Support for Forensic Science Research: Improving the Scientific Role of the National Institute of Justice

DETAILS

116 pages | 6 x 9 | PAPERBACK
ISBN 978-0-309-37645-7 | DOI 10.17226/21772

AUTHORS

Committee on Strengthening Forensic Science at the National Institute of Justice; Committee on Law and Justice; Division of Behavioral and Social Sciences and Education; National Academies of Sciences, Engineering, and Medicine

SUPPORT FOR FORENSIC SCIENCE RESEARCH

Improving the Scientific Role of the National Institute of Justice

Committee on Strengthening Forensic Science at the National Institute of Justice

Committee on Law and Justice

Division of Behavioral and Social Sciences and Education

The National Academies of
SCIENCES • ENGINEERING • MEDICINE

THE NATIONAL ACADEMIES PRESS
Washington, DC
www.nap.edu

THE NATIONAL ACADEMIES PRESS 500 Fifth Street, N.W. Washington, DC 20001

This study was supported by Contract No. 2014-IJ-CX-0113 from the U.S. Department of Justice/National Institute of Justice. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the organizations or agencies that provided support for the project.

International Standard Book Number-13: 978-0-309-37645-7
International Standard Book Number-10: 0-309-37645-9

Additional copies of this report are available for sale from the National Academies Press, 500 Fifth Street, NW, Keck 360, Washington, DC 20001; (800) 624-6242 or (202) 334-3313; http://www.nap.edu.

Printed in the United States of America

Suggested citation: National Academies of Sciences, Engineering, and Medicine. (2015). *Support for Forensic Science Research: Improving the Scientific Role of the National Institute of Justice*. Committee on Strengthening Forensic Science at the National Institute of Justice. Committee on Law and Justice, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

The National Academies of
SCIENCES • ENGINEERING • MEDICINE

The **National Academy of Sciences** was established in 1863 by an Act of Congress, signed by President Lincoln, as a private, nongovernmental institution to advise the nation on issues related to science and technology. Members are elected by their peers for outstanding contributions to research. Dr. Ralph J. Cicerone is president.

The **National Academy of Engineering** was established in 1964 under the charter of the National Academy of Sciences to bring the practices of engineering to advising the nation. Members are elected by their peers for extraordinary contributions to engineering. Dr. C. D. Mote, Jr., is president.

The **National Academy of Medicine** (formerly the Institute of Medicine) was established in 1970 under the charter of the National Academy of Sciences to advise the nation on medical and health issues. Members are elected by their peers for distinguished contributions to medicine and health. Dr. Victor J. Dzau is president.

The three Academies work together as the **National Academies of Sciences, Engineering, and Medicine** to provide independent, objective analysis and advice to the nation and conduct other activities to solve complex problems and inform public policy decisions. The Academies also encourage education and research, recognize outstanding contributions to knowledge, and increase public understanding in matters of science, engineering, and medicine.

Learn more about the National Academies of Sciences, Engineering, and Medicine at **www.national-academies.org**.

COMMITTEE ON STRENGTHENING FORENSIC SCIENCE AT THE NATIONAL INSTITUTE OF JUSTICE

ALAN I. LESHNER (National Academy of Medicine) (*Chair*), American Association for the Advancement of Science (ret.)
JANE E. BUIKSTRA (National Academy of Sciences), Center for Bioarchaeological Research, School of Human Evolution and Social Change, Arizona State University
TODD R. CLEAR, School of Criminal Justice, Rutgers University
J. JEROME HOLTON, Tauri Group, Alexandria, VA
DANIEL S. ISENSCHMID, National Medical Services Labs, Willow Grove, PA
JOSEPH F. PETROSINO, Alkek Center for Metagenomics and Microbiome Research, Baylor College of Medicine, Houston, TX
ALEX R. PIQUERO, Program in Criminology, School of Economic, Political and Policy Sciences, University of Texas at Dallas
CASSIA SPOHN, School of Criminology and Criminal Justice, Arizona State University
DAWNIE WOLFE STEADMAN, Forensic Anthropology Center and Department of Anthropology, University of Tennessee, Knoxville
HAL STERN, Donald Bren School of Information and Computer Sciences, University of California, Irvine
JARRAD WAGNER, School of Forensic Sciences, Oklahoma State University
KELLY A. WALSH, Justice Policy Center, Urban Institute, Washington, DC

DANIEL E.J. TALMAGE, JR., *Study Director*
JULIE ANNE SCHUCK, *Associate Program Officer*
EMILY BACKES, *Research Associate*
LETICIA GARCILAZO GREEN, *Program Assistant*
KATHI GRASSO, *Director,* Committee on Law and Justice (from July 2015)
MALAY MAJMUNDAR, *Associate Director,* Committee on Law and Justice

COMMITTEE ON LAW AND JUSTICE

JEREMY TRAVIS (*Chair*) John Jay College of Criminal Justice, New York
RUTH D. PETERSON (*Vice Chair*), Department of Sociology, Ohio State University
CARL C. BELL, Department of Psychiatry in the School of Medicine and the School of Public Health at the University of Illinois at Chicago, St. Bernard's Hospital's Inpatient Psychiatric Unit, Chicago, Jackson Park Hospital's Family Practice Clinic, Chicago
JOHN J. DONOHUE, III, Stanford Law School, Stanford University
MINDY FULLILOVE, New York State Psychiatric Institute and Mailman School of Public Health, Columbia University
MARK A.R. KLEIMAN, Marron Institute of Urban Management, New York University
GARY LAFREE, Department of Criminology and Criminal Justice, University of Maryland, College Park
JANET L. LAURITSEN, Department of Criminology and Criminal Justice, University of Missouri, St. Louis
GLENN LOURY, Department of Economics, Brown University
JAMES P. LYNCH, Department of Criminology and Criminal Justice, University of Maryland, College Park
CHARLES F. MANSKI, Department of Economics, Northwestern University
DANIEL S. NAGIN, Heinz College, Carnegie Mellon University
ANNE MORRISON PIEHL, Department of Economics and Program in Criminal Justice, Rutgers University
DANIEL B. PRIETO, Cybersecurity and Technology, U.S. Department of Defense
SUSAN B. SORENSON, School of Social Policy & Practice, University of Pennsylvania
DAVID WEISBURD, Center for Evidence-Based Crime Policy, George Mason University
CATHY SPATZ WIDOM, Psychology Department, John Jay College of Criminal Justice, City University of New York
PAUL K. WORMELI, Integrated Justice Information Systems, Ashburn, VA

Staff

KATHI GRASSO, *Director* (from July 2015)
MALAY MAJMUNDAR, *Associate Director*

Preface

The ability to analyze and interpret criminal justice evidence accurately is central to the effective functioning and credibility of every democratic country's justice system, and there is a constant need to keep improving both the accuracy and reliability of forensic analytic techniques, known as forensic science. The best way to meet that need is through bringing the full power of scientific research to bear on forensic science questions and methods. Within the federal government, a variety of agencies both conduct and support research on or related to forensic science, but there is little strategic coordination or leadership among them. The consequences include unmet needs, even in the face of at times unnecessary redundancies, and missed opportunities. This is a persistent problem, mentioned by two earlier National Research Council reports and by virtually every official who interacted with this committee. Although this issue is outside the purview of this committee's work, we believe it urgently needs to be addressed.

This report is the third time in the past 6 years that the National Academies of Sciences, Engineering, and Medicine have been asked to examine, directly or indirectly, the quality of and ways to strengthen federal leadership of forensic science research. The first two reports that discussed forensic science research were *Strengthening Forensic Science in the United States: A Path Forward* and *Strengthening the National Institute of Justice*. Because the three reports have different foci, their sets of recommendations differ in their details, but all three share some conclusions and recommendations. Importantly, they all agree that the National Institute of Justice should be providing greater leadership for this scientific domain but that it

cannot do so unless (1) it also has full freedom to set its research agenda and (2) its agenda accurately reflects the gaps in scientific knowledge as perceived by the researchers themselves, as well as the major problems encountered by the forensic science practice community. This report recommends specific steps that should be taken to achieve these goals. Moreover, the National Institute of Justice must have both financial and human resources that are adequate to implement the tasks with which it has been charged. Unfortunately, the recommendations of the previous reports have been only partially implemented. We hope that the recommendations in this report will be followed more closely.

I wish to express my deep appreciation to the members of the committee for their diligent and dedicated contributions to this study and to the preparation of this report within an expedited time frame. The diverse expertise and experience offered by the members of the committee were indispensable to the formulation of the conclusions and recommendations. I also wish to thank, on behalf of the entire committee, the Academies staff whose expertise and skill were absolutely essential to our meeting the charge.

Alan Leshner, *Chair*
Committee on Strengthening
Forensic Science at the
National Institute of Justice

Acknowledgments

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Academies of Sciences, Engineering, and Medicine's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report: Ann W. Burgess (National Academy of Medicine), School of Nursing, Boston College; Alicia L. Carriquiry, Department of Statistics, Iowa State University; Delores M. Etter (National Academy of Engineering), Engineering Education and Darwin Deason Institute for Cyber Security, Southern Methodist University; Stephen Fienberg (National Academy of Sciences), Department of Statistics, Carnegie Mellon University; Janet L. Lauritsen, Department of Criminology and Criminal Justice, University of Missouri-St. Louis; Charles F. Manski (National Academy of Sciences), Department of Economics, Northwestern University; Peter J. Neufeld, Innocence Project, Benjamin N. Cardozo School of Law, New York, NY; Eric C. Person, College of Science and Mathematics, Department of Chemistry, University of California, Fresno; Tal Simmons, Department of Forensic Science, Virginia Commonwealth University; and George Tita, Criminology, Law and Society, University of California, Irvine.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by the monitor, Ron Brookmeyer (National Academy of Medicine), Department of Biostatistics, University of California, Los Angeles, and coordinator, John Rolph, Department of Statistics (emeritus), University of Southern California. Appointed by the Academies, they were responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

The committee is grateful to the staff of the National Institute of Justice for their active participation throughout the study. The committee also applauds the National Academies of Sciences, Engineering, and Medicine's staff members—Emily Backes, Leticia Garcilazo Green, Malay Majmundar, Julie Schuck, and Daniel Talmage—for their dedication to the study and for their great contributions to the preparation of this report. And finally, we thank the executive office reports staff of the Division of Behavioral and Social Sciences and Education, especially Robert Katt (consultant editor), who provided valuable help with editing the report, and Kirsten Sampson Snyder, who managed the report review process. Without the Academies' guidance and wise counsel, the committee's job would have been even more difficult, if not impossible.

Contents

Figures, Tables, and Boxes

FIGURES

TABLES

BOXES

Acronyms

OIFS	Office of Investigative and Forensic Sciences
OJP	Office of Justice Programs
ORE	Office of Research and Evaluation
OSAC	Organization of Scientific Area Committees
OST	Office of Science and Technology
R&D	research and development
RDT&E	research, development, testing, and evaluation
SRP	Scientific Review Panel
TWG	Technology Working Group

Summary

Reliable and valid forensic science analytic techniques are critical to a credible, fair, and evidence-based criminal justice system. There is widespread agreement that the scientific foundation of some currently available forensic science methods needs strengthening and that additional, more efficient techniques are urgently needed. These needs can only be met through sustained research programs explicitly designed to ensure and improve the reliability and validity of current methods and to foster the development and use of new and better techniques. This task is challenging, due to the broad nature of the field. Issues in forensic science range from crime scene investigations to analysis of a variety of types of evidence. Moreover, forensic science practice is informed by many different disciplines, including biology, chemistry, statistics, and others. Given the challenges facing forensic science laboratories in terms of resources, caseloads, and variations in configuration among state and local jurisdictions, there is an urgent need for leadership at the national level to frame and sustain an extensive program of high-quality, strategically focused forensic science research designed to improve the forensic tools available to the criminal justice system.

