Customized Field Proposal

# Science and Technology Policy

October 2008

## I. Overview of Science and Technology Policy

It is becoming increasingly evident that one of the most striking qualities characterizing the myriad and complex challenges of the 21st century is the multi-faceted intersection of scientific and technological issues with public policy. The relationship between science, technology, and public policy has gained increased attention over the preceding decades as national governments dramatically increased their funding of the research enterprise, as the linkages between discoveries in the academic laboratory and products developed by corporations became more robust, and as the social implications of science and technology became increasingly scrutinized. Not surprisingly, the academic field of science and technology policy is thriving due to a range of research institutions and scholars from a diverse set of disciplinary backgrounds that continue to investigate how science and technology have come to shape, and have been shaped by, society, politics, and the policymaking process. To this end, in a talk outlining the common characteristics of science and technology policy to professionals in the field, Susan Cozzens highlighted the substantial "base of knowledge we build in the field about the science and technology enterprise and how policy affects it" and described a set of central values, including a focus on "the transformative power of science and technology, sound analysis and critical perspective, and public benefit," that constitute the fundamental approach of scholars working in this area of investigation.[1]

The connection between science and public policy grew increasingly strong over the course of the 20th century. As funding by wealthy individuals and private foundations

[1] Cozzens, Susan. Keynote Address, "Science and Technology Policy Professionals: Jobs, Work, Knowledge, and Values," 2001 AAAS Workshop on Science and Technology Policy Careers. Washington, DC: American Association for the Advancement of Science, 2001. Available at http://www.aaas.org/spp/nextgen/2001/cozzens.htm.

began to be overtaken by major government and corporate investments in research and the development, the size, scale, and scope of scientific inquiry required the implementation of new institutions, oversight mechanisms, and coordination processes. Through the first decade of the 21st century, the extent of funding for science and technology remains considerable: the 2009 Presidential budget request included nearly $150 billion for research and development purposes, up from nearly $70 billion in 1976.[2] Although this expansion of the scientific enterprise accelerated during and immediately after World War II in the United States, subsequent decades saw countries throughout Europe and East Asia emerge as major global science and technology powers. A number of countries in the Organization for Economic Co-Operation and Development (OECD)—including Germany, Austria, and France—already spend between 2-3% of their GDP on research and development, while a few leading countries—including Japan, Korea, Sweden, and Finland—have pushed spend over 3% of their GDP for this purpose. Currently, international networks of researchers from both developed and developing countries constitute a global science and technology enterprise that involves formidable financial, human, and political resources. These and other issues—including the ethics of contemporary scientific research, the economic and social value of technological outputs, and public engagement in the science policymaking process—form the core set of concerns in the interdisciplinary, yet coherent field, of science and technology policy.

On a personal note, my interest in science and technology policy emerged a number of years ago from the related, but more abstract, fields of philosophy of science (which considers the philosophical implications of findings in areas such as physics,

[2] "2009 Budget Proposes Physical Sciences and Development Increases, Flat Funding for Biomedical Research," AAAS Analysis of R&D in the FY2009 Budget, Washington, DC: American Association for the Advancement of Science, 2008.

biology, and chemistry), history of science (which looks to analyze the historical factors that impact and drive scientific research), and the social studies of science (which seeks to analyze the societal and cultural facets of science and technology). Through extensive academic and professional experience, I have come to view the field of science and technology policy as central to my research interests, future professional development, and current plan of study. Science and technology policy focuses on the topics of research and innovation as its central issue areas, and I anticipate that my dissertation research will address some component of the governance of emerging technologies, particularly nanotechnology, which falls squarely within this field of investigation. While a few existing fields offered at the Wagner School, such as health policy, may touch tangentially on these topics, they do not take as their starting point scientific research, technological development, or the related policy issues. Moreover, there is a substantial body of literature within the field of science and technology policy that serves as a necessary and solid underpinning to any research effort that looks to investigate the institutional structures of science governance, the public value of science, and the policy trade-offs that have come to shape the modern research enterprise. Finally, science and technology policy emerges from a distinct set of questions that look to uncover the various interests that define the field, including:

- What factors shape government support and regulation of different fields of science and technology?
- How does international technological cooperation and competition impact the research and development system?
- What is the role of non-governmental organizations in influencing and formulating the contours of contemporary science and technology policy?
- What are the creation and diffusion patterns of new technologies throughout society? How to policy decisions hinder or accelerate this diffusion?

- What forward-looking and anticipatory approaches are needed to address the environmental, ethical, and social consequences of new scientific and technological discoveries?

While there may be many ways to parse this field into its constituent components, I have decided to map the critical issues in science and technology policy under three major sections that mirror many of the key debates and the most common analytic frames in the field:

- National innovation systems and global research networks;
- Science policy institutions and the advisory process; and
- Governance of emerging technologies and the role of science in society.

