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Engineering and American Diplomacy

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We need engineering-literate people in the policy-making arena.

During my recently completed three-year tenure as the first science and technology adviser to the secretary of state, I got my comeuppance one day as I addressed a group at the National Academy of Engineering (NAE). As part of the U.S. Department of State's outreach to the U.S. science and technology (S&T) community, I frequently address technical audiences, trying to arouse their interest in S&T as an essential element in the formation of U.S. foreign policy (NRC, 1999a). When I finished my talk and asked for questions, a voice in the audience called out, "You talk about science and technology - well, what about engineering?" Slightly nonplussed, I mumbled something about the word "technology" being synonymous with engineering for me. But later I began to think that I may have been shortchanging engineering as a profession. I realized that to engage the engineering profession, I had to talk not just about technology but also about the role of engineers and engineering societies (Neureiter, 2004). That is why I am pleased to amplify George Bugliarello's eloquent editorial appeal in this issue for more engagement by engineers in addressing global challenges - in both policy and practice.

This is the first time I have written for an engineering publication, and I must begin with a confession. As an organic chemist in college, I admit I looked down on engineers. They were a slightly strange lot of guys (no girls in those days) with pocket protectors and dangling slide rules. Their building at Rochester was across campus, out in the boonies. There was no room in their schedules for English, history, foreign languages, or philosophy. We chemists may have had acid holes in our clothes, but we wore them as badges of honor because we were doing "pure science" in pursuit of "fundamental knowledge." Engineers always seemed to have a kind of academic grease under their fingernails.

My epiphany began when I joined the Humble Oil Company (now part of Exxon) where I found that chemists were outsiders whose ideas were usually dismissed by managers who had grown up in the oil patch. Engineers ran the place, turning sulfurous black crude into the gasoline and petrochemical feedstocks that fuel the national economy. Later, I joined Texas Instruments (TI), where the entire corporate cuture was defined by engineers; even the chief financial officer was an engineer. In 2001, when a revered friend, Jack St. Clair Kilby, a modest former electrical engineer at TI with no Ph.D., was awarded the Nobel Prize in physics for his 1958 invention of the integrated circuit, my false chemist's pride was dashed forever.

Engineers make things, things that work, and engineers keep them working. After a visit a couple of years ago to a deepwater drilling and production platform in the Gulf of Mexico, it seemed to me that engineers could do just about anything they put their minds to. It was an unforgettable experience to see, and even more to feel, that huge, $1.5-billion floating structure tethered to the bottom, producing and partially processing some 50,000 barrels of oil and millions of cubic feet of natural gas per day from 14 different wells and feeding the output directly into pipelines for transit to the East Coast.

But what does engineering have to do with diplomacy and the Department of State? The role of the State Department, with its approximately 250 embassies and consulates abroad, is to formulate and implement the foreign policy of the United States and to manage our relationships with the some 190 countries and many international governmental organizations, such as the United Nations, the World Health Organization (WHO), the Food and Agricultural Organization, NATO, UNESCO, and many others.

Since September 11, 2001, U.S. foreign policy and domestic policy have been dominated by the global war on terrorism and ensuring homeland security. But beyond the horrors of today's headlines, a steadfast goal of U.S. foreign policy continues to be building a world of peace and prosperity for all

people in the world. Beyond stopping terrorists and controlling weapons of mass destruction, U.S. foreign policy addresses climate change and global warming, environmental degradation, natural disasters, new sources of energy, food safety, HIV/AIDS and other infectious diseases, transportation, communications, the livability of cities, and economic viability for a world population that may reach nine billion by 2050.

To meet these formidable challenges in a complex, interdependent world, we must find a path to sustainable development - a way to reconcile development goals with the long-term environmental limits of our planet. The vocabulary of diplomats includes not only politics and conflict, but also other topics, such as new energy technologies, clean water, pandemic diseases, genetically modified foods, the preservation of tropical forests, computer security, education, intellectual property, marine resources, and the role of science and engineering in economic development, to name but a few. In the NRC report I mentioned earlier, the study committee noted that 13 of the 16 stated goals of U.S. foreign policy involve considerations of science, technology, or health. The committee called on the Department of State to strengthen its capacity to deal with these kinds of issues and to appoint a science and technology adviser to the secretary of state to drive the process.

The State Department is a very complex institution, with some 25 bureaus that participate in the policy formation process on a wide range of issues. The traditional heart of the department are the six regional or geographic bureaus that house the "country desks" that oversee U.S. relations with every country in the world. The other bureaus are functional bureaus - centers of expertise in specialized areas that may apply to any or all countries or regions. These specialized areas include economic and business affairs; arms control and nonproliferation; consular matters; oceans, environment, and science; democracy and human rights; and refugees and migration. Bureaus with different perspectives may have different opinions on issues, making the development of a coordinated policy position very challenging.