The National Institute of Justice (NIJ) in the U.S. Department of Justice (DOJ) is recognized as the department's research arm for issues of crime and justice. This agency supports a number of research and development programs aimed at advancing knowledge on crime, crime control, and the administration of justice and improving practices within the criminal justice system. NIJ asked the National Research Council to appoint a committee to examine its recent efforts to strengthen its role as a science agency and to

advance forensic science research. The committee was also asked to recommend steps that would improve its research program (see the committee's Statement of Task in Box S-1).

The committee was asked to review progress made by NIJ since the release of two prior National Research Council reports: the 2009 report, *Strengthening Forensic Science in the United States: A Path Forward,* and the 2010 report, *Strengthening the National Institute of Justice*. The first report raised concerns about the location of a research institute for forensic science within DOJ. The latter report made recommendations for improving the scientific independence and transparency of NIJ's research program while remaining within DOJ. The debate still continues on the appropriate location for a research institute for forensic science in the United States, and this committee did not take a position on that issue because of the narrowness of its charge.

This report focuses on NIJ's existing research role in forensic science and identifies ways to strengthen the agency as a leader in both developing and guiding short- and long-term research agendas for forensic science in the United States. The committee believes recent improvements made by NIJ have strengthened its functioning as a science agency; however, it needs to do more. Building upon NIJ's recent progress, this report includes a set of recommendations intended to improve NIJ's capacity to support

BOX S-1
Statement of Task

An ad hoc committee will conduct a study and prepare a report that will review the progress made by the National Institute of Justice (NIJ) to advance forensic science research since the 2009 report, *Strengthening Forensic Science in the United States: A Path Forward,* and the 2010 report*, Strengthening the National Institute of Justice*. Specifically, this study will focus on (1) the role of the agency to lead critical areas of forensic science research and (2) efforts to strengthen NIJ's role as an independent scientific entity. The review will examine the ways in which NIJ develops its forensic science research priorities and communicates those priorities as well as its findings to the scientific and forensic practitioner communities in order to determine the impact of NIJ forensic science research programs and how that impact can be enhanced. The committee will assess NIJ's progress to date and make recommendations for areas where continued improvement is needed. The committee also will consider budgetary options and funding directives in its assessment of NIJ's forensic science portfolio.

high-quality forensic science research. If these recommendations are fully implemented, the committee believes the forensic science research and development program at NIJ will improve; however, these recommendations are not a panacea for all systemic problems facing forensic science, some are policy dependent and simply beyond the scope of NIJ's research and development mission.

FORENSIC SCIENCE RESEARCH IN THE UNITED STATES

Forensic science research is conducted in public laboratories, private industry laboratories, and academia. Like NIJ, a number of federal agencies, including but not limited to the National Institute of Standards and Technology (NIST), the National Science Foundation, the Federal Bureau of Investigation (FBI) Laboratory, and the Defense Forensic Science Center (DFSC), conduct and support forensic science research.

Among this group of federal players working to strengthen forensic science research, NIJ has a unique and critical role. The agency's mission is to support research that will serve the nation's forensic science field, particularly at the state and local levels, whereas other federal agencies have strategic objectives directed at serving their individual missions and only indirectly affecting the broad field of forensic science.

NIJ also has existing ties to both the forensic science research and practice communities. As the federal government's largest funder of extramural forensic science research, NIJ supports research at state, local, and federal laboratories and research conducted by academics. Close ties to the forensic science practice community continue, as a result of its administration of assistance and capacity-building grants and its support for research conducted within state and local laboratories. These connections enable NIJ to support the transfer of promising evidence-based approaches into practice.

NIJ'S RESEARCH OPERATIONS: PROGRESS SINCE 2009

Given NIJ's critical role in federal efforts to strengthen forensic science research, the committee assessed the agency's current research operations and its progress toward that goal since 2009-2010. The committee believes that NIJ has made some very useful changes to its process for soliciting and awarding research grants, thereby improving the agency's scientific capability. These improvements include

- making its processes to identify the needs of forensic science practitioners more transparent;
- increasing the level of autonomy and independence for its scientific peer-review process;

- obtaining final sign-off authority for its research awards;
- expanding the size of its research and development portfolio across forensic science disciplines;
- expanding outreach and dissemination to the practice and research communities;
- attracting new investigators to forensic science research;
- increasing the number of graduate student fellowships; and
- formalizing partnerships with other federal agencies involved in forensic science research, including NIST, the FBI Laboratory, DFSC, and the Bureau of Alcohol, Tobacco, Firearms and Explosives.

Taken together, these efforts have (1) restored authority that is appropriate for a science agency and addressed some previous concerns about NIJ's independence and (2) contributed to the building of a research infrastructure necessary to develop and sustain research that advances forensic science methods.

BLUEPRINT FOR THE FUTURE

NIJ's scientific capacity has improved since 2009; however, additional improvements are still needed. The committee offers recommendations to NIJ to build upon the agency's recent progress and substantially improve the amount and quality of forensic science research it supports.

In order to identify the needs of forensic science practitioners, NIJ uses its established Technology Working Groups (TWGs). Gathering input from these practicing forensic scientists is important, especially considering that NIJ's applied research portfolio is directed toward improving forensic science methods and analytic techniques at crime scenes or in forensic laboratories. However, the current forensic science TWG does not adequately represent the needs of the broad range of forensic science disciplines. In addition, the agency has yet to develop mechanisms for integrating the perspective of researchers into the process for identifying needs and scientific gaps and opportunities. Including researchers in an advisory capacity will enhance NIJ's ability to prioritize research areas and develop short-term and long-term research agendas.

Currently, the priority issues emphasized in the agency's solicitations appear to be reactive, and it is not clear how the priorities announced by NIJ relate to an overall long-term research agenda for forensic science. For this reason, the committee believes that the development of a strategic plan for forensic science research and development with short-, mid-, and long-term goals and priorities will help NIJ build a portfolio of cumulative knowledge and provide stability for researchers. Such a strategic plan should guide all internal decision making, from the development of solicita-

tions to funding decisions. At a minimum, this plan will need to include a research agenda with foundational research outcomes, technology transfer outcomes, efficiency outcomes, and justice system outcomes. The perspectives of both researchers and practitioners should be integrated into the process of identifying and prioritizing the research needs to be used in developing such a strategic plan for NIJ's forensic science research and development program.

Recommendation 4-1: The National Institute of Justice (NIJ) should take immediate steps to develop a formal and comprehensive strategic plan for its forensic science research and development program. The strategic plan should be based on a thorough understanding of the state of the science, an analysis of NIJ's past and current research portfolios, and extensive consultation with both the research and practice communities.

Recommendation 4-2: The National Institute of Justice should establish a research advisory board that includes a broad array of scientists, including forensic science researchers and practitioners, in order to better integrate their perspectives into its processes for identifying and prioritizing research needs. The research advisory board should also monitor progress in achieving the strategic plan's designated goals.

In the last few years, NIJ has taken positive steps to strengthen its ties to the research community. It has expanded outreach and dissemination to the research community and has increased the number of graduate student fellowships it awards. Through its solicitations, NIJ has taken several steps to attract new investigators. These efforts show promise for broadening the field of researchers engaged in forensic science, but further outreach is needed in order to build the research infrastructure and diversify the forensic science research field. For example, NIJ should consider other opportunities to support graduate students and attract proposals from researchers in a broader set of disciplines by building knowledge within the agency of emerging technologies in related fields that may have forensic uses.

In addition to efforts to broaden the forensic science research community and support the next generation of forensic science researchers, NIJ should incorporate research and evaluation into all of its forensic science activities. NIJ administers grant programs to reduce casework backlogs and fund improvements in state and local forensic laboratories. Given its science mission, it could require these and other assistance grants to include a research component with the potential to bring marked increases in casework processing and accuracy and/or an evaluation component that will help provide an evidence base that could be used to improve the

outcomes of future efforts. Especially in light of shrinking resources and increased demand for services, NIJ needs the ability to invest in innovative scientific research that promises to enhance laboratory capability by orders of magnitude to address growing demand through either new technologies or methods. This requirement would better integrate NIJ's research and development program with its assistance efforts.

Recommendation 4-3: The National Institute of Justice (NIJ) should increase efforts to expand forensic science research by recruiting researchers from the broader scientific community whose work may have a nexus with forensic science. At a minimum, NIJ should promote greater cross-field collaboration, conduct more outreach to research communities in adjacent disciplines that do not currently focus on forensic science applications, and increase the institutional knowledge within NIJ of relevant technology developments in other fields that might have forensic uses.

Recommendation 4-4: In keeping with its scientific mission, all of the National Institute of Justice's (NIJ's) forensic science funding, including capacity-building investments such as backlog reduction, should include a research component and/or an evaluation component. NIJ should create a clear translation pipeline from research to implementation for promising approaches, and future capacity-building funding should be tied to the use of evidence-based practices.

The committee believes that the current level of federal funding available to support NIJ's program of forensic science research and development is sorely inadequate to the task. Congressional appropriations to support NIJ's research programs have declined since the early to mid-2000s and remain insufficient, especially in light of the growing challenges facing the forensic science community. In addition, the programmatic staffing for forensic science research has not changed commensurate with the increasing scope of responsibilities for NIJ in this area.

With limited base funding, NIJ funds research and development from the appropriations for DNA backlog reduction programs and other assistance programs. These carved-out funds are essentially supporting NIJ's current forensic science portfolio, but there are pressures to limit the amount used for research from these programs. In the past 3 years, funding for these assistance programs has declined; therefore, funds available for research have also been reduced. In addition, some of NIJ's formalized federal partnerships, although commendable, as currently executed depend solely on the agency for funding and further diminish the agency's limited resources for funding its own projects.

The varying and unpredictable funding levels from year to year are counterproductive to the agency's goals and contribute to the difficulty of establishing a long-term research agenda for forensic science. Funding stability, at least at some core level, as well as staffing commensurate with increasing responsibilities for forensic science research, would improve NIJ's ability to establish appropriate short- and long-term research agendas for forensic science.

Recommendation 4-5: Federal policy makers should ensure the ability of the National Institute of Justice to advance forensic science research and development through dedicated, adequate, and stable appropriations coupled with funding flexibility to help support both short- and long-term research strategies. In order to ensure funding stability from year to year, policy makers should designate a dedicated funding stream for research and development that is of sufficient magnitude to address the challenges facing forensic science.

To build support for a robust research budget, the impact of NIJ's forensic science research and development program must be more effectively communicated to researchers, practitioners, policy makers, and the public. In addition to employing a science writer and using multiple media venues to alert audiences to available research findings, NIJ supports the Forensic Technology Center of Excellence in its role to provide resources and workshops to practitioners and to maintain a connection between NIJ's research portfolio and the practice of forensic science. However, the center's efforts are not reflected in a strategic research plan or a strategic communication's plan.

NIJ should develop a strategic communication plan that proactively promotes the value of the agency's investment in research and development in forensic science to policy makers and the public by stressing the importance of forensic science research to the criminal justice system and by estimating future savings from the creation and adoption of innovative tools and techniques. Implementation of a well-thought-out communications plan will help the agency achieve its goal of advancing forensic science by encouraging the uptake of innovative evidence-based practices by practitioners and more actively recruiting researchers from related disciplines.

Recommendation 4-6: In concert with the development of a strategic plan, the National Institute of Justice should develop and implement a strategic communication plan that directs its messages in ways appropriate to its various constituencies. This plan should include valuable in-person activities, such as hosting national conferences and workshops.