While the focus of this field proposal will predominantly be trained on federal level policymaking in the United States, it is inevitable that these three core issues will touch both on the international role of science and technology policy as a lever of global collaboration and competition and on the local role of science and technology policy as an instrument of economic development.

In the following sections of the proposal, I will provide an overview for each of these three core issues, highlight important works and findings in the field, and identify the relationship between these issues and contemporary science and technology policy concerns. These sections will be followed with a listing of the major journals, associations, scholars, university programs, independent research centers, and government organizations that relate directly to the field. An expanded reading list mirroring these key issues will be presented, followed by a list and description of relevant coursework that I have completed, and recent articles I have published, within the field. The proposal concludes with signatures from three faculty members indicating that this new field is comparable in breadth and scope to existing fields and denoting their willingness to coordinate the writing and grading of the comprehensive examination.

## II. Description of the Field

### ***National Innovation Systems and Global Research Networks***

One of the main areas of study that has emerged as a central theme in the field is analyzing how different nations employ science and technology as part of their overall innovation strategy. Traditionally, this approach is premised on the notion of the *linear model of innovation*, which, in its simplest form, stipulates that the innovation process begins with basic scientific research, leads to a period of applied research, and results in technological development. It is possible to trace the origins of this conceptualization back to Vannevar Bush, who headed the Office of Scientific Research and Development (OSRD) during World War II and authored of one of the foundational treatises of science policy as a response to a request by President Roosevelt on how to ensure America could maintain its post-war scientific and technology leadership. This report, *Science: The Endless Frontier* (1945), lays out much of the operational structure, funding system, and justification for the structure of American science and technology policy. Much debated and criticized since its publication, the report’s resounding influences can be still found, both explicitly and implicitly, in policies associated in branches of contemporary science.

Bush’s central argument is that in order to maintain American superiority in scientific and technological research and development, the “the Government should accept new responsibilities for promoting the flow of new scientific knowledge” by way of funding basic scientific research, primarily conducted at America’s leading research universities and its government-sponsored research laboratories. For Bush, ensuring a strong foundation of basic research—one that regularly creates new, fundamental knowledge for use by other actors—is of paramount importance. He argued that only a system in which basic research is given highest priority could guarantee the continued strength of the national scientific enterprise. However, he argued that government funders must realize that basic research remains open-ended and that any attempt to guide such inquiry toward a particular direction or end-goal will be resigned to failure. Bush reaches such conclusions explicitly, noting that "basic research is performed without thought of practical ends" and that "today, it is truer than ever that basic research is the pacemaker of technological progress." For over half a century, this point has been at the center of the science policy contract: government provides the funds for basic science but does not specify or stipulate particular innovations or outcomes, while researchers are free to investigate natural phenomena as they wish but must make their findings publicly available for later use by government, academia, or industry.

Not surprisingly, this seemingly unencumbered process of the translated benefits of research stipulated in the linear model oversimplifies how science and technology work in the real world. Daniel Sarewitz, in *The Frontiers of Illusion* (1992) offers a point-by-point rebuttal of many of Bush's central tenets, noting that this "myth of unfettered research" is just that—a myth—that operates in a much more complex manner. For instance, case studies presented by Stuart Leslie in *The Cold War and American Science* (1993) and Peter Galison in *Image and Logic* (1997) illustrate the complex, iterative processes that connect basic research to technological development, usually characterized by scientists and researchers exploring areas of particular interest to industry, by government funders guiding research through support of "hot" areas of scientific inquiry, and of corporations like DuPont and Bell Laboratories assembling research teams in-house to build up a proprietary base of research findings.

The particular national policy context within which the linear model of innovation occurs has become a key area of investigation and study within the field. This notion of the *national innovation system*, codified in Richard Nelson (1993) classic of the same name, emphasizes that the contours of the scientific and innovation enterprise adapt, morph, and evolve within the framework of a particular nation-state's unique set of research needs, government and industry relationships, and economic structure. For example, while it is the case that the predominant funder of basic science in the United States has become the federal government, this situation is different in many East Asian countries like Japan and South Korea, where industry has become a major, if not equal, supporter, of basic research. In some industrialized European countries, particularly Germany and the states of Northern Europe, local and sub-national levels of government have emerged as the powerful and predominant driver of science funding and policy development. The circumstances surrounding the emergence of these national systems of innovation have lead to particular institutional structures for science in different countries, including the rise of federal research laboratories in the United States and the strong science funding councils in the United Kingdom. Not surprisingly, countries in the Western world have developed many advanced and sophisticated science research funding and policy systems, although there is a growing literature (UN Millennium Project, 2005; InterAcademy Council, 2004) on how to strengthen national innovation systems in the developing world.

