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ABSTRACT

In the United States, the Federal Government spends around $150 billion annually on Research and Development (R&D) at federal labs, universities, and research organizations. This investment in early-stage R&D together with the technology transfer process strengthened by the Stevenson-Wydler Act makes federal labs an important source of innovation that leads to products and processes with a private and social benefit. In this monograph, we present a structured case study approach to illustrate the benefits of the transferred research and technology as well as the circumstances that influenced the success of that transfer. Technology transfer from federal has widespread public benefits in areas that would not typically be addressed by the private sector and are difficult to quantify. The nine case studies presented span a mix of federal agencies, technology types, and transfer

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mechanisms. They illustrate a novel approach to matched case study research in this field, and explore the benefits, success factors, and lessons learned for federal managers. Each case presented a unique agency, transfer mechanism, and technology but illustrated some common success factors: deep research expertise, a clear demand environment, existing relationships, and legal mechanisms including licensing and CRADAs increased the likelihood of success. Research from federal labs requires a long-term commitment, but our case studies demonstrate how it can have widespread economic, environmental and public health benefits in addition to commercial benefits to the transfer recipient.

1

Introduction

Public support of efforts to transfer technology from federal agencies to private and public organizations has long had bipartisan support from both Congress and the White House. The Federal Government invests approximately $150 billion annually in research and development (R&D) conducted at federal laboratories, universities, and other research organizations. For the United States to maintain its position as the leader in global innovation, bring products to market more quickly, grow the economy, and maintain a strong national security innovation base, it is essential to optimize technology transfer and support programs to increase the return on investment (ROI) from federally funded R&D. Passage of the Bayh-Dole and Stevenson-Wydler Acts in 1980 permitted commercialization of federally funded research, and led to an increase in university and federal lab technology transfer and the establishment of technology transfer offices to commercialize research through patents, licenses, and start-ups. There was also a concomitant increase in academic and public policy interest in assessing the economic impact and effectiveness of university technology transfer, and a large literature now exists on its quantitative impacts.

Federal legislation has changed the technology transfer landscape, and subsequently the interest among researchers and policymakers to understand the economic impacts of federally funded technology transfer. While the Stevenson-Wydler Technology Innovation Act of 1980 has not received the same attention as the Bayh-Dole Act, it has changed the way that federal labs engage in research commercialization through technology transfer. It allowed federal labs, for the first time, to engage in disposition of intellectual property, technology transfer, and commercialization. For the first time, federal employees were permitted to commercialize laboratory-based intellectual property and commercialize innovations, which subsequently influenced the culture of innovation in laboratories. The Stevenson-Wydler Act stated:

> It is the continuing responsibility of the Federal Government to ensure the full use of the results of the Nation's Federal investment in research and development. To this end the Federal Government shall strive where appropriate to transfer federally owned or originated technology to state and local governments and to the private sector.

Thus, the Stevenson-Wydler Technology Innovation Act of 1980 made explicit the technology transfer responsibilities of federal laboratories. To enhance the ability of the laboratories to transfer their technologies to state and local governments and private industry, the FTTA of 1986 also facilitated technology transfer by permitting the laboratories to enter into cooperative research and development agreements (CRADAs) with public and private organizations.

For stakeholders within the federal government in the 21st century, motivations for effective technology transfer are outlined in various policy documents from the White House, Office of Management and Budget, Department of Commerce, and others and span Democratic and Republican administrations. One example, the Inter-Agency Workgroup on Technology Transfer (IAWGTT), which is charged with making recommendations to the Department of Commerce for improving technology transfer across federal agencies. In particular, President Obama's October 28, 2011, Presidential Memorandum (IAWGTT, 2012) has stimulated new academic and policy interest in assessing technology transfer

activities associated with federal research, in general, and with federal laboratories, in particular. The Presidential Memorandum, Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses, is premised by:

> Innovation fuels economic growth, the creation of new industries, companies, jobs, products and services, and the global competitiveness of U.S. industries. One driver of successful innovation is technology transfer, in which the private sector adapts Federal research for use in the marketplace.