Recommendation 4-7: As part of its strategic plan, the National Institute of Justice should support transfer of technologies developed in its research and development portfolio to end users.

NIJ currently does not have adequate mechanisms to measure and communicate the impact of its forensic science research and development program. It has recently made strides in this area: NIJ now routinely tracks publications and presentations, dissemination activities, and technology-transition activities. However, the mere counting of these activities only measures the productivity of its funded researchers and does not assess the impact of research output on the practice of forensic science. NIJ should develop a set of metrics that go beyond primarily tracking outputs to a process that also measures the outcomes resulting from the activities it supports (e.g., increased accuracy of particular forensic methods, the use of NIJ-sponsored research to set legal precedent, and the implementation of new methods and techniques in laboratories). These metrics, measuring both outputs and outcomes, should be used to continuously evaluate NIJ's impact.

Recommendation 4-8: The National Institute of Justice should develop an appropriate set of procedures and metrics to measure outcomes regularly and evaluate the impact of its forensic science research and capacity-building portfolio.

CONCLUSION

The need to improve the scientific basis for some forensic disciplines is high: because of the volume of forensic transactions processed annually in the United States, even the smallest of error rates can have great consequences and erode the public's confidence in a fair and credible criminal justice system. Given NIJ's mission to serve state and local law enforcement as well as its ties to the forensic science research and practitioner communities, the agency has a unique and critical role to play in efforts to advance forensic science research.

NIJ has made progress in the past 5-6 years toward improving its research operations and expanding efforts to build a research infrastructure in forensic science. Given this progress, it is now better positioned as a science agency. Although these improvements provide a solid foundation, more work is necessary to bolster NIJ's ability to advance forensic science research. This report offers recommendations to strengthen the role, capacity, and commitment of NIJ to support forensic science research. However, NIJ's ability to improve forensic science research in the foreseeable future will be constrained without adequate support from federal policy mak-

ers across both the executive and legislative branches. Support from DOJ leadership is particularly essential, given that NIJ's placement within the department has been perceived as a potential source of conflict of interest (National Research Council, 2009b, pp. 79-80).

Assuming these recommendations are fully implemented and any barriers overcome, this committee believes NIJ has the potential to lead forensic science research across the federal government, a role with clear and striking consequences for the criminal justice system.

1

Introduction

Forensic science is the application of science-based techniques and technologies to the identification and quantification of criminal justice evidence. Reliable and valid forensic science analytic techniques are critical to a credible and fair criminal justice system. The state of forensic science in the United States, its infrastructure and delivery, have been the focus of increasing attention by Congress, the courts, and the media, and they have been previously studied in depth in earlier National Research Council (NRC) reports (National Research Council, 2004, 2008a, 2009b; National Research Council and Federal Judicial Center, 2011).

Concerns have been raised repeatedly about the ability of the criminal justice system to collect and analyze evidence efficiently and to be fair in its verdicts. Although significant progress has been made in some forensic science disciplines, the forensic science community still faces many challenges. To address some of these challenges, an extensive program of high-quality, strategically focused forensic science research is vital to improving the quality, validity, reliability, and breadth of forensic tools available to the criminal justice system. Federal leadership, particularly in regard to research and the scientific validation of forensic science methods, is needed to help meet the pressing issues facing state and local jurisdictions.

Many federal agencies support and engage in research that could benefit the forensic science disciplines. However, the National Institute of Justice (NIJ) in the U.S. Department of Justice (DOJ) is currently the only federal agency specifically charged with advancing scientific research, development, and evaluation on crime and crime control and the administration of justice and public safety. Its research and development portfolio covers

a broad set of areas designed to address present challenges of the criminal justice field, including advancing DNA technologies, pattern comparison, and other forensic science methods.

NIJ asked the NRC to appoint an ad hoc committee to provide an independent review of the progress the agency has made in improving its research operations in regard to its forensic science research and development program. In response, the NRC established the Committee on Strengthening Forensic Science at the National Institute of Justice to assess NIJ progress and to make recommendations to improve NIJ's forensic science research program.

CHARGE TO COMMITTEE

The charge to the committee is as follows:

> An ad hoc committee will conduct a study and prepare a report that will review the progress made by the National Institute of Justice (NIJ) to advance forensic science research since the 2009 report, *Strengthening Forensic Science in the United States: A Path Forward*, and the 2010 report, *Strengthening the National Institute of Justice*. Specifically, this study will focus on (1) the role of the agency to lead critical areas of forensic science research, and (2) efforts to strengthen NIJ's role as an independent scientific entity. The review will examine the ways in which NIJ develops its forensic science research priorities and communicates those priorities as well as its findings to the scientific and forensic practitioner communities in order to determine the impact of NIJ forensic science research programs and how that impact can be enhanced. The committee will assess NIJ's progress to date and make recommendations for areas where continued improvement is needed. The committee also will consider budgetary options and funding directives in its assessment of NIJ's forensic science portfolio.

In undertaking the charge, the committee set about gathering information from NIJ and a number of NIJ's federal and research partners (see Appendix A for a full list of speakers at the committee's three information-gathering meetings) in order to examine how NIJ carries out its research mission in the area of forensic science. The committee reviewed how research priorities are developed, communicated, and implemented; how young and future scholars are supported; and how research findings are disseminated to the academic community and other stakeholders. In discussions with the committee, NIJ noted it has worked toward addressing many of the recommendations in the NRC report *Strengthening Forensic Science in the United States: A Path Forward* (National Research Council,

2009b)[1] but has particularly focused on three recommendations that relate to its research mission (see Recommendations 3, 5, and 6 in Appendix B). Efforts to improve NIJ's stature as a science agency are occurring at a time when there is a weakening of confidence in the reliability and validity of forensic science. A stronger research effort and knowledge base would do much to improve confidence but cannot address all the challenges facing forensic science. Other organizations and working groups will also need to take the lead on issues of policy, standards, or training.

The committee considered whether NIJ has indeed made progress from 2009 to the present in strengthening its role as an independent scientific entity in order to advance forensic science research. The committee agreed, after discussion, that the quality of NIJ's operations and procedures for building and managing its forensic science research portfolio is critical to the overall quality of its research portfolio. The committee examined NIJ's ability to lead critical areas of forensic science research by studying its current research operations and how they have changed since 2009. A prior NRC report *Strengthening the National Institute of Justice* provides descriptions of NIJ's earlier operations (National Research Council, 2010).[2] Chapter 3 reviews the changes observed by the committee since these two NRC reports.

The committee was asked to provide advice on the work undertaken by NIJ regarding forensic science. Although the review that follows responds to that specific charge, the committee was also mindful of the broader concerns that have received much public attention regarding the state of forensic science as portrayed in *Forensic Science: Path Forward*.

The committee accepts the fundamental notion that any scientific research organization must be independent, meaning that it is able to carry out proposal reviews, make funding decisions, and report research findings independently of any political or policy interference in order to guarantee the objectivity of scientific inquiry. Protecting research findings from even the appearance of undue influence is necessary to ensure that the pressing forensic science challenges facing the country are identified, studied, and met. *Forensic Science: Path Forward* raised the question about the location of a research institute for forensic science within DOJ, citing concerns about "the potential for conflicts of interest between the needs of law enforcement and the broader needs of forensic science . . ." (National Research Council, 2009b, p. 17). *Strengthening NIJ* argued that support of forensic science research was appropriate to NIJ's mission and that, if

[1] *Strengthening Forensic Science in the United States: A Path Forward* hereafter will be referred to as *Forensic Science: Path Forward*.

[2] *Strengthening the National Institute of Justice* hereafter will be referred to as *Strengthening NIJ*.

afforded increased independence and transparency, NIJ could remain within DOJ's Office of Justice Programs (National Research Council, 2010, p. 2). This committee considers the question of the optimal organizational location for NIJ outside the scope of our work and has focused on identifying ways to continue to improve the forensic science research program at NIJ regardless of where it is placed within the government structure.

As context for the committee's review of NIJ's support for forensic science research, the committee considered the overall array of federal support for this kind of work. The committee found much to admire but also saw missed opportunities. In this report, the committee acknowledges NIJ's progress since 2009 in bolstering its procedures for soliciting and communicating the results of forensic science research, but it also emphasizes actions needed to develop and sustain a stronger forensic science research agenda that will serve the nation.

CALL TO STRENGTHEN FORENSIC SCIENCE RESEARCH

Disparities exist among forensic science methods and technologies in terms of their accuracy and reliability, error rates, research foundation, and general acceptability. In addition, variations in policies and procedures, the availability of resources, and access to training have resulted in large differences among existing forensic science services at the federal, state, and local levels (National Research Council, 2009b; Gabel, 2014). *Forensic Science: Path Forward* documented the lack of standards for the field, the absence of rigorous practitioner and laboratory accreditation programs, and problems with the interpretation of forensic evidence. That report also articulated the need for adopting and implementing an aggressive, long-term research agenda to strengthen forensic science. Unfortunately, such a research agenda has not yet been developed.

NIJ provides most of the funding for forensic science research, both for research conducted within forensic laboratories (Bureau of Justice Statistics, 2012) and for research conducted by academic researchers.[3] However, *Forensic Science: Path Forward* (National Research Council, 2009b, p. 78) found that

> Forensic science research is [overall] not well supported. . . . Relative to other areas of science, the forensic science disciplines have extremely limited opportunities for research funding. Although the FBI and NIJ have supported some research in the forensic science disciplines, the level of

[3]The National Science Foundation, National Institute of Standards and Technology, Federal Bureau of Investigation (FBI) Laboratory, and Defense Forensic Science Center, among others, also support forensic science research, either internally or through funding of external grantees. (Chapter 2 further discusses support for forensic science research.)

> support has been well short of what is necessary for the forensic science community to establish strong links with a broad base of research universities and the national research community. Moreover, funding for academic research is limited . . . , which can inhibit the pursuit of more fundamental scientific questions essential to establishing the foundation of forensic science. Finally, the broader research community generally is not engaged in conducting research relevant to advancing the forensic science disciplines.

The status of forensic science research funding has not improved much since *Forensic Science: Path Forward*. NIJ is still the primary federal source for funding for forensic science research, but the agency's overall budget is quite limited (see discussion in Chapter 3). Although funding allotted to NIJ's forensic science research portfolio has increased since 2009, these funds are tied to the appropriations for assistance programs (e.g., DNA backlog program) and the budget for these programs has declined in the past 3 years. As a result, the funding allocated to forensic science research within NIJ has varied substantially from year to year. Stable and adequate funding is essential to building a research field, and that is sorely lacking.

Forensic Science: Path Forward called for significant improvements to the forensic science enterprise and argued for the creation of a new, independent federal agency to advance forensic science into a mature field of multidisciplinary research and practice. That report made 13 recommendations that were to be carried out by the new agency to help support and oversee the forensic science community. Three of those recommendations specifically focused on advancing forensic science research by enhancing the scientific rigor and minimizing bias and human error across the forensic science disciplines (see Recommendations 3, 5, and 6 in Appendix B).

Forensic Science: Path Forward recommended the creation of a new independent federal agency was not followed, and, as stated earlier, this committee did not take a position on that issue.[4] One recommended task for this new agency was "developing a strategy to improve forensic science research" and "promoting scholarly, competitive peer-reviewed research and technical development" (National Research Council, 2009b, p. 19). Since the establishment of a new agency does not appear likely in the near future, a goal of this report is to recommend ways that NIJ can improve its forensic science research portfolio.

[4]Bills have been introduced in the past to advance the recommendations in *Forensic Science: Path Forward* and change the administration of forensic science research, but none have been enacted. See H.R. 3064 (113th Congress—2013-2014), S. 2022 (113th Congress—2013-2014), H.R. 6106 (112th Congress—2011-2012), and S. 3378 (112th Congress—2011-2012).