However, the classic notion of national innovation systems has evolved more recently to take into account an emerging trend that has seen scientists from different countries collaborate, publish, and conduct research together at an ever-increasing rate. Caroline Wagner's *The New Invisible College* (2008) emphasizes this shift away from research predominantly centered on, and bounded within, national boundaries to research that is truly global in scope. This concept of this new global geography of knowledge has significant implications for how science policy is made, how funding mechanisms operate, and how and where the public benefits of science accrue. For example, these geographically dispersed networks of scientific research and knowledge-making will require changes in how government, industry, and academia relate (Etzkowitz and Leydesdorff, 2001), particularly when coupled with the complementary trend of increasingly interdisciplinary scientific work (Gibbons et al, 1994) and the blurring of the boundaries between pure science and technological development (Kash and Rycroft, 2002). In fact, many of today's most promising fields of research—nanotechnology, biotechnology, and neuroscience—blend various elements of physics, chemistry, biology, materials science, computing, toxicology, medicine, and environmental science, just to name a few. The focus on anticipating the convergence of these strands of science and technology—and the associated policy implications for technology assessment—will be described in more detail in later sections of the proposal.

The issue of the transformation of national innovation systems to global networks of innovation within the field of science and technology policy is also accompanied by a re-evaluation of a well-known and oft-stated dichotomy in the field: the difference between the idea of *science for policy* and *policy for science*. The notion of science for policy captures the role that scientific and technological data and information can play in enlightening a wide range of policy debates. Under this role, climate change findings can be used to inform policies related to carbon capture and emissions, environmental field research can be used to inform policies related to conservation, and the discovery of new physical processes can be used to inform policies related to national security and weapons development. In these situations, scientists and researchers speak to policymakers in order formulate, shape, or evaluate the direction and plausibility of a policy or set of policies. On the other hand, policy for science relates to instances where policymakers set decisions about what lines of science to fund, regulate, or even curtail. Under this role, ethical and policy questions about biotechnology and biomedical engineering can lead to limits on stem cell research, concerns about national economic competitiveness can lead to boosts in funding for nanotechnology, and a desire for international leadership and prestige can lead to public support and investment for space science and exploration (McDougall, 1985). In these situations, the scientific and technological enterprise is impacted by public policies that can have a range of effects on the shape of science itself, from spurring new lines of research to increasing international scientific collaboration. As the following section describes, these negotiated interactions of science policy occur at key institutional sites through a contentious, intricate, and ever-evolving advisory process.

### ***Science Policy Institutions and the Advisory Process***

In the United States, there are a number of important institutional sites, both within and outside of government, where the science advisory process occurs and where the debates and issues surrounding science and technology policy take place. Academic scholars have analyzed the role that these institutions—consisting of Executive branch agencies, Congressional committees, government policy analysis offices, and non-governmental advisory and advocacy bodies—play in shaping science policy. For example, the notion of creating an institution for the purpose of evaluating basic research proposals and funding all branches of fundamental science was first suggested in Bush's report through the recommendation of a National Research Foundation. Although the broad contours of his idea were eventually embodied in the National Science Foundation (NSF) when it was established in 1950, the number and extent of government institutions involved in setting and managing science policy remains considerable.

For instance, the National Institutes of Health (NIH) have funded and set policies related to medical research since before World War II. The Food and Drug Administration (FDA) has overseen the approval of drugs, cosmetics, and food additives since the early 20th Century. The National Aeronautics and Space Administration (NASA) has funded space research and set space exploration policy since the late 1950s. The Environmental Protection Agency (EPA) and the Department of Energy (DOE) have formulated environmental and energy policy, respectively, since the late 1970s. In fact, one of the most influential factors leading to the current status of science and technology policy in the United States is the establishment of this mission agency system, with responsibility for science funding and policymaking dispersed across different organizations, with varying mandates, political power, and operational budgets.

A number of challenges related to this institutionally compartmentalized, mission-oriented science system in the United States is that it can lead to a lack of funding integration across scientific disciplines, a poorly conceptualized set of the totality of research activities supported by the federal government, continued entrenchment of outdated scientific priorities, and organizational structures arranged to deal predominantly with "crisis situations" related to science and technology. The landscape of federal science policy institutions is littered with examples reflecting various components of these characteristics, particularly the last point. Consider that early 20$^{th}$ century public health scares spurred the creation of FDA, the launch of Sputnik spurred the creation of NASA, the two energy shocks of the 1970s spurred the creation of DOE, and the sharp critique of government from the environmental movement spurred the creation of EPA. The effect of such fragmented institutional homes for science and technology issues had led to the disaggregation of decisions associated with science funding, research, and oversight. Matching these Executive branch structures for science onto the Congressional decision-making process for science adds an additional layer of complexity, as the House Committee on Science and Technology and the Senate Committee on Commerce, Science, and Transportation maintain overall, although incomplete, stewardship of science issues within the federal government. It remains the case that numerous organizational and ideological barriers exist with respect to the creation of a more integrated and cohesive approach to science policy at the federal level.

