps just a much more selective extent, industry also plays a role in bringing science and technology issues to the attention of lawmakers.

Second, the scientific community must carry out an effective and persistent campaign of science advocacy. Actually you must develop many campaigns, for science funding, science policies, and the role of science in broader societal challenges. If you want science at the table, you have to march up to the Hill and make your case. And then you must recruit others, especially the private sector, to join you in making the case to Congress. A few business sectors have become increasingly visible on research funding and science education issues in the last few years. But overall, private sector lobbying on these issues still pales in comparison to the time and money spent lobbying on tax, visa, and regulatory policies. It is also important to reach out to your Representatives and their staff back in your home districts, where they have more time to spend with constituents and where there is a better opportunity to establish lasting relationships.

By now you have noticed that I am simultaneously discussing two somewhat distinct topics: policy for science and science for policy. Or, more specifically, advocacy for policies and budgets that directly affect the scientific enterprise itself; and advocacy for the inclusion of scientific data and understanding in decision making on the full range of policies affecting health, environment, energy, national security, and other major issues before our country and the world. If there is one key point I hope to make, it is that on both fronts, scientists have to speak to be heard. I hope the following two examples will convince you of just how important it is for the scientific community to actively participate in the policy-making process.

A few months after I started as an American Institute of Physics (AIP) fellow on the Science Committee, I was handed the nuclear Research and Development (R&D) portfolio. I knew nothing about the nuclear fuel cycle, and practically overnight I became the Committee's, and one of the House's leading experts on it. I say that not to sing my own praises but once again to underscore the fact that for such highly technical topics, the overwhelming majority of Members and staff simply lack the tools to really dig deep and understand them. I had a physics background (my own dissertation topic of cavitation was not particularly helpful), which was necessary if not sufficient for understanding the nuclear fuel cycle. It also didn't hurt that I spent two years as a post-doc in a radiation oncology lab. Still, I had a lot to learn. At one point, I taped a periodic table of elements to my office wall so I could keep straight in my head the different constituent elements of spent nuclear fuel. I also read as many nuclear fuel cycle primers as I could get my hands on and asked a lot of questions of the experts when I had the opportunity to meet with them.

It was just at that time that the Bush Administration announced the Global Nuclear Energy Partnership, or GNEP. In short, the Department of Energy (DOE) was proposing to move expeditiously to a regime of fuel reprocessing and recycling. After all, the French and Japanese were way ahead of us, according to their argument, and it was in our economic and national security interest to take the lead once again. Actually, DOE rolled out many versions of GNEP over the next 20 or so months until the Democrats took over Congress and effectively killed it. But the gist was always the same, and if anything, each iteration moved further away from any kind of scientific and for that matter, economic or political reality. Congressional testimony, expert panel reviews, and editorials in major newspapers and trade press by and large supported this skeptical view of GNEP by the end.

My subcommittee chair at that time, who was a strong advocate for a nuclear renaissance, had oversight responsibilities for DOE's nuclear R&D programs. In other words, our subcommittee had oversight over all of the R&D components of GNEP. DOE's plan, as I and many experts saw it, was to skip over most of the basic scientific and technological challenges in reprocessing and recycling, and jump clear ahead to large-scale demonstrations of separations technology already demonstrated in other countries. And yet, if you looked at the illustrations and description of the fuel cycle on the agency's glossy power point presentations, someone without the technical understanding might easily believe that what DOE was planning to do was much more technologically advanced than the Japanese or French had already demonstrated. DOE's story was quite compelling to most of the pro-nuclear Members of my committee, including my own subcommittee chair.

There were additional political, or at least parochial, factors at play. Funding for GNEP meant funding for a few of DOE's National Labs, including Labs in the districts of more than one of our committee members, Republican and Democrat. So, not surprisingly, the scientists and engineers at those Labs were advocating for GNEP to my committee. Some of those scientists and engineers later quietly admitted that they had significant reservations about DOE's plans, but at the time, they saw an opportunity for increased research funding and they understandably pursued it. At the same time, the Energy and Water Appropriations Subcommittee Chair in the House, and the Senator who wore both the authorizing and appropriating hats in the Senate, were also very pro-nuclear. One was generally sympathetic to, and the other a passionate champion of DOE's GNEP plans. Major companies hoping for an opportunity to secure big government contracts were also lobbying for GNEP. Despite the significant flaws in its plans, DOE had almost everything aligned in its favor.