THE NIJ ROLE

NIJ has supported research in forensic science since the 1970s, and it remains the principal federal agency funding research in the field. There is continuing interest, expressed by academics, other federal agencies, and forensic science practitioners, in a leadership role in forensic science research for NIJ (see National Research Council, 2010).[5,6,7] However, congressional appropriations to support NIJ's research programs have declined since 2003-2008, and they remain insufficient to adequately plan and sustain a long-term research agenda for forensic science. NIJ has the authority to move funds for research and development from the DNA backlog reduction programs and other assistance programs, but it does so under infrastructure and budgetary constraints (see discussion in Chapter 3).

Historically, NIJ's forensic science research has focused on technological solutions with the goals of improving the usefulness, efficiency, and affordability of forensic analyses. For instance, NIJ funded the application of research in biology and medicine to forensic science through its forensic DNA portfolio. With support from the DNA Initiative in the 2004 Justice for All Act[8] and other legislative actions, NIJ was able to sustain a long-term research agenda in forensic DNA, which is still thriving (National Research Council, 2010). However, during 2000-2009, NIJ did not have discretion to apply this funding to other forensic techniques; as a result, other areas received far less attention than DNA analysis received (National Research Council, 2009b). Despite some growth in research in the last few years, substantially more effort is needed to provide other forensic techniques with the same scientific basis established for forensic DNA.

In addition to funding research, NIJ carries out a number of activities to support state and local forensic laboratories, including testing and evaluation of forensic techniques, technical assistance in the application of the science, and funds for DNA backlog reduction and crime laboratory improvements. *Strengthening NIJ* concluded that administration of these activities may have diminished NIJ's capacity to direct and sustain research in forensic science and other areas (National Research Council, 2010, pp. 102-103).

Strengthening NIJ also identified ways to improve the agency's mandated mission to advance scientific research, development, and evaluation.

[5]Comments to the committee by the PI Panel on Impact of Research, April 1, 2015. See Appendix A for a list of speakers.

[6]Comments to the committee by the Federal Forensic Sector panelists on May 7, 2015. See Appendix A for a list of speakers.

[7]Comments to the committee by the NIJ Peer Review panelists on April 1, 2015. See Appendix A for a list of speakers.

[8]Public Law 108-405.

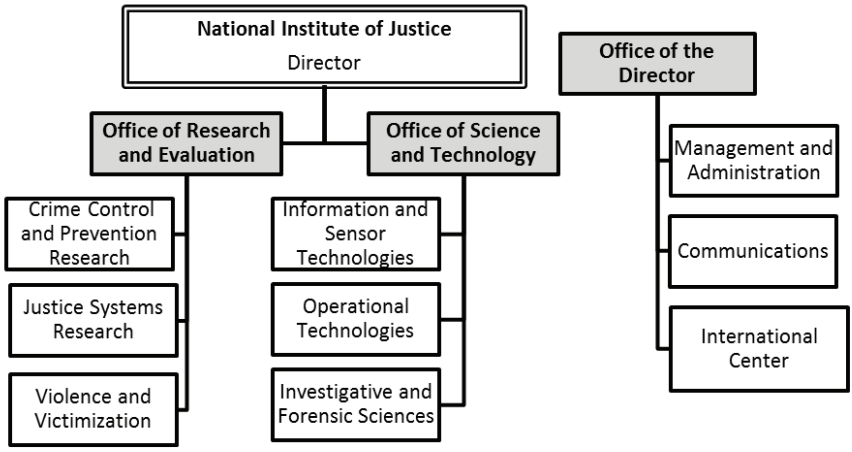

FIGURE 1-1 National Institute of Justice organization chart as of March 2008.
SOURCE: Adapted from National Research Council (2010, Figure 1-2).

The report's five recommendations aimed to provide the agency with essential tools to support needed research on crime, crime control, and the administration of justice (see Appendix B). NIJ has acknowledged the findings and recommendations in both *Forensic Science: Path Forward* and *Strengthening NIJ*; efforts to respond to the recommendations are in motion, and some improvements have been made to NIJ's research operations (National Institute of Justice, 2010, 2011a; Laub, 2011; Executive Office of the President, 2014a, 2014b).[9] Some of these efforts include creating the Office of Investigative and Forensic Sciences as a parallel program office to the Office of Research and Evaluation and the Office of Science and Technology within NIJ (see Figures 1-1 and 1-2), as well as establishing new partnerships; expanding support to graduate students; and making adjustments to the solicitation, review, and award processes. This committee's report examines NIJ's efforts and comments on the progress made (see Chapter 3). In addition, the report looks ahead to what is needed to develop and sustain a strong research program for forensic science.

[9]See also NIJ's acknowledgment of *Forensic Science: Path Forward* and its effort to elevate forensic science, see http://www.nij.gov/about/Pages/organization.aspx [June 2015].

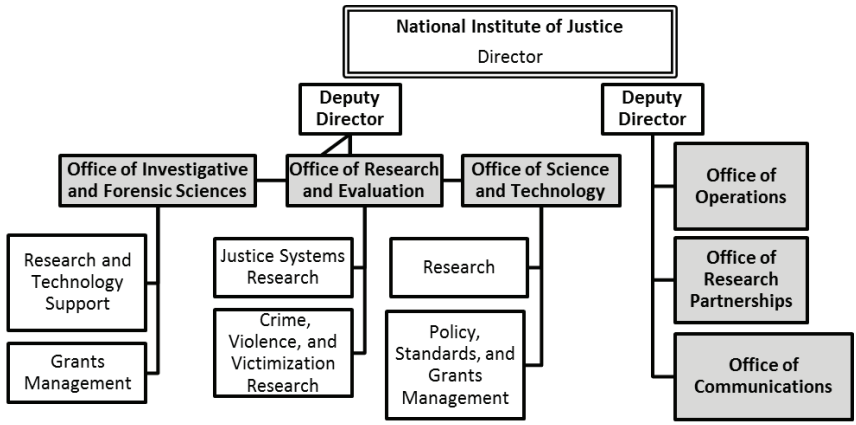

FIGURE 1-2 National Institute of Justice organization chart as of May 2015.
SOURCE: Adapted from NIJ, see http://www.nij.gov/about/Pages/organization.aspx [June 2015]. Figure last modified July 25, 2012.

STUDY METHODS

The committee held four meetings during the course of the study. The first three were information-gathering meetings during which the committee heard presentations from a variety of stakeholders, including the NIJ director and deputy director, representatives from NIJ's Office of Investigative and Forensic Sciences, former NIJ directors, and representatives from partner federal agencies, including the FBI, the Defense Forensic Science Center, the National Institute of Standards and Technology, and the National Science Foundation. The committee also heard from forensic scientists, forensic laboratory directors and personnel, and academic researchers who had worked with NIJ as principal investigators or had served on peer-review panels or Technology Working Groups. See Appendix A for more information on speakers and panelists. The last meeting was closed to the public in order for the committee to deliberate on the report and finalize its conclusions and recommendations.

To understand NIJ's processes and the forensic science program, the committee reviewed multiple sources of information. Although earlier documents were considered occasionally for comparison, the assessment focused primarily on the period from 2009 to 2014. The committee reviewed public documents such as authorizing and appropriations legislation and NIJ's solicitation and award archive, as well as recent reports and articles on the state of forensic science in the United States, including those released by the White House Office of Science and Technology Policy. The commit-

tee received from NIJ responses and documents pertinent to a number of questions regarding its budget; research awards; partnerships; the Forensic Technology Center for Excellence; and its procedures for setting priorities, peer review of grant proposals, and measuring impact (see Appendix C for the committee questions to NIJ). During the committee's study, NIJ was notably forthcoming and timely with information and responses to questions from the committee.

ORGANIZATION OF THE REPORT

The committee's report on its assessment of and guidance for NIJ has been organized into four chapters. Following this introduction, Chapter 2 describes the forensic science community—the landscape of disciplines, forensic science practice, and forensic science research—and assesses NIJ's role among federal agencies that support forensic science research. Chapter 3 reviews NIJ's research operations and examines the changes that have been made to the agency's operations since *Forensic Science: Path Forward* and *Strengthening NIJ* and assesses whether efforts in motion are building up an appropriate research infrastructure. The chapter also summarizes the committee's conclusions. Chapter 4 makes recommendations for improving NIJ's capacity to develop and sustain a high-quality forensic science research program.

In addition to the main chapters, four appendixes supply background information on this study. Appendix A gives a list of all speakers at the three public meetings. Appendix B documents the formal recommendations from *Forensic Science: Path Forward* and *Strengthening NIJ*. Appendix C lists the committee's questions and requests for information directed to NIJ. Appendix D presents biographical sketches of committee members.

2

Forensic Science in the United States

The forensic science field is composed of public and private entities and organizations that range from those that conduct crime scene investigations and medical examinations to state and local forensic laboratories and federal agencies that provide forensic services and training and support research. Scientific research, development, and evaluation of new and existing tools and procedures are indispensable toward advancing forensic science services and ensuring the administration of justice. As such, academic researchers who conduct basic and applied forensic science research are considered an important part of the field.[1] This chapter outlines the forensic science disciplines within the field of forensic science and the nature of services in the practice of forensic science. It considers the need for forensic science research and examines the sources for such research at the state, local, and federal levels. The chapter concludes with the committee's assessment of the role of the National Institute of Justice (NIJ) in the landscape of forensic science research.

[1]In referring to researchers, the committee includes those from a wide range of fields (e.g., chemistry, physics, statistics) engaged in basic research and applied research. Basic researchers typically conduct scientific studies aimed at developing new knowledge, technologies, and information or at validating existing methods from other disciplines for forensic purposes. Forensic science researchers engaged in applied research use existing scientific knowledge to develop new methods and techniques for forensic analysis. Forensic science practitioners use forensic techniques to conduct analyses and interpret evidence.

SPECTRUM OF FORENSIC SCIENCE DISCIPLINES

The nature of the work within the forensic science field is broad, and the level of scientific development and evaluation varies substantially among the disciplines (National Research Council, 2009b, p. 182). According to *Forensic Science: Path Forward*,

> Forensic science encompasses a broad range of disciplines, each with its own distinct practices. The forensic science disciplines exhibit wide variability with regard to techniques, methodologies, reliability, level of error, research, general acceptability, and published material. Some of the disciplines are laboratory based (e.g., nuclear and mitochondrial DNA analysis, toxicology, and drug analysis); others are based on expert interpretation of observed patterns (e.g., fingerprints, writing samples, toolmarks, bite marks). Some activities require the skills and analytical expertise of individuals trained as scientists (e.g., chemists or biologists); other activities are conducted by scientists as well as by individuals trained in law enforcement (e.g., crime scene investigators, blood spatter analysts, crime reconstruction specialists), medicine (e.g., forensic pathologists), or laboratory methods (e.g., technologists).
>
> (National Research Council, 2009b, p. 38)

The need to improve the scientific basis for some forensic disciplines is high. Because of the volume of forensic transactions processed annually in the United States (4.1 million transactions in 2009; see discussion below), even the smallest of error rates can have great consequences and erode the public's confidence in a fair and effective criminal justice system.

The committee found NIJ's listing of forensic science disciplines used by the Office of Investigative and Forensic Sciences (OIFS) in its 2015 general forensic science research and development (R&D) solicitation to be useful (National Institute of Justice, 2015b). Box 2-1 includes these disciplines and adds digital evidence, a discipline for which NIJ's Office of Science and Technology makes awards.