Each of these institutions employs a series of institutional mechanisms that exist at the nexus of policymaking and the science advisory process, including technical and policy advisory committees, public hearings, and notice-and-comment rulemaking (Smith, 1992). Sheila Jasanoff (1998) has characterized the aforementioned role of science in the provision of advice as the "fifth branch" of government, detailing the technical, legal, institutional, and social qualities that distinguish successful instances of government science policy guidance from failing instances.

In addition to the mission agencies as sites of the science advisory process, two other institutions are of particular importance with respect to the linking of scientific and technical information to policymaking. The first is the Office of Science and Technology Policy (OSTP), which plays a central role in the federal government in providing science advice to the President. OSTP also coordinates both the National Science and Technology Council (NSTC)—which consists of Cabinet level representatives and focuses on inter-agency synchronization of science and technology policy—and the President's Council of Advisors on Science and Technology (PCAST)—which brings external science and engineering experts from industry, academia, and other research institutions into the science advisory process. The second institution is the now-defunct Office of Technology Assessment (OTA), which existed from 1972 to 1995 with the mandate of providing timely, nonpartisan analysis of science and technology issues to the United States Congress (Bimber, 1996). The suite of reports produced by OTA cover policy-relevant topics in many branches of basic and applied research, and there remains an ongoing debate in the field about how to institutionalize and re-introduce the capacity for government-focused technology assessment work that OTA pioneered in the second half of the 20$^{th}$ Century.

Outside of government, there are a number of science advisory research institutions that look to shape various debates in science and technology policy. The National Academies serves as both an honorific and research institution that brings together the nation’s leading scientists, engineers, and doctors to analyze science and technology related issues that cut across scientific domains, policy areas, and geographical regions. The committees convened by The National Academies work on a request-based system from Congress, and many of their peer-reviewed reports have become seminal and classic works in various subfields of science policy. For example, the report *The Pervasive Role of Science, Technology, and Health in Foreign Policy* (1999) outlined the imperative and need for greater science advice within the Department of State; *Improving Risk Communication* (1989) set new standards for how information about environmental risks should be shared with policymakers and the public; and the more recent *Rising Above the Gathering Storm* (2007) renewed a debate about whether and how the United States needs to boost the size and quality of its science and technology workforce and educational system in light of challenges from the emerging science powers of China and India.

Other organizations, like the professional membership-based American Association for the Advancement of Science (AAAS) and non-governmental think tanks, also offer regular briefings, testimony, and other input on matters of science and technology policy. Over recent years, however, the independent nature of science and technology advice, and its practitioners, has been called into question and raised as a serious policy concern. A number of analyses conclude that when scientists advise government, they may not be operating in a value-free manner (as is typically posited) and that these values need to be more transparently expressed as science becomes more inexplicitly linked and intertwined with policy considerations. This point is made explicitly in Roger Pielke, Jr.'s recent book *The Honest Broker* (2007), noting that a more accurate analysis of the role of science in policymaking can only be achieved if uncomplicated notions like the "pure scientist" and "issue advocate" are replaced with finer grained distinctions of how the science policy advising enterprise actually functions.

***<u>Governance of Emerging Technologies and The Role of Science in Society</u>***

As the pace of discovery and research in science and technology advance at a seemingly ever-increasing rate, a body of scholarship has emerged that investigates how best to oversee and manage the social implications of emerging technologies and questions the ability of political and social institutions to respond to the risks and challenges that these new lines of investigation pose for society. One particular set of inter-linked technologies—which include nanotechnology, biotechnology, information technology, and cognitive science—have become the focal point of such inquiries. Known collectively as *converging technologies* (Roco and Bainbridge, 2003), these areas of investigation have greatly expanded the potential to create socially transformative technologies, from new forms of inorganic materials that possess novel physical and chemical properties to new connections between high-technology disciplines that have lead to the establishment of interdisciplinary research areas in synthetic biology and robotics. Much of my academic writings have focused on the issue of how to identify the key metrics that indicate how this process of technological convergence is evolving and suggesting what policy responses are needed to ensure the maximum social benefit from these strands of research.

The advancement of these emerging technologies has renewed interest in employing the social sciences in helping policy to address and anticipate the long-term social and environmental implications of these developments. A variety of theories within the area of *technology foresight* have been directed toward addressing this issue. For instance, Ravetz and Funtowicz (1993) have adopted a framework known as *post-normal science* to characterize the complex interaction of contemporary science and technology research with social systems. Guston and Sarewitz (2002) have advanced the notion of *real-time technology assessment* to argue in favor of having scientists conduct research in a manner that reflects its potential social and political implications and to encourage the development of policy institutions that are capable of conducting quick turn-around, anticipatory analyses of emerging technologies. Wilsdon and Willis (2004) and Kuzma et al (2008) have, respectively, developed and applied the theoretical concepts of *upstream public engagement* and *integrated oversight assessment* to argue in favor of strengthening the interaction between the public and policy-makers in reaching decisions about how science is funded and what kinds of science is funded. Similarly, Gorman et al (2004) have expanded Peter Galison's notion of the *trading zone* to include non-scientific disciplines and have argued an explicit role for the public in influencing the nature of government support of science and technology.