Almost everything, that is, except for the broader scientific community outside the National Labs, and those of us in Washington who were helping to serve as a bridge between the scientists and the policy makers. I know there were many people who played a role here, most of them much greater experts than me, so I don't mean to overstate my own role. If

I wasn't there, I could name at least a couple of former colleagues who could have served the same role as I did within my own Committee. At the same time, I don't want you to underestimate the role that a single, well-placed, scientifically literate staffer in Congress can play in ensuring that science is incorporated into decision making.

Over the course of several months, as I became more and more educated about the challenges and opportunities in nuclear R&D, I communicated what I knew and understood to my subcommittee chair in a way that she could understand. And I continued to advise her as she became one of the most vocal Republican critics of GNEP on the Hill at the same time she remained one of the most passionate advocates for an expanded role for nuclear energy. I emphasize Republican because the Republicans were in control then, of both Congress and the White House, so Democratic opponents to GNEP could throw stink bombs, but they lacked the power to block the Administration (at least in the House). And then I sat down with the House appropriations clerk responsible for advising his Members on funding decisions for DOE's energy programs, and walked him through what I knew and understood. As I mentioned previously, his boss was generally sympathetic to the idea of GNEP, but also very skeptical about the details. The clerk used my scientific arguments on top of the project cost arguments to support his boss's advocacy for reducing funding for GNEP and prohibiting premature large-scale demonstrations. In negotiations with the Senate, the House position prevailed. Remember, that happened during a Republican Congress in response to a Republican administration's proposal.

Other people were focused on the economic and security implications of GNEP. My job was to help introduce the scientific arguments, translated from the scientists themselves. We had a physicist among our Republican committee members, and he caught on very quickly that the GNEP proposal was highly flawed, but as highly respected as he was by his colleagues, his voice alone would not have been enough. Members needed to hear from the scientific community directly. So we held hearings and invited a diverse group of experts to testify before the Subcommittee. Notably, all of the witnesses invited by my subcommittee chair were supportive of nuclear power and of a nuclear research program at DOE. Most of them, however, offered stinging critiques of the Administration's plans under GNEP.

One of my most memorable moments from that entire period was when a mid-level DOE official testifying before my subcommittee made the following statement in response to a question from my chair: "Like you, I will admit, a facility on the order of, you know, 200 metric tons to 500 metric tons 'scares me to death.' One is we don't know enough to go to that size facility. Secondly, I doubt we could afford it."[1] At the time, DOE was proposing an engineering-scale facility of about 100-200 metric tons. That official's very off-message, spontaneous remark was telling for how much the Administration had excluded its own experts in developing the GNEP vision. The DOE political leadership believed that they needed to move beyond funding the basic research and start actually "doing something" about nuclear energy. Even those who supported this premise eventually concluded that DOE's plans completely ignored the current state of the science and technology. To be sure, I am not making any sweeping generalizations about the Bush Administration's treatment of science, nor about the role of science at DOE during that Administration. I am simply describing one narrow but potentially consequential example of an arguably well-meaning policy proposal that dismissed the science from the outset, and how those of us working on that issue at that time forced the science back to the table.

My own role on the committee took a pretty sharp turn in 2007 when I joined the Democratic staff (where I continue to serve) and swapped DOE and nuclear energy for the National Science Foundation (NSF) and academic research policy. It turns out to be a pretty different job in many ways. Now my specific scientific background is less important than just the fact that I have a decent sense of how a university research lab operates and I can personally relate to the experiences of undergraduate and graduate science and engineering students. If anything, my "jack of all trades" training is advantageous in that it enables me to communicate with scientists and engineers across many disciplines.

In 2007, and again in 2010, I played a lead staff role in the development and passage of the America Creating Opportunities to Meaningfully Promote Excellence in Technology Education (COMPETES) Act and the subsequent COMPETES Reauthorization Act. The COMPETES Act includes authorizations for the National Science Foundation, DOE's Office of Science, and the National Institute of Standards and Technology. The 2007 Act also created the Advaced Research Projects Administration-Energy (ARPA-E) at the Department of Energy, a significant achievement for my former chairman. The 2010 Reauthorization Act authorizes a number of new and ongoing innovation programs and activities consistent with the current administration's innovation agenda. Both laws seek to strengthen the federal role in improving science, technology, engineering, and mathematics (STEM) education.

The Science and Technology (S&T) community tends to focus on the authorization levels in COMPETES, but I consider those numbers only a small part of what makes the bills important. The policy details are where authorizing committees such as my own exercise real authority in helping to shape the directions of the agencies and their various R&D and STEM programs. The Appropriators, on the other hand, set actual funding levels, from the top level funding for DOE's Office of Science, for example, down to individual project funding if they want to. The Appropriators are guided, but not bound by authorized funding levels.