FORENSIC SCIENCE PRACTICE

Forensic science practice is broadly defined as using scientific techniques to analyze and interpret evidence for use in legal proceedings. Almost all types of forensic analyses, regardless of specific discipline, address one or more of the following purposes: identification (e.g., determining whether a white powder is cocaine), determination of common origin (e.g., DNA profiles link a blood stain to a suspect), or reconstruction of events (e.g., analyzing physical evidence to determine the origins of a fire).

In general, forensic science practice in the United States takes place in law enforcement identification units, public forensic laboratories (state,

BOX 2-1
Forensic Science Disciplines

- Controlled substances
- Digital evidence
- DNA and forensic biology
- Fire debris analysis and arson scene investigations
- Firearms and toolmark identification
- Forensic anthropology and odontology*
- Forensic crime scene analysis
- Forensic toxicology
- Latent print
- Medicolegal death investigations, including forensic pathology
- Questioned documents
- Shoeprint/tire tread examination
- Trace evidence

*Forensic anthropology and forensic odontology are more commonly referred to as separate disciplines; see National Institute of Standards and Technology (2015b).
SOURCE: National Institute of Justice (2011b, 2015b).

local, and federal), medical examiner and coroner offices, and academic institutions as part of departments or standalone service centers. (Public forensic laboratories are discussed in further detail below.) In addition, some forensic services are performed at private for-profit laboratories; however, the number of these entities is small (National Research Council, 2009b, p. 58).

The 411 public forensic laboratories in the United States differ by jurisdiction—municipal, county, state, and federal. According to the 2009 Census of Publicly Funded Forensic Crime Laboratories (CPFFCL) conducted by the Bureau of Justice Statistics, there are 373 municipal, county, and state laboratories and 38 federal laboratories in the United States.[2] These laboratories performed an average of five different forensic services,

[2]Law enforcement identification units, privately operated facilities, and most medical examiners/coroners offices were not included in the CPFFCL. Of the 373 municipal, county, and state laboratories, 362 responded to the Bureau of Justice Statistics survey. The 38 federal laboratories identified by the CPFFCL serve agencies such as the Bureau of Alcohol, Tobacco, Firearms and Explosives; Department of Defense; Department of Homeland Security; Drug Enforcement Agency; Environmental Protection Agency; Federal Bureau of Investigation; Fish and Wildlife Service; and United States Postal Service.

the most common being controlled substance analysis, latent print examination, forensic biology, crime scene response, and trace evidence analysis.

More than half of the estimated 4.1 million requests for forensic services received by publicly funded crime laboratories in 2009 were submitted to state laboratories (Bureau of Justice Statistics, 2012). Although requests for services have increased, funding for laboratories has not kept pace with the demand (National Research Council, 2009b, p. 58). Budgetary support for the laboratories comes from their jurisdictions (and/or the agency with oversight of the laboratory), but 69 percent of laboratories in 2009 reported receiving some additional funding from grants (Bureau of Justice Statistics, 2012). The majority of those grants are administered by NIJ as part of its laboratory capacity-building and assistance-funding streams.

Because of the increased demand for services and limited resources, case backlogs are a persistent problem that reduces faith and confidence in the ability of the criminal justice system to be fair. By year-end 2009, according to the CPFFCL, the 411 publicly funded laboratories had a backlog of about 1.2 million requests (Bureau of Justice Statistics, 2012). Box 2-2 discusses the forensic services backlogs in greater detail.

FORENSIC SCIENCE RESEARCH

Validity, reliability, and also credibility in the practice of forensic science are critically dependent on a strong research base. Forensic science research is both basic and applied in character, and it occurs in public laboratories, private industry laboratories, and academia; almost all of it is funded by the federal government (discussed further below).

Table 2-1 shows the small percentage of publicly funded forensic crime laboratories with resources dedicated specifically for research, for which the primary funding source is NIJ (Bureau of Justice Statistics, 2012).[3,4] In remarks to the committee, representatives from state and local public laboratories expressed their desire to perform more research but stated that due to casework load and resource constraints (time, staff, budget), they were unable to do so.[5]

[3]The 2009 CPFFCL found that 7 percent of publicly funded laboratories devoted staff time, supplies, or other resources to forensic science research, including experimentation aimed at the discovery and interpretation of facts, the revision of accepted theories, and practical application of such new or revised theories or technologies (Bureau of Justice Statistics, 2012, p. 8).

[4]NIJ is believed to be the only federal entity that has a grant program dedicated specifically to research and development for state and local forensic science laboratories. See also Gerry LaPorte, OIFS, NIJ, correspondence with the committee, May 13, 2015.

[5]Panel presentation on *Perspectives of Forensic Labs*, by Peter Stout, Houston Forensic Science Center, and Kristine Olsson, Johnson County Sheriff's Office Crime Laboratory, to the Committee on Strengthening Forensic Science at the National Institute of Justice, May 7, 2015.

BOX 2-2
Forensic Services Backlogs and the Need for Research

In general, forensic requests that have been submitted to laboratories but are not examined and reported to the submitting agency within 30 days are considered "backlogged" (Bureau of Justice Statistics, 2012). Ultimately, these backlogs are a symptom of insufficient capacity to meet demand. Though progress has been made in reducing the backlog for certain services in recent years, the problem persists and in some cases is growing (Bureau of Justice Statistics, 2012, p. 5).

In order to reduce backlogs, a laboratory can increase capacity by increasing the human and/or technological resources of current systems (e.g., more hires and more equipment), improving the efficiency of current procedures, or adopting more efficient new technologies. Historically, efforts to reduce casework backlogs and fund improvements in forensic laboratories have been used to directly support the purchase of equipment, training, and additional staffing (Nelson, 2010). Laboratories may also restrict the types and quantities of evidence that they will analyze in order to address backlogs; while this may improve turnaround times, it presents other justice issues.

Given the large increase in the number of requests for services, innovative solutions are needed to address not only capacity but also efficiency and effectiveness in case processing. Investments in forensic science research are necessary to develop these scientific innovations to revolutionize precision and capacity. For example, a current National Institute of Justice–funded research project is working to develop a camera with imaging capabilities to detect and identify fingerprints, body fluids, stains, and other residues at crime scenes, which if realized and widely adopted, could reduce the time crime laboratory personnel spend examining evidence for trace amounts of blood or other biological material (National Institute of Justice, 2015a).

NIJ is the largest external research funder, supporting research at state and local laboratories and research conducted by academics. The National Science Foundation (NSF) and the National Institute of Standards and Technology (NIST) also provide funding for forensic science research; the majority of the research funds dispersed by the Federal Bureau of Investigation (FBI) Laboratory and the Defense Forensic Science Center (DFSC) are for R&D targeted to fulfilling their agency's mission. These agencies,

TABLE 2-1 Percentage of Publicly Funded Forensic Crime Laboratories with Resources Dedicated to Research, by Type of Jurisdiction and Staff Size, 2002 and 2009

	2002	2009
All Laboratories	12%	7%
By Type of Jurisdiction		
State	8%	6%
County	11	5
Municipal	10	2
Federal	53	29
By Number of Full-Time Employees		
Fewer than 10	8%	2%
10 to 24	6	4
25 to 49	13	2
50 to 99	32	20
100 or more	21	43

NOTE: Data on research were reported by 98% of 397 laboratories responding to the 2009 census and 89% of the 306 laboratories responding to the 2002 census. Employee data were reported by 99% of the laboratories responding to the 2009 census and 89% of the laboratories responding to the 2002 census. In the 2005 census, data were not collected on research.
SOURCE: Bureau of Justice Statistics (2012, p. 8).

as some of the major federal supporters of forensic science research, are described in further detail below.[6]

National Institute of Justice

NIJ is the federal agency charged with bringing the power of scientific research to bear on the administration of a fair and effective criminal justice system. This mission guides the agency to support research that will serve the nation's forensic science field, particularly at the state and local levels.

As the principal federal agency that has supported a broad array of primarily applied forensic science research since the 1970s, NIJ has an extensive relationship with the forensic science research community. NIJ also has close ties to the practice community through its efforts to gather op-

[6]A number of other federal agencies support or conduct forensic science research on a mission-specific basis, including the Department of Energy, Department of Health and Human Services, Department of Homeland Security, Department of Interior, Department of Treasury, the Environmental Protection Agency, the National Transportation Safety Board, the Office of the Federal Public Defender, the United States Postal Inspection Service, and the Smithsonian Institution.

erational needs and to support the transfer of promising evidence-based approaches into practice (see *Strengthening NIJ* and discussion in Chapter 3). In addition, laboratory capacity and assistance funding for most public laboratories is administered through NIJ, and funding for R&D projects within the public laboratories is largely distributed by NIJ. Even the federal laboratories, such as the FBI Laboratory and the DFSC, receive funding from NIJ to conduct forensic science R&D (see discussion below).

NIJ funds a diverse portfolio of extramural forensic science R&D from forensic DNA to forensic pathology and crime scene investigation. It funds both basic and applied research, with a heavy focus on applied research. During fiscal 2014, it dedicated $23 million to funding forensic science R&D. Since 2009, NIJ has funded 269 research projects ($116 million) and distributed nearly $11 million to its federal partners for forensic science R&D (National Institute of Justice, 2015a, p. 8). NIJ's forensic science R&D program will be discussed in further detail in Chapter 3.

National Science Foundation

NSF is the largest funder of basic scientific research in the United States. Its core strategic objective is to invest in basic research to ensure significant continuing advances across science, engineering, and education (National Science Foundation, 2014). NSF makes awards through its 7 research directorates and 32 divisions. There is no division dedicated to forensic science, but an NSF representative reported to the committee that interest in forensic science spans all seven directorates.[7] The majority of NSF's recent attention to forensic science R&D has come through a 2013 "dear colleague" letter soliciting research that would lead to "breakthroughs in fundamental and basic research and education" in the forensic sciences. In 2014, NSF initiated, with NIJ, an Industry/University Cooperative Research Centers Program to advance cooperation in forensic science R&D and education.[8]

NSF recently began systematically coding its grants for forensic relevance; a search of NSF's awards database conducted to identify forensic-coded grants revealed that from 2013 to mid-2015 it has funded 25 proposals, totaling $4.38 million.[9] For a lengthier assessment of NSF's support for forensic science research, a search was conducted of NSF's awards

[7]Presentation on *NSF and NIJ—A Partnership to Advance the Fundamental Science Underlying Forensics*, by Mark Weiss, NSF (retired), and Kelsey Cook, NSF, to the Committee on Strengthening Forensic Science at the National Institute of Justice, May 7, 2015.

[8]The Industry/University Cooperative Research Centers Program also receives support from the Department of Defense, Department of Homeland Security, and NIST. As of May 2015, no awards had been made.

[9]The search was conducted in May 2015 and includes grants that were coded for forensic relevance (coding began in 2013).

database using natural language search tools to identify "forensic" awards. Using this method, NSF reports that from 2004 to mid-2015, it granted 209 "forensic-related" awards, amounting to $147 million invested in R&D.[10] NSF's funding of forensic science research is similar to NIJ in that it is awarded to external entities; however, in accordance with its mission, NSF's forensic science investment is in basic research whereas NIJ focuses primarily on applied research, so it complements rather than duplicates NIJ's portfolio of funded research.