Recently, a number attempts at science policy public engagement have occurred under the auspices of a variety of institutions, including universities, governments, think tanks, and corporations. Many of these institutions have begun holding public forums and developing collaborative platforms for discussing the complex policy and social issues inherent in a range of emerging technologies. For example, some scholarship in the field (Olson and Rejeski, 2005) uses these outreach activities to take a forward-looking approach on the potentially damaging health and environmental risks associated with certain technologies—in particular, nanotechnology—and to analyze the similarities and differences with respect to other science and technology policy debates like asbestos, nuclear power, and genetically modified foods. Public engagement interventions (Kleinman, 2000) that include science café dialogues, citizen consensus conferences, and web-based dialogues have all taken place over the past few years, although the literature evaluating their impact and effectiveness remains scarce.

It remains an open question as to the best way of integrating findings from these technology foresight and public engagement activities into the policy-making process. As the diversity and complexity of interested constituencies and stakeholders involved in science policy debates increases, there is the additional challenge of broadening the relationship between scientists and policymakers, as noted earlier. As can be expected, these deliberations occur in a much more dynamic and messy process in the real world, and it is anticipated that, over time, the connection between science and society will continue to strengthen. Lewis Branscomb (2003) highlights this intertwined connection between scientific research and society as he notes, "even basic science…is now frequently coupled to specific public goals," and there remains much work to be done that investigates the degree to which the stated public value of science responds to the public as a whole. It is at that intersection point where I plan to focus my dissertation research over the coming years.

***<u>Universities, Research Centers, and Scholars</u>***

- Center for International Science and Technology Policy, The George Washington University
    - Nicholas Vonortas, Director and Professor of Economics and International Affairs
    - Caroline Wagner, Lead Research Scientist
- Center for Science, Policy, and Outcomes, Arizona State University
    - Daniel Sarewitz, Co-Director
    - David Guston, Co-Director
- Technology Policy and Assessment Center, School of Public Policy, Georgia Institute of Technology
    - Susan Cozzens, Director

    - Philip Shapira, Professor of Public Policy
- Center for Science and Technology Policy, George Mason University
    - Philip Auerswald, Director
    - Christopher Hill, Professor of Public Policy
    - Thomas Ratchford, Director, National Center for Technology and Law
- Center for Science and Technology Policy Research, University of Colorado at Boulder
    - Roger Pielke, Jr., Director
- Science, Technology and Public Policy Program, University of Michigan
    - Shobita Parthasarathy, Co-Director
- Belfer Center for Science and International Affairs, Harvard University
    - John Holdren, Director, Science, Technology, and Public Policy Program
    - Calestous Juma, Science, Technology and Globalization Project
    - Lewis Branscomb, Director Emeritus of the Science, Technology and Public Policy Program
    - Sheila Jasanoff, Professor of Science and Public Policy
- The Program in Science, Technology, and Environmental Policy, Woodrow Wilson School of Public and International Affairs, Princeton University
    - Michael Oppenheimer, Director
- Program on Science, Technology, and Global Development, Columbia University
    - Richard Nelson, Director
- Policy Research in Engineering, Science and Technology/ Manchester Institute of Innovation Research (PREST/MIIR), The University of Manchester, United Kingdom
    - Luke Georghiou, Director
- James Martin Institute for Science and Civilization, University of Oxford, United Kingdom
    - Steve Rayner, Director
    - Brian Wynne, Fellow and Professor of Science Studies, University of Lancaster, United Kingdom
- Science and Technology Policy Research (SPRU), University of Sussex, United Kingdom
    - Michael Gibbons, Director
    - Andrew Stirling, Director for Science
- Maastricht Economic and Social Research and Training Center on Innovation and Technology (UNU-MERIT), Maastricht University, The Netherlands
    - Luc Soete, Director
- Ortwin Renn, Institute of Management and Technology, University of Stuttgart, Germany
- Arie Rip, University of Twente, Centre for Studies of Science, Technology and Society, The Netherlands
- James Wilsdon, Senior Research Fellow, Lancaster University, United Kingdom
- Science and Technology Studies (STS) Programs at Cornell University, Virginia Tech, University of Virginia, Rensselaer Polytechnic Institute, University of California-Berkeley, University of Wisconsin-Madison, University of Pennsylvania, University of Edinburgh (United Kingdom), and University College-London (United Kingdom)