It would be nice if S&T inputs to policy could be made by whispering in the secretary's ear, but nothing could be further from the truth. Policies move up through the bureaus, and by the time they reach the secretary, they reflect the multiple views of the offices concerned. Because S&T inputs are essential elements of many policies, but rarely the ultimate subject of the policy, they must be made early in the policy process to have an impact. I concluded very soon that the department needed more in-house technical capacity - more scientists and engineers distributed throughout the bureaus - to make those technical inputs. We could no longer wait until policies had moved up through the bureaucracy and reached the secretary's level.

One longer term approach to increasing the in-house S&T capacity of the State Department is to recruit more scientists and engineers into the Foreign Service - to encourage them to change careers and become professional Foreign Service officers. We did make some efforts in that direction.

In the past, Foreign Service officers typically had backgrounds in political science, international relations, or history, but today the State Department is looking for more diversity in the disciplines and previous work experience of Foreign Service candidates. Scientists and engineers with firsthand experience of the scientific, technical, and health issues that are fast becoming the main items on the diplomatic agenda will become the diplomats of the twenty-first century. Technology has become a kind of new international currency, and intellectual property rights and technological competitiveness are items on the global trade agenda and the subject of international negotiations. Engineers can make unique contributions to discussions in all of these areas.

But the focus of our work was on fellowship programs to bring professional scientists and engineers into the State Department for one or two years to work alongside diplomats to ensure that the technical dimensions of policies were fully comprehended in the policy-making process. Our efforts in this direction succeeded beyond all expectations. In fact, I feel that my greatest legacy is the growth of these fellowship programs. By September 2003, 40 scientists and engineers had committed to work as fellows in 12 different bureaus on dozens of issues - everything from climate change and agricultural trade to nonproliferation of weapons of mass destruction and human rights.

The fellowship programs could not have succeeded without tremendous support from the scientific and engineering communities. We started with an expansion of the AAAS Fellows Program, which had been operating at a modest level for many years. Then the American Institute of Physics (AIP) stepped forward; AIP now provides one fellow each year. A similar program with the American Chemical Society is

now beginning, and a fellowship agreement has been signed with the Industrial Research Institute. The IEEE made engineering history two years ago when it became the first professional engineering society to create a fellowship program, selecting one engineer each year. Collectively, these are now called the Professional Science and Engineering Society Fellows Program. My successor as science adviser has developed the Jefferson Fellows Program, in partnership with some 50 research universities, that will bring in active professors for one year and retain them as professional consultants for an additional five years. A three-year pilot program at a level of five fellows per year is being funded by the MacArthur and Sloan Foundations.

Of course, engineer-fellows cannot expect to design or build new gadgets, but to provide advice, counsel, and personal involvement in the daily business of American diplomacy. One engineer-fellow is working in the International Communications and Information Policy Office of the Economics and Business Affairs Bureau, which draws on his expertise in electrical engineering and information technology in formulating international telecommunications policies, frequency allocation negotiations, and so on. He loves his work, but he also told me that his engineer friends cannot understand why he is "wasting his time" working on policy, on international blah-blah, when he could be doing real work and making something. Convincing young engineers of the importance of formulating policies that organize and regulate a technologically driven world is a challenge for the engineering community. People who understand the consequences of those policies should play a major role in their formation. I would like to see at least 50 S&T fellows a year in the Department of State, a good share of them engineers.

An excellent way to sample the diplomatic life is to spend one or two years as a fellow under one of the Department of State's fellowship programs. Undergraduates and graduate students can also work in the State Department as interns - mostly during the summer, but programs are available throughout the year. Interns can work at U.S. embassies overseas as well as in Washington.

Professional scientists and engineers are also welcome in many embassies overseas. Many ambassadors have become aware of the tremendous admiration of host countries for U.S. science and engineering. Professional scientists and engineers have immediate access to technical circles abroad at a level of acceptance rarely accorded regular diplomatic personnel. We succeeded in establishing one position for an embassy S&T adviser in Australia, an earth scientist on long-term detail from NASA, who has been tremendously successful in building closer ties between the embassy and the university and research communities and has initiated some cooperative projects. The new Jefferson Fellows Program provides for fellows to spend a portion of their time working with embassies abroad.

Under the Embassy Fellows Program, scientists and engineers from U.S government technical agencies are detailed for one to three months to U.S. embassies abroad to work on specific issues. The demand from embassies still exceeds the current supply, but with six or seven agencies now participating, the program is running at about 45 visits per year. Scientists and engineers readily find a common language throughout the world, regardless of the strains that may exist in political relations.

I recently read a fascinating history of the first 25 years of NAE and its ultimately successful struggle to become a respected source of advice to government on the vast range of technological issues that affect the lives of all Americans. The point is that foreign policies also need the advice and counsel of the engineering community. This advice can be formally commissioned from an outside body, such as the NAE/NRC, or obtained informally in roundtable discussions. But even these simple events will not take place unless there are more engineering-literate people inside the system, either as fellows or regular employees, who appreciate the value of technical advice and know how and where to get it.