National Institute of Standards and Technology

NIST, in the U.S. Department of Commerce, has a long history of working in support of forensic science. Much of that work has been dedicated to developing and validating standards for forensic science products. Currently, NIST is involved in forensics in four ways:

1. NIST supports forensic science research conducted within the institute.
2. NIST leads the Organization of Scientific Area Committees (OSAC; see Box 2-3).
3. NIST cochairs the National Commission on Forensic Sciences with the Department of Justice (see Box 2-4).
4. NIST supports a Forensic Science Center of Excellence to improve statistical analysis of forensic evidence.[11]

The mission of NIST's forensic science program is to strengthen the practice of forensic science through conducting research, facilitating documentary standards development, and producing quality reference standards, among other activities.[12] Unlike NIJ, which funds extramural research across the forensic disciplines, much of NIST's resources are allocated for intramural research. Its special programs office dedicated $6,850,000 to internal forensic science research in fiscal 2015.[13] Although much of NIST's

[10]These data reflect all NSF grants since 2004 that were identified in the NSF awards database, using natural language search tools, as containing the term "forensic." The search was conducted in May 2015.

[11]Presentation on *Standards and Practices of Forensic Science from a NIST Perspective,* by John Butler, NIST, and Mark Stolorow, NIST, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015.

[12]Presentation on *Standards and Practices of Forensic Science from a NIST Perspective*, by John Butler, NIST, and Mark Stolorow, NIST, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015.

[13]Other NIST organizational units receive other agency funds and expend their own base funds for work in forensic science; these expenditures are not included in the special programs office figure cited here.

BOX 2-3
Organization of Scientific Area Committees (OSAC)

The OSAC is a joint initiative of the Department of Justice and National Institute of Standards and Technology (NIST). The OSAC process was established to provide quality standards and guidelines for the forensic science community. The organization is practice focused, with more than 500 members and 1,200 affiliates who are forensic science practitioners and other experts representing local, state, and federal agencies; academia; and industry. Each member participates in 1 of the 24 subcommittees that are grouped under 5 area committees: biology/DNA, chemistry/instrumental analysis, crime scene/death investigation, digital/multimedia, and physics/pattern. Each area committee and subcommittee is tasked with identifying and developing technically sound, consensus-based documentary standards and guidelines (e.g., terminology, reporting requirements, and conclusion statements). To support the work of these committees and subcommittees, the OSAC has three resource committees: the Human Factors Committee (to provide guidance on systems design and human performance), the Legal Resource Committee (to provide guidance about the legal ramifications of forensic standards and presentation of forensic results to the legal system), and the Quality Infrastructure Committee (to assemble and update a forensic science code of practice). The work of the resource committees and the area committees and subcommittees is overseen by the Forensic Science Standards Board, which approves the developed standards.

The National Institute of Justice (NIJ) provided $3 million in funding to NIST in fiscal 2014 (as directed by Congress) to support the OSAC process.[a] However, beyond funding and some initial collaboration to develop the OSAC framework, there are no formal ties between NIJ and the OSAC. According to NIST, there is potential to create ties between the OSAC outcomes and future NIJ efforts. For example, NIJ-funded research at NIST could provide supporting data to validate existing guidelines; any discovered contradictions would trigger redrafting by an OSAC committee or subcommittee. In addition, standards development by entities within the OSAC can highlight research needs that NIJ could use to set research priorities.[b]

---

[a]Presentation on *Office of Investigative and Forensic Sciences Budget*, by Gerry LaPorte, OIFS, NIJ, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015.

[b]Presentation on *Standards and Practices of Forensic Science from a NIST Perspective*, by John Butler, NIST, and Mark Stolorow, NIST, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015.

BOX 2-4
National Commission on Forensic Science

The National Commission on Forensic Science was established in 2013 by the Department of Justice in collaboration with the National Institute of Standards and Technology (NIST) and is focused on federal policies surrounding the practice of forensic science. The commission meets quarterly and aims to promote scientific validity, reduce fragmentation, and improve coordination of federal activities guiding forensic science policy. It comprises 31 voting members and 8 ex officio members, including federal, state, and local forensic science service providers; research scientists and academics; law enforcement officials; prosecutors, defense attorneys, and judges; and other stakeholders. The commission is cochaired by the Deputy Attorney General and the Director of NIST.

To fulfill its objectives, the commission is tasked with the following duties:

- To recommend priorities for standards development to the Attorney General.
- To review and recommend that the Attorney General endorse guidance identified or developed by subject matter experts.
- To develop proposed guidance concerning the intersection of forensic science and the courtroom.
- To develop policy recommendations, including a uniform code of professional responsibility and minimum requirements for training, accreditation, and/or certification.
- To consider the recommendations of the National Science and Technology Council's Subcommittee on Forensic Science.
- To identify and assess the current and future needs of forensic science to strengthen its disciplines and meet growing demands.

(U.S. Department of Justice, 2013).

In fiscal 2014, NIJ provided approximately $1 million for the commission's operating expenses. The director of NIJ's Office of Investigative and Forensic Sciences is an ex officio member of the commission.[a]

[a]Presentation on *Office of Investigative and Forensic Sciences Budget*, by Gerry LaPorte, OIFS, NIJ, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015.

resources support intramural research, it recently awarded a 5-year, $20 million grant for the establishment of a center of excellence charged with building a statistically sound and scientifically solid foundation for pattern evidence and digital evidence (National Institute of Standards and Technology, 2015a).

FBI Laboratory

The FBI Laboratory spent $10.9 million in fiscal 2014 on forensic science R&D.[14] The majority of this intramural research is carried out by its Counterterrorism and Forensic Science Research Unit, which "provides technical leadership and advancement of forensic sciences for the FBI—as well as for federal, state, local, and international agencies—through applied R&D."[15] Although the FBI's research may result in advances that can be used across the forensic science community, its research funding is primarily dedicated to supporting FBI casework and the directives of its units.

Defense Forensic Science Center

Like the FBI Laboratory, the DFSC in the Department of Defense (DOD) performs forensic R&D that aligns with its internal research priorities, balancing scientific opportunity with potential impact for the military. Its mission is to provide forensic support to DOD entities and to provide "specialized" forensic training and research.[16] In fiscal 2015, the DFSC allocated $328,000 to internal forensic R&D and $10.8 million to external projects. Much of the nearly $11 million for external projects is currently focused on sexual assault research due to the military's current interest in this area.[17] Like research conducted by the FBI Laboratory, DSFC research will likely result indirectly in advances of use to the entire forensic science community, but its research funding is primarily dedicated to supporting DOD.

[14]This includes grants from NIST ($700,000) and the Department of Homeland Security ($4.7 million). This figure does not include a multiyear grant ($4.8 million) from NIJ for research and analysis on sexual assault kits.

[15]Federal Bureau of Investigation, *Counterterrorism and Forensic Science Research*; see http://www.fbi.gov/about-us/lab/scientific-analysis/counterterrorism-forensic-science-research [June 2015].

[16]U.S. Army Criminal Investigation Command, *Defense Forensic Science Center*; see http://www.cid.army.mil/dfsc.html [June 2015].

[17]According to the DFSC, the amount listed for internal projects represents funds leveraged from non-DFSC sources to support research associates, supplies, etc. Presentation on *Defense Forensic Science Center: Federal Forensic Sector Panel,* by Rick Tontarski, DFSC, to the Committee on Strengthening Forensic Science at the National Institute of Justice, May 7, 2015.

CONCLUSION

An effective criminal justice system requires a broad range of valid and reliable forensic techniques and tools developed from a strong base of scientific evidence, maintained and advanced by sound and stable programs of basic and applied research. Given the challenges facing forensic science practice (see Chapter 1, this volume; National Research Council, 2009b) and the limited ability to conduct research at state and local levels, there is an urgent need for federal leadership and support to sustain an extensive program of high-quality, strategically focused forensic science research. As pointed out in *Forensic Science: Path Forward,* although there are multiple agencies that support this kind of research, there is relatively little coordination and leadership among them. This committee spoke to a number of stakeholders who emphasized that this lack of leadership and overall coordination is a continuing problem.[18] It is outside the purview of this committee to assign such a responsibility to any agency, but it is the committee's view that this problem of leadership needs to be solved. The National Science and Technology Council's Subcommittee on Forensic Science appears to be a start toward providing coordination, but it has not yet clearly asserted that role.

NIJ has a unique and critical role in efforts to strengthen forensic science research because its mission guides the agency to support research that will serve the nation's forensic science field, particularly at the state and local levels, whereas other federal agencies have strategic objectives that serve the broad forensic science field only indirectly and occasionally. NIJ is the federal government's largest funder of extramural forensic science research, and as such has deep ties to the forensic science research community. It also has close ties to the forensic science practice community, which enables it to support the transfer of promising evidence-based approaches into practice. In addition, other federal agencies that conduct forensic science research have specialized foci or other priorities beyond research and development. For example, NSF, like NIJ, makes grants to external entities for forensic science research, but its awards are limited to basic, not applied, research. Further, NSF has no dedicated forensic science program, unlike NIJ, and much of its work to support the forensic science field is conducted in conjunction with NIJ.

NIJ's mission to support forensic science research in the service of state and local law enforcement, its broad forensic portfolio, and its ability to engage forensic science researchers and practitioners give it a unique and critical role to play in federal efforts to strengthen forensic science. As will

[18]See, for example, presentations by the DFSC, FBI, and NSF ("Federal Forensic Sector" panel) to the Committee on Strengthening Forensic Science at the National Institute of Justice, May 7, 2015.

be discussed in Chapter 3, NIJ has made a number of improvements to its research program since 2009. If additional improvements are made, such as those recommended in Chapter 4, the agency will be able to more effectively support forensic science research, a role with clear and striking consequences for the criminal justice system.

3

Research Operations of the National Institute of Justice

As discussed in Chapter 2, a variety of federal entities engage in forensic science research and practice. However, the National Institute of Justice (NIJ) is the principal federal agency that supports research and development (R&D) for forensic science, having done so since the 1970s.

In 2009 and 2010, two reports of the National Research Council (NRC) critically reviewed the needs of the forensic science field and the performance of NIJ as a science agency, respectively (National Research Council, 2009b, 2010). The recommendations in those reports include some directed at NIJ, some directed at policy makers, and others directed at the broader forensic science field (see Appendix B). Both reports recognized that NIJ was operating under significant challenges and lacked strategic direction at the time. This chapter reviews the agency's current research operations and its progress toward advancing forensic science research since the previous two NRC reports. The committee also examines and assesses the adequacy of the resources NIJ has available to support its research operations.

As discussed below, NIJ has made productive organizational and process changes in its operations since the release of *Forensic Science: Path Forward* in 2009 and *Strengthening NIJ* in 2010.[1] However, the committee believes the agency still lacks a clear strategy for its research portfolio and thus falls short in its ability to advance the field.

[1]As noted in Chapter 1, this report uses the abbreviation *Forensic Science: Path Forward* for the 2009 NRC report and *Strengthening NIJ* for the 2010 report.

NIJ'S FORENSIC SCIENCE RESEARCH PROGRAM

NIJ's forensic science R&D portfolio is divided among its three science offices (see Figure 1-2 in Chapter 1): The Office of Investigative and Forensic Sciences (OIFS) manages R&D to support forensic disciplines that are based on physical and life sciences (anthropology, biology/DNA, drug chemistry, pathology, toxicology, trace evidence analysis, etc.). The Office of Science and Technology (OST) manages technology development associated with digital and multimedia forensic evidence. The Office of Research and Evaluation (ORE) manages social science research related to forensic science.[2]

The work of OIFS is entirely focused on forensic science, whereas OST and ORE also manage research in other areas of crime, crime control, and the administration of justice. Prior to 2009, a division of investigative and forensic sciences was housed within OST (see Figure 1-1 in Chapter 1); many of that division's activities were subsequently assumed by OIFS when the office was created. The motivation for the change, according to documents provided by NIJ,[3] was to focus efforts on building a body of research in forensic science and to explicitly highlight NIJ activity in this critical area to audiences within the Department of Justice and across the forensic science field. The committee believes this reorganization is appropriate to elevate the stature of forensic science and improve access to resources within the agency.