***Academic Journals***

Research Policy
Issues in Science and Technology
Bulletin of Science, Technology and Society
Technology in Society
Science and Public Policy
IEEE Technology and Society Magazine
Minerva
Science, Technology & Human Values
Journal of Technology Studies
Social Studies of Science
Innovations: Technology, Governance, and Globalization
Technological Forecasting and Social Change
Environmental Science and Policy
Risk Analysis
Journal of Industrial Ecology
Scientometrics
International Journal of Technology and Globalization
Technology Analysis and Strategic Management
Nanoethics: The Ethics of Technologies that Converge at the Nanoscale
Review of Policy Research: The Politics and Policy of Science and Technology
International Journal of Foresight and Innovation Policy
Science as Culture
Research Evaluation
Journal of Technology Transfer
Public Understanding of Science
Science (Policy Forum section)
Nature (Commentary section)

***Professional Associations, Independent Research Organizations, and Government Agencies***

- The National Academies
    - Committee on Science, Engineering, and Public Policy
    - Board on Science, Technology, and Technology Policy
    - Board on International Scientific Organizations
    - Committee on Science, Technology, and the Law
- American Association for the Advancement of Science
    - Center for Science, Technology, & Congress
    - R&D Budget Analysis Center
    - Science and Human Rights Program
    - Center for Science, Technology & Security Policy
- The Society for Social Studies of Science
- International Association for Science, Technology, and Society
- American Political Science Association
    - Science, Technology, and Environmental Politics Organized Section
- IEEE

  - Society on Social Implications of Technology
- Federation of American Scientists
- The Royal Society
  - Science, Policy and Government Program
- Independent Research Organizations
  - Foresight and Governance Project, Woodrow Wilson Center
  - Technology and Public Policy Program, Center for Strategic and International Studies (CSIS)
  - Center for Science, Technology, and Economic Development, SRI International
  - Atlas of Ideas Project, Demos (United Kingdom)
  - Transition to New Technology Project, International Institute for Applied Systems Analysis (IIASA), Austria
  - Science and Technology Program, RAND Corporation
  - Science and Technology Policy, Gordon Research Conference Series
- Government Agencies
  - Office of Science and Technology Policy
  - Office of Technology Assessment
  - National Science Foundation
  - Environmental Protection Agency

## III. Reading List

### *A1. Background and Historical Overview*

Lightman, Alan, Daniel Sarewitz, and Christina Desser. *Living with the Genie: Essays on Technology and the Quest for Human Mastery*. Washington, DC: Island Press, 2003.

Galison, Peter and Bruce Hevly, eds. *Big Science: The Growth of Large-Scale Research*. Stanford: Stanford University Press, 1992.

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### *A2. Science Policy Classics*

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*A3. The Scientific Method and Its Philosophical and Policy Implications*

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***B1. National Innovation Systems and Global Research Networks***

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*B2. International Cooperation and Competitiveness*

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*D3. Public Engagement in Science and Technology Policy*

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## IV. Coursework and Preparation

In addition to my graduate level science and technology policy coursework at New York University and the Center for International Science and Technology Policy and The George Washington University, I have extensive professional and research experience in the field. In 2005, I received a National Science Foundation fellowship to conduct research at the Korea Science and Engineering Foundation by way of a comparative study of science and technology policy in Korea and the United States. In 2006, I received a National Science Foundation Young Scholar fellowship through George Mason University to conduct a comparative analysis of nanotechnology policy in China and the United States in conjunction with a U.S.-China Forum on Science and Technology Policy. From 2005-2008, I worked as a research associate at the Project on Emerging Nanotechnologies and was responsible for managing research projects directed at anticipating the long-term policy implications of nanotechnology. I have also served in a volunteer capacity as a reviewer of poster proposals for the 2008 Gordon Research Conference on Science and Technology and as a fellowship application reviewer for young science and technology policy researchers to attend the 2008 China-India-US Workshop on Science, Technology and Innovation Policy.

Both during and before my affiliation with the Wagner School, I have published a number of peer reviewed articles and book chapters covering a variety of topics in science and technology policy, with a particular focus on analyzing the long-term policy and social implications of nanotechnology. As indicated below, many of these publications have appeared in leading journals in the field, including *Science & Public Policy*, *Technology in Society*, and the *Bulletin of Science, Technology & Society*. Future publications in press include a brief overview of the ethical implications of nanotechnology, a book chapter on the potential policy implications of nanotechnology in the water sector, and a book chapter on how the emergence of converging technologies may impact innovation policy domestically and internationally.

| ***Courses taken at NYU Relevant to Science and Technology Policy*** | **Professor**<br>**Date**<br>**Grade** |
|---|---|
| **P11.3900**<br>**Independent Study—Science and Technology Policy**<br>The focus on this independent study was extensive reading in the field of science | Rogan Kersh and<br>Gerard Fitzgerald<br>Summer 2008<br>Grade: A |