Thirty-five years ago at Cape Kennedy in Florida, I marveled at the sight and sound of Apollo 11 blasting off for man's first step on the moon. NASA Administrator James Webb had described the challenges of managing an engineering enterprise of that magnitude - hundreds of thousands of separate parts, all supplied by the lowest bidder, that all had to work, and work together, for the program to succeed. The trick, he said, was to have at least 15 percent of the engineering capabilities in house, to ensure that NASA had enough "smarts" to manage and monitor what the contractors were doing. The State Department, too, needs a certain complement of S&T skills in house to ensure that S&T considerations are fully integrated into the policy process. The department needs scientists and engineers - as interns, as fellows, and as Foreign Service officers.

It is interesting to note that a majority of the senior political leaders of China were trained as engineers. They are driving both China's rapid rate of economic development and its huge national commitment to progress in S&T. The outsourcing of manufacturing jobs to China, the enormous U.S. trade deficit with China, and concerns about the lack of enforcement of intellectual property laws are the subjects of intense diplomatic dialogue, as well as internal U.S. political debate.

In Atlanta recently for an IEEE meeting, I met a recent Ph.D. engineering graduate from Georgia Tech, who had stayed on after graduation as an instructor. He and his research professor had formed a company to market a patented invention based on his thesis research. When he heard about my work, he provided me with the text of a lecture by John Sununu (2002) given at Georgia Tech some two years before.

John Sununu, a mechanical engineer with a Ph.D. from MIT, has had a remarkable career. He has been a professor and associate dean of engineering at Tufts, president of his own engineering company, a member of NAE, governor of New Hampshire, and then chief of staff in the White House to the first President Bush - an incredible leap from education and practical engineering to the arena of public policy and foreign policy at the very highest level. His speech in Atlanta contained some powerful and prescient words:

> *Good public policy needs engineers to be good public policy makers. There isn't much new or better that happens in the world today that isn't made possible by some innovation in engineering. But all the changes that make life better also make life a bit more complicated. To deal with these complications, we develop public policies, laws, and regulations to provide the framework for the operation of an orderly beneficial society.*
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> *While engineers continue to drive real progress and improvements to the quality of life, they generally have been reluctant to get involved in the process of developing public policy. Unfortunately, they have long considered that arena as being more appropriately the domain for other professions such as lawyers. In fact, however, society needs a more active involvement in policy development by those who understand both the potential and the limitations of technology. Engineers need to think more seriously about accepting the responsibility of public office. If the problem solvers of the world don't participate in making public policy, then policies will be developed by those who don't know how to solve problems.*

Now that does not mean that engineers or chemists have greater insight on public policy issues than lawyers. But many foreign policy issues today involve technical considerations, and it is essential that we have people in the decision-making process who understand those considerations. Their advice may be the salient factor in whether or not a policy succeeds.

A primary challenge for the developed world is to deal not just with acts of terrorism, but also with the causes of terrorism. Many people believe that economic development in the Third World is an essential step toward this end. Certainly, development of Third World countries is an enormously complex process, but in simple terms it means enabling countries to participate effectively in the global economy - an economy driven by technology. To me this means countries must have an indigenous capacity for dealing with technology, and there must be a local decision-making process, which, at best, fully embraces science and engineering advice or, at least, does not ignore the technical realities in making national decisions.

In late 2002, the World Summit on Sustainable Development (WSSD) brought tens of thousands of political leaders, delegates, and observers to Johannesburg, South Africa, in an attempt to move toward a global consensus on how to advance the cause of sustainable development. In addition to stressing the importance of good governance, the United States made a strong effort to emphasize the role of science and engineering in an effective development program.
Prior to the conference, NAE and the engineering community issued a "Declaration on Sustainability," which stressed the importance of involving engineers at every stage of the process. The meeting also emphasized the importance of public/private partnerships, bringing governments, corporations, universities, private foundations, international lending institutions, and nongovernmental organizations (NGOs) together to achieve specific goals.

WSSD should not be considered a one-shot event but the beginning of a long and enduring process. The State Department website (www.state.gov) lists examples of emerging partnerships. The present focus lasting two years is on clean water; energy will be the next two-year priority. In addition, the National Academies is beginning a series of initiatives on sustainable development that will build on their excellent earlier study on sustainability (NRC, 1999b).

NAE recently published a splendid volume to celebrate the 20 greatest engineering achievements of the twentieth century, the engineering developments of the past 100 years that have had the greatest effect on peoples' lives (Constable and Somerville, 2003). In essence, those achievements and their broad availability in developed countries define the difference between the developed and developing worlds. A major goal of U.S. foreign policy is to narrow this gap significantly over the next 20 years. To do this, we must have the full support of the U.S. engineering community - in terms of both policy and implementation. Addressing the needs for water, energy, food, health, education, and jobs offers great and rewarding opportunities for bringing together American diplomacy and engineering - with immense portent for this perilous world.

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