Grants awarded by OIFS comprise most of the forensic science portfolio at NIJ; this portfolio includes forensic science research cooperative agreements as well as assistance grants for casework backlog reduction and forensic laboratory improvements. The mission of OIFS and its goals for R&D are shown in Box 3-1.

Much of NIJ's research portfolio in forensic science has focused on developing technologies and tools for forensic science practitioners. The portfolio and its size and areas of research are discussed later in the chapter. NIJ follows a research, development, testing, and evaluation (RDT&E) process that is designed to align its R&D portfolio with the expressed needs of the forensic science community.[4] The process has five phases: (1) determine technology needs; (2) develop a program plan to address these

[2]ORE has historically provided oversight to the agency's social science research and evaluation studies. OST manages science and technology research and development, creates technical standards and equipment testing for certain technologies, and provides technology assistance to state and local law enforcement and corrections agencies (National Research Council, 2010, p. 16).

[3]Written response to Question 1, provided by the NIJ's OIFS, in response to committee's questions found in Appendix C.

[4]The RDT&E process is also used in OST to develop other technology-based research and development portfolios.

BOX 3-1
Mission and R&D Goals of NIJ's
Office of Investigative and Forensic Sciences

Mission: improve the quality and practice of forensic science through innovative solutions that support research and development, testing and evaluation, technology, information exchange, and the development of training resources for the criminal justice community.

Research and development goals: (1) expand the information that can be extracted from forensic evidence, including DNA, and quantify its evidentiary value; (2) develop reliable and widely applicable tools and technologies that allow faster, cheaper, and less labor-intensive identification, collection, preservation, and analysis of forensic evidence of all kinds and reduce existing case backlogs; and (3) strengthen the scientific basis of the forensic science disciplines.

SOURCE: NIJ's Office of Investigative and Forensic Sciences, see http://www.nij.gov/about/pages/oifs.aspx [June 2015].

needs; (3) develop solutions; (4) demonstrate, test, evaluate, and adopt into practice; and (5) build capacity and inform the forensic science community. These phases are similar to steps taken by other federal agencies or other entities to gather needs or requirements and define and develop research priorities that will address policy and practice issues (Lenaway et al., 2006; Campbell, 2010). Notably, such steps include identifying needs, setting research priorities, communicating research priorities, and building an infrastructure for research and for the translation of research to practice. In accordance with its charge (see Chapter 1), the committee reviews NIJ's operations in terms of these general research-setting strategies in order to determine how NIJ develops forensic science research priorities and communicates these priorities, as well as research findings, to the scientific and practitioner communities. Strengths in its process as well as areas for improvement are identified.

IDENTIFYING FORENSIC SCIENCE NEEDS

NIJ has a process for identifying the forensic science needs of practitioners, and it uses these needs as a significant input to the development of its research solicitations. Both OST and OIFS use Technology Working Groups

(TWGs) to develop and categorize a list of operational and technology needs and practical problems affecting the day-to-day work of practitioners; until recently, this list was only used internally by staff.[5] This process is very similar to that used by OST prior to 2009. At that time, there were two TWGs related to forensic science (of 17 TWGs across OST): one focused on DNA and another on general forensics. Currently, there is one forensic science TWG that is overseen by OIFS; it has 5 subgroups, each with 8 to 14 members: (1) Standard DNA, (2) Non-Standard DNA, (3) Crime Scene and Medicolegal Death Investigations, (4) Pattern and Trace Evidence, and (5) Drugs and Toxicology. These subgroups cover a greater breadth of forensic science disciplines than before and are able to identify at least a few needs in each of the disciplines listed in Box 2-1 (see Chapter 2). However, the resulting TWG review is by no means a comprehensive analysis of all the research gaps in each discipline.

The TWG, made up of forensic science practitioners, is not intended to be a research advisory group but rather to be a source of input into the research priorities ultimately chosen by NIJ. According to OIFS, the current TWG process is designed to avoid bias by researcher input and avoid conflating current practices with technologies in development or research findings not yet published.[6] For those reasons, individuals who are primarily researchers and not practicing forensic scientists have not been included in the TWG membership. The committee finds that the current process of gathering and assessing needs is entirely focused on the needs within the practice of forensic science and does not reflect the views or address the needs as seen by researchers trying to advance the scientific basis of forensic science.

For fiscal 2015, OIFS made its full list of TWG-generated forensic science needs more transparent to the research community by posting it on the NIJ website and providing a link within the R&D solicitation (National Institute of Justice, 2015b, p. 4). Providing the full list of identified needs is intended to inform researchers of practitioners' priorities and assist in proposal development (National Institute of Justice, 2015b). However, the list is made available solely for researchers' consideration; there is no requirement or incentive to develop proposals that specifically address the identified needs. NIJ notes that it writes its solicitation broadly enough so that researchers are not restricted to ideas proposed by practitioners and to allow them to propose other solutions designed to move the state of the science forward.[7]

[5]The current list of needs can be found at http://www.nij.gov/topics/forensics/Documents/fy15-forensic-twg-table.pdf [April 2015].

[6]Written response to Question 6, provided by the NIJ's OIFS, in response to committee's questions found in Appendix C.

[7]Written response to Question 6, provided by the NIJ's OIFS, in response to committee's questions found in Appendix C.

The committee heard from both practitioners and researchers who found the compilation and broader availability of the TWG-generated list useful.[8] However, the committee found that the list of needs is not comprehensive across all the forensic science disciplines (e.g., there are over 40 needs identified for forensic biology/DNA and only 4 needs for crime scene analysis); it also lacks description of critical research gaps and promising new approaches. Moreover, it is a long list with little structure or hierarchy of priorities and without any connection to the priorities (e.g., microbiome) identified in the most recent NIJ R&D solicitation (National Institute of Justice, 2015b, pp. 9-10).

Strengthening NIJ recommended that NIJ "strengthen its science mission" and "revise its research operations to allow greater transparency, consistency, timeliness, and appropriate involvement of the research and practitioner communities" (National Research Council, 2010, pp. 4, 7; also reproduced in Appendix B of this report). The committee observed that NIJ has taken steps in the last 5 years to respond to these recommendations, including a renewed focus on science and research (see, for example, Box 3-1 and recent NIJ solicitations [National Institute of Justice, 2010, 2015b]) and efforts to make its processes more transparent. However, the agency has yet to appropriately involve the research community in identifying research priorities.

The committee commends OIFS for engaging with the practitioner community. Forensic science work is necessarily practical; assessing the needs of practitioners is therefore critical to carrying out OIFS's mission. But including researchers more actively in the process of identifying research gaps and articulating priorities would be useful, since relevant disciplinary researchers (anthropologists, biologists, chemists, physicists, statisticians, etc.) can bring their specialized knowledge to bear on possible uses and limitations of forensic evidence as well as promising areas for advancing research and knowledge. Currently, NIJ uses its broad solicitation for forensic science R&D as the avenue for researchers to direct priorities (i.e., by proposing research projects in response to the extensive statement of needs), as opposed

[8]Panel presentations to the committee. *PI Panel*, by Ann Bunch, SUNY-Brockport; Cedric Nueman, South Dakota State University; and Hanlee Ji, Stanford University (April 1, 2015) and *Technology Working Groups* panel, by George Herrin, Georgia Bureau of Investigation; Mike Gorn, Sarasota County Sheriff; and Steve Renteria, Los Angeles County Sheriff's Department, to the Committee on Strengthening Forensic Science at the National Institute of Justice, May 7, 2015. The practicing forensic scientists from the *Technology Working Groups* panel acknowledged that because of large caseloads there is little to no time to conduct research in the laboratories, so they appreciate the larger research community's awareness of needs in their field. A 2009 census of public crime laboratories found that approximately 7 percent of respondents reported the ability to dedicate any resources to research activities (Bureau of Justice Statistics, 2012).

to asking researchers for scientific advice on framing research opportunities before the solicitation is created. Including researchers at an earlier stage in solicitation development would enhance NIJ's ability to prioritize research areas and develop short- and long-term research agendas. This practice is used by many other funding agencies (e.g., National Science Foundation [NSF], National Institutes of Health) and should not pose a significant conflict of interest for the researchers, since their role is purely advisory and the final decisions are made by the agency staff.

Conclusion 3-1: The National Institute of Justice has an established mechanism for identifying the needs of forensic science in practice through a Technology Working Group of practitioners. However, this group does not adequately represent the needs or perspectives of the broad range of forensic science disciplines. In addition, there is no mechanism for integrating the perspective of research scientists to help identify scientific gaps and opportunities and develop an overarching strategic research agenda.

COMMUNICATING RESEARCH PRIORITIES

Currently, NIJ does not have a strategic plan that lays out its short-term and long-term forensic science research priorities or how it will go about achieving these priorities. NIJ has not changed how it communicates research priorities to researchers. The committee heard that NIJ still communicates its forensic science research priorities to the research community only through its solicitations.[9] The committee believes that this approach is not as effective as having a public statement of research priorities, which is available before the release of solicitations and can direct researchers to critical areas in forensic science for longer-term funding opportunities. However, NIJ has made other changes to its procedures for awarding research grants. The following sections review recent changes in its solicitations, peer review, and award decisions and assess whether these changes have positively affected NIJ's stature as a research agency.

Solicitations

According to NIJ, reviewing the priority areas for forensic science research occurs on a routine and continuing basis. Within OIFS, program managers hold weekly meetings to discuss current R&D investments, potential new funding opportunities, recent scientific or legal events that may

[9]Written response to Questions 6, provided by the NIJ's OIFS, in response to committee's questions found in Appendix C.

impact the forensic community, and dissemination of key research findings. NIJ representatives informed the committee that changes to the solicitation process reflected in the fiscal 2011 and 2014 forensic science R&D solicitations were the result of such internal planning.[10]

Recent solicitations have focused on building the scientific basis supporting forensic science practice, most notably the 2009 and 2010 solicitation, *Fundamental Research to Improve Understanding of the Accuracy, Reliability, and Measurement Validity of Forensic Science Disciplines*, in direct response to recommendations in *Forensic Science: Path Forward* (see, for example, National Institute of Justice, 2009, p. 3; 2010, p. 5). NIJ has increased efforts to promote its forensic science R&D funding solicitations to the academic community via presentations and booths at annual meetings of scientific organizations, as well as through social media and email notices.[11]

Solicitations encourage new investigators (i.e., junior faculty who have never received NIJ funding for research projects or established researchers who have not received NIJ funding in the past 10 years) in an attempt to expand research interest in forensic science issues. In addition, proposals in NIJ-specified innovative areas of research are encouraged by giving them special consideration in the selection process. The three designated innovative areas for fiscal 2015 were nanotechnology, the microbiome, and fatal head trauma (National Institute of Justice, 2015b, pp. 8-10).

These innovative areas reflect national research initiatives throughout the federal government, but the level of strategic planning involved in designating them as special-consideration areas for forensic research is unclear. OIFS does not articulate how these innovative areas may advance the stated goals of the R&D program more than other areas of forensic research. Nor is it clear how long these areas will remain priority areas for NIJ funding.

Conclusion 3-2: Through its solicitations, the National Institute of Justice (NIJ) has taken several steps to advance forensic science research and attract new investigators. However, the priority issues emphasized in the agency's solicitations appear to be reactive to short-term political

[10]Written response to Questions 6 and 15, provided by the NIJ's OIFS, in response to committee's questions found in Appendix C. After 2009, the solicitations by OIFS became less targeted and were generalized into one (fiscal 2014) or two (fiscal 2011) solicitations to cover basic and applied research across a broad range of disciplines (National Institute of Justice, 2011c, 2011d, 2014b). NIJ's expired solicitations are available at http://www.nij.gov/funding/Pages/expired.aspx [June 2015].