In the memorandum, President Obama directed heads of executive departments and agencies to take three actions:

- Establish performance goals, metrics, and assessment methods, as well as implement and track progress relative to those goals.
- Streamline the federal government's technology transfer and commercialization process.
- Facilitate commercialization of federal laboratory technologies through local and regional partnerships.

In November 2012, the IAWGTT prepared a response to the President's October 2011 memorandum.[1] Comments from 11 agencies formed the basis of the IAWGTT's response report.[2] The responding agencies affirmed the need for the actions specified in the President's memorandum, and agencies acknowledged that "it is the impact of their technology transfer activities that is important, rather than tallies of output. However, no efficient way to consistently measure impact in the

[1] See https://www.nist.gov/tpo/agency-responses-presidential-memorandum.

[2] These agencies were the Department of Agriculture (USDA), Department of Commerce (DOC), Department of Defense (DoD), Department of Energy (DOE), Department of Health and Human Services (HHS) (separate reports for Centers for Disease Control and Prevention [CDC], Food and Drug Administration [FDA], and National Institutes of Health [NIH]), Department of Homeland Security (DHS), Department of Interior (DOI), Department of Transportation (DOT), Department of Veterans Affairs (VA), Environmental Protection Agency (EPA), and National Aeronautics and Space Administration (NASA).

aggregate or to calibrate the impact of one technology transfer activity over another has been identified."[3]

In 2014, the Obama administration's "Lab to Market Initiative" pushed to accelerate the transfer of federally funded research to the market, which included improved IP management for federally held patents, exchanges between federal, private sector, and university researchers, incentives for R&D, and improved human capital.[4] It was amended in 2016,[5] and support for research and technology transfer from federal labs continues to receive bipartisan support. The Trump Administration's support for enhancing technology transfer from federal laboratories was recently reiterated in the July 31, 2018, memorandum from the Office of Management and Budget, "FY 2020 Administration Research and Development Budget Priorities:"

> Federally funded R&D can lead to transformative products and services that solve problems from the boardroom to the classroom. Agencies should continue to focus on the basic and early-stage applied research that provides the fundamental building blocks of new technological advances and expand efforts that empower the private sector to accelerate the transfer of research discoveries from the laboratory to the marketplace.

The President's Management Agenda, released in 2019, outlines 14 goals to modernize government in the 21st century, the last of which is to "improve transfer of federally funded technologies from lab-to-market". Its stated goals include reducing regulatory burdens and developing new effective partnering mechanisms, to bring greater levels of collaboration and investment from the private sector. It continues the long-term focus on federally funded research for improved economic development and

[3] See https://www.nist.gov/tpo/agency-responses-presidential-memorandum, p. 2.

[4] https://obamawhitehouse.archives.gov/blog/2014/03/14/lab-market-accelerating-research-breakthroughs-and-economic-growth.

[5] https://obamawhitehouse.archives.gov/blog/2016/11/22/lab-market-commercializing-new-technologies-exchanging-talent.

national security and emphasizes the importance of effective mechanisms for collaboration and innovation to bring new innovations to market.[6]

1.1 Characteristics of Technology Transfer from Federal Laboratories

Technology transfer at federal laboratories does not follow a cookbook or lock-step process. Among other things, technology transfer activity is driven by the organizational and technology characteristics of a federal laboratory. Federal laboratories are mission driven and thus not homogeneous with respect to culture or activities. As shown in the high-level logic model depicted in Exhibit 1.1, each laboratory has numerous mechanisms for directly interacting with businesses, such as cooperative research agreements, and licensing and technical services, such as those provided in user facilities (Leyden and Link, 1999). Very often collaborations are formed and new and existing partnerships are involved in supportive roles. Indirect transfers can occur from dissemination of knowledge through publications, new research techniques and tools, or private-sector modifications of laboratory-mission deliverables.