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| and technology policy. The aim was to understand the history of science policy in the United States, its institutional dimensions, and the process of science policy-making. It also focused on the major theoretical concepts in the field, the operation and organization of multi-agency science and technology initiatives, and how their public value is explained, justified, and implemented. | |
| **P11.2901**<br>**Research Methods**<br>This course prepares the student to do and to evaluate social science research using a variety of research methods. Basic issues regarding the formulation of research questions, research design, and data collection and analysis are addressed. The course material encompasses both quantitative and qualitative methods in the discussion of the basic components of the research process: conceptualization and measurement, sample selection, and causal modeling. During this course, I wrote a research proposal focusing on the public perception and understanding of nanotechnology and its social and policy implications. | Colleen Gillespie<br>Fall 2007<br>Grade: A |
| **E10.2180**<br>**Interview and Observation**<br>This course is a practicum in semi-structured interviewing & participant observation, which include primary modes of qualitative data generation in the social sciences. Students learn these techniques by using them to gather novel empirical data. The course provides instruction on note-taking, data organization, preliminary analysis, and the ethics and politics of research with human subjects. During this course I presented a paper critique of a qualitative study in science and technology policy, and I anticipate applying the skills I learned in this course to my dissertation. | Mitchell Stevens<br>Spring 2008<br>Grade: A |
| **P11.2908**<br>**Doctoral Seminar: Policy Analysis**<br>The overarching purpose of the course is to expose you to literature and debates in public policy analysis, to provide opportunities to critically analyze published research, to identify interesting research questions, and formulate research strategies to address these questions. Instead, the goal is to learn how to formulate a policy analysis research project, and to critique and evaluate existing literature, including classics and contemporary research. I anticipate writing a paper focused on a specific aspect of domestic science and technology policy. | Amy Schwartz<br>Fall 2008<br>Grade: Ongoing |
| **P11.2905**<br>**Qualitative Research Methods**<br>This course provides a hands-on opportunity for doctoral students to experience the practice of qualitative research. We will address the nature of qualitative research in the administrative and policy sciences, with ample opportunities to discuss the implications of the choices made in designing, implementing and reporting the findings of a "mock" project which we will determine in class, with your input. Since I anticipate conducting a qualitative research project focused on science policy for my dissertation, the methods presented in this class have a direct relevance to my field. | Sonia Ospina<br>Fall 2008<br>Grade: Ongoing |
| ***Courses taken at GWU Relevant to Science and Technology Policy*** | **Professor**<br>**Date**<br>**Grade** |
| **Science, Technology, and International Affairs** | Robert Rycroft and<br>Nicholas Vonortas |

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| This course will examine the public policy behind, and the federal government's role in, the science and technology innovation system. This course offers an introduction to the study of international science and technology policy, with a focus on policy issues that arise from interactions between scientific and technological developments and government activity. | Fall 2003<br>Grade: A |
| **Technology Creation and Diffusion**<br>The purpose of this course is to examine the factors that underlie the creation of new technologies and their dissemination throughout the economy. The discussion will cover issues of interest to new technology producers and users in the private business sector, universities and government. It examines in some depth important global aspects of technology creation and dissemination and their historical extensions and addresses issues of technology management in industry, universities, and government. And, of course, we will address the implications for policy. | David F.J. Campbell<br>Fall 2003<br>Grade: A |
| **Space Policy**<br>This course is an examination of the origins, evolution, current status, and future prospects of U.S. space policies and programs. It will cover the civilian, military, and national security space programs of the U.S. government and the space activities of the U.S. private sector, and the interactions among these four sectors of U.S. space activity. This examination will be cast in the context of the space activities of other countries, and of international cooperation and competition in space. The goal of the course is to give the student an exposure to the policy debates and decisions that have shaped U.S. efforts in space to date, and to the policy issues that must be addressed in order to determine the future goals, content, pace, and organization of U.S. space activities, both public and private | John Logsdon<br>Fall 2003<br>Grade: A- |
| **Forward Engagement**<br>The objective of this course is to accustom graduate and qualified honors students to thinking in a disciplined fashion about potentially major societal events now gestating in the longer-range future, and simultaneously, to consider initiatives that might be taken in contemporary public policy to meet these contingencies. In the real world, issues are far more inter-connected than our specializations suggest, and to filter out these connections imperils our ability to appreciate what is shaping our lives. Therefore, Forward Engagement does not relate only to security issues: it tries to comprehend major developments in the broad categories of defense, economics, science and technology, and governance–and it also strives to understand how these developments interact. | Leon Fuerth<br>Fall 2004<br>Grade: A |
| **Environmental Policy**<br>This is a seminar that examines policy designed to protect the human and physical environment. Throughout the seminar, the dominant theme will be the role of science and technology in creating environmental problems and providing opportunities. Topics covered include a comparative analysis of national and multinational environmental policy, the relationship between science, technology, and modern environmentalism, and the degree to which some 'greening' of the private sector has been taking place. | Robert Rycroft<br>Spring 2005<br>Grade: A |
| **Science Policy Seminar**<br>This graduate seminar focuses on the fundamental forces and issues behind the governance of scientific research. How scientists attempt to maintain their autonomy by controlling membership in their community, by restricting the | David Grier<br>Fall 2004<br>Grade: A |