The many policy provisions in COMPETES reflect extensive input from the dozens of hearings and countless meetings we held with both agency officials and nonfederal stakeholders. We are one of the checks in a system that was designed for checks and balances, and because Members of Congress answer directly to stakeholders to a degree that agency officials rarely do, it is in particular a check to ensure that the federal government is responsive to the needs and priorities of all of the communities it serves. For COM-

PETES, the nonfederal stakeholders include colleges and universities big and small, individual faculty, science and engineering societies, companies big and small, industry associations, various advocacy groups for issues such as women and minorities in science, and many more individuals and organizations focused on improving K-12 STEM education. We had to weigh and balance these views against our own Members' priorities, agency priorities, and budget and other political realities. There are maybe 10 pages in either COMPETES bill that have anything to do with how budgets are allocated. The rest represents our best efforts to incorporate all of the aforementioned input into coherent guidance for agency policies and programs that still allows agencies flexibility to shape the details and let programs evolve with time. There is some amount of compromise every step of the way—but we learn quickly not to let (what we believe to be) the perfect to be the enemy of the good. I suspect that nobody will say that either COMPETES Act is perfect. But I personally believe that both of those laws are very good, and as important in the message they send as the policies they establish.

I've just briefly described two examples of "science policy" that were enacted by Congress in the last several years. But the truth is, my first instinct in answering the question of how federal science policy is made is to answer, "it isn't." There is no single authorizing committee in either chamber of Congress responsible for all federal R&D, even all civilian R&D. It's fractured and stove-piped, driven in part by personalities, political winds, and the two-year election cycle. The same is the case for appropriations, where each of the 12 subcommittees is its own fiefdom and R&D accounts are scattered across the majority of the subcommittees—nine at my count.

And so it goes for the executive branch as well. In Fiscal Year 2011, the proposed federal R&D budget is $148 billion, of which $66 billion is nondefense. (I did not update these numbers to reflect the final appropriations bill enacted by Congress in April.) A total of 14 federal agencies, including the Smithsonian, are considered to have significant enough R&D expenditures to report as part of the White House's annual R&D summary. The largest, of course, is the Department of Defense, followed by Health and Human Services (HHS). But many of those 14 agencies listed are at the cabinet level, such as DOE, which has both the Office of Science and several applied energy R&D offices; Commerce, which houses both the National Oceanic and Atmospheric Administration (NOAA) and National Institute of Standards and Technology (NIST); and HHS, which is the parent agency to National Institutes of Health (NIH), the Food and Drug Administration (FDA), and the Centers for Disease Control and Prevention (CDC). So in practice, we have many more than 14 at least somewhat autonomous federal R&D performers. The White House Office of Science and Technology Policy (OSTP) was established to coordinate R&D initiatives and budgets across the federal government. But with a small operating budget and no programmatic authority of its own, OSTP can only do so much in terms of developing and implementing coherent national policies.

In the end, even when the White House does announce (with every good intention) a new national initiative, every agency defends its own priorities and own way of doing business. In fact, every office within every agency has its own priorities and culture. Returning to Congress, the House and Senate, their respective leadership, the relevant committees, and even senior rank and file Members have their own priorities. So there's a complicated dance that goes on across the government every year, and nobody, anywhere, is truly looking across the entire R&D portfolio and trying to manage and prioritize across agencies, science and engineering disciplines, and national needs.

But let us explore the alternative here for a moment. What if we were to consolidate authority for all civilian R&D, in both Congress and the Administration? For the purpose of this exercise, we'll leave the weapons development to the Pentagon. Many countries do indeed have a Ministry of Science and Technology, or something comparable. One of the complaints we often hear from science attachés in embassies here in Washington is that there is no single point of contact within the federal government on almost any S&T issue. But what if we had a single point of contact? A single agency or at least a much smaller number of agencies.

There are advantages to such a model, for sure. Coordination across missions, such as energy and agriculture, and across science and engineering disciplines, such as computer science and biomedical science, would be much easier. There would be no need for an OSTP without budget authority, because we would have a Department of S&T with budget authority. We would be able to establish cross-cutting priorities and actually implement them as intended, or at least face fewer obstacles to implementing them. Likewise, Congress would have the opportunity to look holistically at the federal R&D enterprise when developing its own policy and budget priorities, even if it all still goes through the sausage-making process in the end. How rational is it, after all, that my committee has authority over most of the federal civilian R&D enterprise, but not NIH? Instead, NIH is overseen by the Energy & Commerce Committee, where, even at $30 billion, it is a relatively low priority compared to the rest of the committee's vast jurisdiction. In my 4 ½ years serving on the subcommittee that oversees NSF, not once have staff from Energy & Commerce reached out to me or my colleagues to discuss how NIH can better coordinate with NSF and the other science agencies to improve the health and well-being of our society. On the other hand, I have actively collaborated with Armed Services Committee staff on a few issues of mutual interest. We even put together a successful joint hearing a few years back, which was no small feat. But in general, we're all so stove-piped, in the executive branch and in Congress. Wouldn't it be better to consolidate the R&D authority? I believe the answer is no, for the following reasons:

