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Federally-Funded Research and Development Centers and Universities: Roles and Influence on STI Policy Decision-Making in the United States

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Universities and federally-funded research and development centers (FFRDCs) play an important role in the complex web of institutions that drive science, technology, and innovation (STI) policy and investments in the United States. Universities and FFRDCs have overlapping but distinctive roles in developing STI investments by the U.S. government. Three large-scale initiatives—the Human Genome Project, x-ray synchrotron technology, and the National Nanotechnology Initiative—are outlined in this brief to illuminate the process by which major STI decisions are made in the United States.

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INTRODUCTION

The centroid of STI activities at universities is a project that is performed by a single investigator on a time scale of a graduate student. FFRDCs exist primarily to build and operate large scientific facilities and pursue mission-focused activities that often have long-term requirements.

FFRDCs like the Department of Energy (DOE) National Laboratories were created to execute the mission of the Department of Energy. They exist because the government wanted to take advantage of the management skills of industry and universities to manage the laboratories. The employees work for the contractor that manages the laboratories, not for the government. The DOE labs execute the mission of the Department of Energy, but they do not have an official role in STI policy because only government employees can create a budget for an institution funded by Congress. However DOE labs and universities have the science and technology capability that through discovery or problem identification creates the basis for new STI initiatives. Virtually all new STI investments and policy made by the government are based on work performed by universities, national laboratories, or industry. And some FFRDCs such as the Lawrence Berkeley National Laboratory have a very close relationship with a university, in this case the University of California, Berkeley. The synergy between the university and the laboratory has strengthened both institutions and produced a better result for all stakeholders.

CREATING NEW STI POLICIES AND INITIATIVES

Initiating a major project or investment that will be funded by the federal government is often a difficult and arduous process. A successful project requires support of universities, FFRDCs, agency officials, and, ultimately, Congress. The path to success for a project is varied and depends on the alignment of many factors. The first step in the process is for the STI community to establish a need. Workshops and white papers help define major initiatives. The next step is for a federal agency to agree to review a project proposal and place it high on a list of priorities. For a major project to go forward it must be placed in the President's budget. And finally for a project to be funded it must receive funding through a Congressional appropriation.

The above process is best understood through examples in which major STI decisions were made. In each of the examples the process was modified somewhat to fit the project initiative.

The Human Genome Project

The Human Genome Project was the culmination of several years of work and workshops, in particular workshops supported by the Department of Energy in 1984. This project was quite controversial because many biologists simply could not imagine the technological advances required to produce the sequence of 3 billion base pairs that make up the genome of a human. One might have imagined that this project would have started in the National Institutes of Health but this was not the case. The first official funding for the project originated with the U.S. Department of Energy's Office of Health and Environmental Research, headed by Charles DeLisi, and was in the Reagan administration's 1987 budget submission to the Congress. It subsequently passed both the House and the Senate.

The initial project supported work in three national laboratories, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, and Los Alamos National Laboratory. In 1990 this project brought in the National Institutes of Health, and a joint project was announced in 1993. The project ultimately transformed into an international one with cooperation of several countries and private industry and private foundations. The Celera Corporation in particular made major contributions to its success.

The sequence of the human genome was announced three years ahead of schedule in the year 2003. This advance changed the field of biology forever and pushed biology to become a more quantitative science. The project spawned new understandings of human health, animals, and plants. In addition, the field of metagenomics is becoming a new tool for analyzing the environment. In sum, this was a project led by a mid-level DOE program manager who built a consensus with the scientific community and was able to work the process and persuade the president to support a $3 billion dollar project and get Congress to fund it.

X-ray Synchrotron Technology

The second project is really several large projects that can be referred to as "x-ray synchrotron technology." Before synchrotrons, X-rays were generated using electron tube technology. Synchrotron radiation itself was seen for the first time at General Electric in the United States in 1947 in a particle accelerator (synchrotron). It was considered a nuisance because it caused the particles to lose energy. It was recognized in the 1960s that synchrotron radiation had properties that overcame the shortcomings of X-ray tubes.