There is a huge variety in what is transferred, the sectors that absorb each technology, and the speed and scope of the resulting impact. The assumption of our logic model is that technology transfer from federal

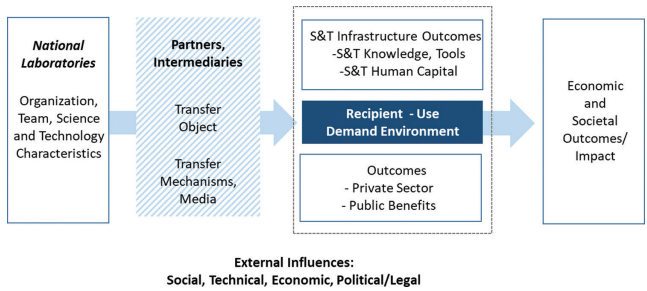

Exhibit 1.1: Simple technology transfer logic model for federal labs.

[6]The President's Management Agenda is regularly updated and available at https://www.whitehouse.gov/omb/management/pma/.

laboratories affects society through the public sector missions of the agencies, often, but not always, through the actions of the private sector.

1.2 Purpose of This Monograph

The purpose of this monograph is to present a case study protocol and analyses of nine technology transfer success stories across federal agencies and their research laboratories to begin to fill a gap in the existing literature. The impact of federally funded technology transfer at universities has been well documented and there is a strong body of literature on the mechanisms and relationships that facilitate transfer of inventions from universities to the marketplace through technology transfer offices and academic entrepreneurship (Hayter *et al.*, 2018). However, there is less available research on the impact and the mechanisms of technology transfer from federal labs. Our goal is to present a methodology for doing case studies of technology transfer from federal laboratories and showcase a group of case studies done using that methodology. The case studies describe the benefits of the transferred research and technology as well as the contingencies that influenced the success of that transfer. In addition to providing rich insights into different technology transfer processes, analysis across case studies with the same methodology allows us to begin to draw conclusions about similarities and differences in the mechanisms and conditions leading to successful technology transfer from national laboratories. The scope of federal lab research is vast and crosses a variety of agencies. Because of the diversity of agencies involved, mechanisms used, technologies, and projects, these case studies provide a semi-structured format to explore those barriers and success factors.

This monograph was motivated by RTI International's NIST-sponsored project, *Empirical Analyses of Federal Laboratory Technology Transfer*, which tested new methods for assessing quantitative outcomes. To enrich the quantitative estimates of outcomes the research team also conducted nine case studies using a case study methodology developed specifically for federal laboratory technology transfer.

We conducted nine mission-specific case studies, one for each participating federal agency. Based on available information, we documented

observed outcomes in each case study and traced how the federal agency and laboratory support, as well as other factors, contributed to these outcomes. Each participating federal agency worked with the project team to select a case study topic with a combination of data availability, relevance, and value to the agency. Given the short period of time and budget, the team focused on cases where data and interview subjects were readily available. This research is a first approach on how to look at the variety of research, contexts, and mechanisms for technology transfer from federal labs. It is hoped that others will use the suggested protocol to complete additional case studies and that further cross case analysis will inform technology transfer processes and policies.

As we will outline in the following subsections, the case studies we conducted were structured to conform to a logical framework designed to document successful technology transfer efforts through the identification of specific outcomes and impacts associated with a technology transferred from a federal laboratory, accounting for the variety of factors that contributed to successful outcomes. The case studies illustrate that bringing innovations derived from federally transferred technology to the public sector or to and through the private-sector marketplace takes time as well as the federal laboratories' long-term commitment to investments in R&D. Federal laboratory management may facilitate the success of technology transfer by providing resources, championing the to-be-transferred technologies, and instilling a culture in the federal laboratory that values such activity. Additionally, the analysis examines how a federal laboratory's co-development of a transferred technology with individuals or companies with supplementary expertise increases the likelihood that the transferred technology will have market success.

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Gretchen Jordan, PhD, Principal of 360 Innovation LLC, is an independent consultant who has worked in evaluation of research and technology development programs and organizations for 27 years. Much of the work was for the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy and Office of Science. She retired as a Principal Member of Technical Staff at Sandia National Laboratories in 2011.

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