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| problems they investigate and methods they use, and by having at least moral suasion over resources allocated to scientific research. | |
| **Science, Technology, and Globalization**<br>This capstone course focuses on analyzing the impact of science and technology policy in a particular context through a group project. It is a seminar designed to synthesize the skills and knowledge that students have acquired in their graduate study. | Nicholas Vonortas and Robert Rycroft<br>Spring 2005<br>Grade: A |

**Relevant Science and Technology Publications by Evan Michelson**

*Book Chapters*

- Michelson, Evan S. "The Globalization of Converging Nanotechnologies", in Goran Marklund, Nicholas S. Vonortas, Charles W. Wessner, eds. *The Innovation Imperative: National Innovation Strategies in the Global Economy*. Cheltenham, UK: Edward Elgar Publishing, forthcoming (2009).
- Rejeski, David and Evan S. Michelson. "International Governance Perspectives on Nanotechnology and Water Innovation" in Mamadou Diallo, Jeremiah Duncan, Nora Savage, Anita Street, Richard Sustich, eds. *Nanotechnology Applications for Clean Water*. Norwich, NY: William Andrew, Inc., forthcoming (2008).
- Michelson, Evan S. and David Rejeski, "Transnational Nanotechnology Governance: A Comparison of the US and China," in Fritz Allhoff and Patrick Lin, ed. *Nanotechnology & Society: Current and Emerging Ethical Issues*. Dordrecht, The Netherlands: Springer, 2008.
- Michelson, Evan S. "Individual Freedom or Collective Welfare? An Analysis of Quarantine as a Response to Global Infectious Disease," in Michael J. Selgelid, Margaret P. Battin and Charles B. Smith, eds. *Ethics and Infectious Disease*. Oxford, UK: Blackwell Publishing Ltd., 2006.
- Michelson, Evan S. "Measuring the Merger: Examining the Onset of Converging Technologies," in William Sims Bainbridge and Mihail Roco, eds. *Managing Nano-Bio-Info-Cogno Innovations: Converging Technologies in Society*. Dordrecht, Netherlands: Springer, 2006.

*Journal Articles*

- Smiley Smith, Sara E., H. Dean Hosgood, Evan S. Michelson, and Meredith H. Stowe. "Americans' Nanotechnology Risk Perception: Assessing Opinion Change" *Journal of Industrial Ecology* (2008).
- Foss Hansen, Steffen, Evan S. Michelson, Anja Kamper, Pernille Borling, Frank Stuer-Lauridsen and Anders Baun. "Categorization Framework to Aid Exposure Assessment of Nanomaterials in Consumer Products" *Ecotoxicology* 17:5 (2008): 438-447.
- Michelson, Evan S. "Globalization at the NanoFrontier: The Future of Nanotechnology Policy in the United States, China, and India," *Technology in Society* 30 (2008) 405– 410.
- Michelson, Evan S. "Performance Assessment in the United States: An Overview of Recent Research and Development Evaluation Trends," *Science and Public Policy* 33 (8) October 2006: 546-560.
- Michelson, Evan S. "The Transformation of African Academies of Science: The Evolution of New Institutions," *Bulletin of Science, Technology & Society* 26 (5) October 2006: 419-429.
- Michelson, Evan S. "Clicking Towards Development: Understanding the Role of ICTs for Civil Society," *Journal of Technology Studies* 32(1) Winter 2006: 53-63.
- Michelson, Evan S. "Dodging a Bullet: WHO, SARS, and the Successful Management of Infectious Disease," *Bulletin of Science, Technology & Society* 25 (5) Oct. 2005: 379-286.

**V. Faculty Signatures**

These signatures certify that this field of science and technology policy is comparable in breadth and scope to existing fields. These signatures also confirm that these faculty assume the responsibility of coordinating the writing and grading of the comprehensive examination.

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**Rogan Kersh**, Associate Professor of Public Service and Associate Dean for Academic Affairs, Wagner School of Public Service, New York University — Date

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**Rae Zimmerman**, Professor of Planning and Public Administration, Wagner School of Public Service, New York University — Date

______________________________________ ________________

**Gerard Fitzgerald**, Adjunct Associate Professor University of Pennsylvania — Date