The first synchrotron scientific user activities were originally attached to the SPEAR ring at the Stanford Linear Accelerator Laboratory and were operated in "parasitic mode" on the SPEAR high-energy physics program. Experiments at this site by industry and university and laboratory scientists created a groundswell of demand to build a dedicated synchrotron facility. Again workshops and scientific reviews built the support to fund the first specifically designed accelerator for synchrotron radiation at Brookhaven National Laboratory. This project was funded by the Department of Energy. Ground was broken for the National Synchrotron Light Source on September 28, 1978. The VUV (vacuum ultraviolet) ring began operations in late 1982 and the X-ray ring was commissioned in 1984. In the ensuing years, scientific progress and demand for synchrotron radiation led to DOE-supported synchrotron radiation sources of a third generation were built at several laboratories around the United States including Lawrence Berkeley National Laboratory, SLAC National Accelerator Laboratory, and Argonne Laboratory.

Synchrotrons have been built all over the world and are now a standard tool for science. The impact of synchrotrons on molecular structure and materials properties has been very significant. The success of synchrotron projects was built on scientific discovery and support from industry and university scientists that built the case for the Department of Energy to persuade the President and Congress to fund these efforts.

The National Nanotechnology Initiative

The next example is interesting because scientists at the National Science Foundation pulled many levers of government to create a National Nanotechnology Initiative. An "Interagency Working Group on Nanoscale Science, Engineering, and Technology" (IWGN) was established in 1998 (October 1998–July 2000) as a cross-cutting working group in the National Science and Technology Council (NSTC) in the White House. In July 2000, the White House elevated the IWGN to the level of "Nanoscale Science, Engineering and Technology" (NSET) Subcommittee of the NSTC's Committee on Technology with the role "to implement NNI."

Following this preparatory work, President Bill Clinton advocated nanotechnology development. In a January 21, 2000, speech at the California Institute of Technology, Clinton stated, "Some of our research goals may take twenty or more years to achieve, but that is precisely why there is an important role for the federal government." President George W. Bush further increased funding for nanotechnology. On December 3, 2003, Bush signed into law the Twenty-First Century Nanotechnology Research and Development Act, which authorized expenditures for five of the participating agencies totaling $3.63 billion over four years.

Since the National Nanotechnology Initiative was a Presidential initiative it was up to the various agencies to establish nanotechnology programs in their agencies. After numerous workshops and scientific reviews, the Department of Energy decided to establish Nanotechnology Centers at five DOE laboratories that would each have a different emphasis. All would be user facilities that make state-of-the-art equipment available to scientific researchers from universities and industry. These centers have been established and are currently functioning.

Although the government led this initiative, the scientific community defined the individual elements of the program. This was a rare occasion when the government was receptive to funding a new scientific program that was broadly supported by the scientific community.

CONCLUSION

These examples show that new STI projects and initiatives require broad scientific support, an agency or multiple agencies in the government to make the effort a high priority, and an administration and Congress willing to support and fund the effort. In the end, the basis for STI initiatives has to come from where the knowledge resides, that is, universities, FFRDCs, and industry. It helps to have government agencies populated by people with experience in FFRDCs and universities to make connections to these institutions. For large expenditures of money it helps to have the president make it his or her initiative. Finally, the FFRDCs or national laboratories and universities must have the capability and competence to execute the project.

Critique and Caveats for Chinese Policymakers

In the U.S. system only the government actually makes policy. Universities, FFRDCs, and industry can provide information to elected government decision makers. Universities, FFRDCs and industry can lobby their government for changes in STI policy. Competence in government agencies to make good decisions often makes this a challenging process. In addition, STI priorities often do not fare well when placed against other, near-term needs of society.

There are other avenues to support STI projects in the United States besides the government. Private money funds a significant amount of work at universities. A private foundation such as the Howard Hughes Medical Foundation (HHMI) funds one of the largest research efforts in the world in neuroscience at the Janelia Farm Research Campus in Virginia, a laboratory owned and operated by HHMI. Efforts such as these can have influence on public proposals such as the recent BRAIN Initiative. The take-away message here is that it is important to have several pathways to success.

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