1. Across the leadership of our government, at all levels of leadership, in all parts of our government, there are visionaries who can't manage, excellent managers with no vision, egos enough to drown you, Washington savvy without substantive expertise, substantive expertise without Washington savvy, and so on. Nobody has it all. So what if, instead of a dozen Cabinet Secretaries, several Congressional Committees, and hundreds of senior agency officials with significant budgetary authority, we have just a handful of people with any real influence on setting R&D priorities. The naïve part of me suggests that we might lose a lot of the wisdom, vision, and experience (and likely some less flattering attributes) of the hundreds no longer part of the process, but maybe we can make much of that up through advisory boards and other forms of input. But the cynical part of me says that putting all decisions for the direction of science in this country in the hands of a few is a bad idea—bad because of the constantly shifting political winds and because the consequences of mistakes, poor decisions, and incompetence would be amplified, perhaps catastrophically. We may have removed some redundancy and inefficiency, but we have also removed a lot of the checks from the system that keep it vibrant, diverse, and sustainable.

2. Lawmakers don't often connect support for research budgets to the issues they care about most. And even when they do make that connection, the electoral system forces them to think in terms of short-term benefits, while the benefits of scientific research are usually long-term and often unknown. Therefore, they may say all the right things about science, but they won't put science ahead of other priorities during tough budget times. So if you put all $66 billion of civilian research into a single budget line, rather than scattered across several smaller budget lines, such a large number may be even harder to defend and easier to raid.

3. Finally, I worry about the consequences of separating R&D from the missions. With the exception of NSF and the National Aeronautics and Space Administration (NASA), every other R&D agency or office is part of a larger agency with a domestic mission—agriculture, energy, environment, oceans, health. Does it really make sense to disconnect the R&D underpinning those critical missions from the regulatory and policy making for those missions? By placing all R&D in its own agency and giving it its own budget as we are imagining, we have created a new, potentially more consequential stovepipe in our government.

So our system might be chaotic and irrational to those of us with scientific (read: rational) training, but in the end it seems to work pretty well. I would love to tinker around the edges, but I would not propose a wholesale overhaul of our federal S&T enterprise. We remain, after all, the overall leader in generating new ideas, pushing the frontiers, and educating the world's best scientists and engineers. There are troubling signs that our lead is slipping and I do believe that we should collectively challenge our leaders and our universities to take a hard look at where we are, where we want to be, and what we need to do to get there. While I understand how difficult it is to achieve meaningful reform, I do see promising movement in the greater scientific community to take on this challenge, both with and without regard to the current budget context. I look forward to seeing the fruits of their efforts in the years ahead.

I opened by stating that this is an interesting time. What I meant, of course, is that this is a frustrating time in which optimism is hard to come by. Since deciding to leave research for policy, I have had the honor and privilege of serving under some true leaders in what has been the most exciting, challenging, and fulfilling job I can imagine. And through all of the ups and downs (and there have been downs) I have never compromised, or been asked to compromise, my integrity as a scientist. This job has been for me the perfect intersection of two passions: science and policy. But it feels a little worse now—not just the painful cuts to research and research infrastructure budgets across the board and what that may mean for U.S. leadership in science and technology and our long-term economic growth, but the rhetoric around the integrity of scientists and of the scientific enterprise. Some days I feel like I woke up in an alternate universe. But I also believe that times like this can jolt us out of complacency in a way that generates real reform. So I choose to reach way down to summon some optimism. Giving up is not the answer. With that said, I look forward to continuing to work with my colleagues in Washington and across the scientific enterprise toward our shared goals of a vibrant R&D enterprise and a rightful place for science in the policy making process.**AT**

References

1 This article is adapted from a talk I delivered as part of a week-long seminar in science and technology policy offered annually to science and engineering professionals in the Washington, DC area. This article contains my own opinions only. Nothing written here should be construed to represent the official position of the Science, Space, and Technology Committee or any Member of the Committee.

2 Hearing on Assessing the Goals, Schedule, and Costs of the Global Nuclear Energy Partnership, Subcommittee on Energy, April 6, 2006, GPO Serial No. 109-44.

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