[11]Presentation on *Research, Development, Testing, and Evaluation Process,* by Gerry LaPorte and Danielle McLeod-Henning, OIFS, NIJ, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015.

and public concerns, and it is not clear how the priorities announced by NIJ relate to an overall long-term research agenda for forensic science.

Peer Review

Proposals to NIJ in response to solicitations have undergone peer review since the late 1970s. In 2004, the Office of Justice Programs (OJP), the parent agency of NIJ and other agencies, centralized the peer-review process for all its bureaus, including NIJ. *Strengthening NIJ* found that this centralized process limited NIJ's ability to tailor peer review to its own needs and mission—that is, applications proposing to conduct research require a different kind of expertise and review than those requesting programmatic support. *Strengthening NIJ* noted that ". . . the use of practitioners on review panels, the scoring and ranking system, and the process for making individual peer reviews available . . ." deserved reconsideration (National Research Council, 2010, p. 123).

NIJ and OIFS have made changes to their peer-review process since 2009. As a pilot program, NIJ has instituted Standing Review Panels (SRPs) for a number of its solicitations, including those for forensic science. Proposals related to R&D on impression/pattern evidence and trace evidence analysis are reviewed through SRPs.[12] Proposals submitted in other forensic areas, such as those for biology/DNA, controlled substances, crime scene investigation, forensic anthropology, forensic pathology, and toxicology, are reviewed by what are known as ad hoc review panels.

NIJ oversees its own peer-review panels following OJP standard operating procedures or procedures for SRPs developed in consultation with OJP's Office of Audit, Assessment, and Management. But, notably since 2009, NIJ as well as the Bureau of Justice Statistics and Office of Juvenile Justice and Delinquency Prevention have been exempt from certain procedures/criteria that apply to other OJP bureaus. With these exemptions, NIJ does not have to follow OJP's normalization process for peer-review scores and has the ability to vary peer-review formats under one solicitation. The latter approach has been used for its forensic science R&D solicitation, which receives proposals across a broad array of disciplines (Office of Justice Programs, 2013).

As a result, instructions to proposal reviewers currently reflect a greater focus on science; recently, the weight assigned to the research idea in the scoring system has increased, so that 50 percent of the proposal score is now based on the quality of the idea, the project design, and the implementation. The rest of the score is based on the quality of the statement

[12]NIJ's OIFS also uses a SRP for proposals received under its Paul Coverdell Forensic Science Improvement Grants Program.

of the problem (10%), the potential impact of the research (20%), and capabilities/competencies of the investigators (20%). The budget and plan for dissemination are reviewed but not scored (Office of Investigative and Forensic Sciences, 2015). Additionally, in recent years considerable effort has gone into enhancing the scientific credentials of individuals on the review panels. For example, NIJ has reached out to the American Statistical Association for help in identifying statisticians to serve on the review panels.

In remarks to the committee, a number of NIJ peer reviewers described their experiences with NIJ as comparable to other federal agencies, including the National Institutes of Health, NSF, and the Department of Defense. Those with experience as members of SRPs and ad hoc review panels expressed their belief that both capably assess the science underlying the proposals.[13]

Some previous concerns about NIJ's lack of independence (National Research Council, 2010, pp. 3-4) have been addressed in the award process by designating final sign-off authority to the NIJ director. Previously, the Assistant Attorney General, as the head of OJP, had to sign off on all of NIJ's awards. Now the Department of Justice Scientific and Integrity Policy[14] states (p. 7): "[t]he Director of the National Institute of Justice shall have final authority over all grants, cooperative agreements and contracts awarded by the institute. . . ." From the committee's perspective, this is an important improvement.

OIFS staff recommend forensic science research proposals for funding to the NIJ director based on a number of factors, including the strength of the research proposals as evaluated through their peer-review rankings, the needs of the forensic science practitioner community, and the quality and state of existing R&D initiatives.[15] In addition, special consideration may also be given to proposals that involve investigators not previously funded by NIJ or that address one of the designated innovative areas of research (discussed above).[16] Peer-reviewer recommendations are used as guidance in

[13]Panel presentations on *NIJ Peer Review Panels,* by Phillip Danielson, University of Denver, and Eric Bartelink, California State University, Chico, and *Standing Review Panels at NIJ,* by Eric Buel, State of Vermont Forensic Laboratory; Brooke Weinger Kammrath, University of New Haven; and Martin Wells, Cornell University, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015.

[14]Available: http://www.justice.gov/sites/default/files/open/legacy/2013/07/29/doj-scientific-integrity-policy.pdf [June 2015].

[15]Presentation on *Research, Development, Testing, and Evaluation Process,* by Gerry LaPorte and Danielle McLeod-Henning, OIFS, NIJ, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015.

[16]Presentation on *Research, Development, Testing, and Evaluation Process,* by Gerry LaPorte and Danielle McLeod-Henning, OIFS, NIJ, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015.

selecting awardees (Office of Justice Programs, 2013) but are not the only consideration. In the determination of awards, it is unclear to the committee what weight is given to peer-review rankings in relation to the TWG-generated list of needs discussed earlier and to other staff considerations, such as current investments and recent events.

Conclusion 3-3: As recommended in previous National Research Council reports, the National Institute of Justice has obtained an increased level of autonomy and independence for its scientific peer-review process.

Conclusion 3-4: As recommended in previous National Research Council reports, the Director of the National Institute of Justice was given final sign-off authority for research awards.

NIJ'S RESEARCH PORTFOLIO

OIFS has been able to expand the size of its forensic science research portfolio. In the period from fiscal 2004 through 2008, there were 13 to 39 research grants awarded annually, with total annual research funding in the range of $6 to $15 million. In the period from fiscal 2009 through 2013, there were 33 to 65 research grants awarded annually, with total annual research funding in the range of $15 to $33 million. The budget for NIJ's forensic science research awards is discussed later in this chapter. Here the general nature of its research awards is examined.

Forensic science research spans a number of disciplines. Figure 3-1 shows the distribution by forensic science discipline of research awards administered by OIFS in the periods fiscal 2004-2008 and fiscal 2009-2013. Forensic DNA research still accounts for a large proportion of NIJ's forensic science portfolio in number of awards (as well as funding). Since fiscal 2009, the number of grant awards in the areas of medicolegal death investigations (forensic pathology), impression and pattern evidence, and trace evidence has significantly increased. There have also been more awards in the areas of DNA and forensic biology, fire debris analysis and arson, questioned documents, forensic crime scene analysis, and forensic toxicology/controlled substances.

Conclusion 3-5: From fiscal 2009 to fiscal 2013, the National Institute of Justice has increased the number of awards for forensic science research across disciplines in comparison with prior years, and it has expanded research attention in areas recommended in previous National Research Council reports.

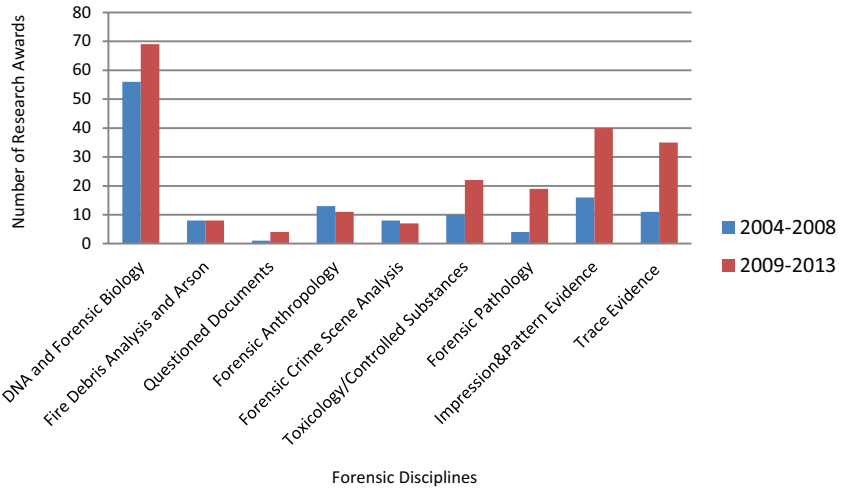

FIGURE 3-1 Distribution of research awards by discipline, fiscal 2004-2008 and 2009-2013.
SOURCE: Committee generated using data provided by NIJ. Disciplines are those outlined in NIJ's forensic science R&D solicitation (National Institute of Justice, 2015b), shown in Box 2-1 in Chapter 2, except that Controlled Substances and Forensic Toxicology have been combined; firearms and toolmark identification, latent print, and shoeprint/tire tread examination were all considered under Impression & Pattern Evidence; and award data were unavailable for the digital evidence discipline.

NIJ's R&D portfolio has covered a wide range of technology development and process validation, as suggested by the number of disciplines and distribution of awards in Figure 3-1. The agency's programs and studies around DNA evidence are most often recognized (Lovrich et al., 2004; National Research Council, 2010). NIJ continues to support research in this area that could advance techniques and technologies, including automated systems, or that could allow laboratories to work more efficiently and at lower cost. It also supports research to improve the collection and processing of other types of forensic evidence. Recent projects, for example, are developing imaging technologies for detection of fingerprints, body fluids, and other residues at crime scenes; developing hand-held analyzers for controlled substances; and tackling new challenges such as the identification of synthetic cannabinoids. Other studies have focused on validating the accuracy of expert forensic examinations (e.g., blood stain patterns, fingerprints, and firearms) and investigating any sources of human error and bias (National Institute of Justice, 2015a).

Findings and developments from NIJ-funded studies can and have been used in the protocols and practices of forensic laboratories.[17] According to NIJ-involved researchers and practitioners, the forensic science community makes use of the knowledge and products produced through NIJ and values the informational resources available.[18] Similar support from the community for a research agency focused on criminal justice challenges was also documented in *Strengthening NIJ* (see National Research Council, 2010, p. 12).

The advances in practice observed today were influenced by research conducted years ago, some notably funded by NIJ prior to 2009. OIFS

[17]NIJ-funded research was used to benchmark how DNA should be quantified and served as a guide for industry to develop analysis kits, which ultimately streamlined the process from 2.5 hours to a semi-automated 15-minute procedure (presentation on *Standing Review Panels at NIJ,* by Eric Buel, State of Vermont Forensic Laboratory, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015). Findings from an NIJ-funded study on applying signal-to-noise ratios in forensic glass analysis (Ernst et al., 2012) have been adopted into the laboratory protocol of Johnson County, KS (presentation on *Perspectives of Forensic Labs*, by Kristine Olsson, Johnson County Sheriff's Office Crime Laboratory, to the Committee on Strengthening Forensic Science at the National Institute of Justice, May 7, 2015). NIJ and the National Institute of Standards and Technology (NIST) have collaborated on publications for the community, notably handbooks related to biological evidence preservation, laboratory construction, and crime scene investigation. They also recently sponsored a working group (Expert Working Group on Human Factors in Latent Print Analysis, 2012) to recommend ways to improve the practice of latent print analysis and reduce the risk of human error (presentation on *Standards and Practices of Forensic Science from an NIST Perspective,* by John Butler, NIST, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015). Researchers recognize that initial work was done through NIJ funding, notably in the introduction of automation, such as the implementation of capillary electrophoresis in laboratories, and development of better kits for processing Y-STR (short tandem repeat on the Y-chromosome) casework (presentation on *PI Panel on Impact of Research,* by Bruce McCord, Florida International University, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015).

[18]Techniques initiated by NIJ-funded work have transformed laboratory work, such as advances in mass spectrometric methods for toxicology and real-time polymerase chain reaction quantification. NIJ support for databases is also useful. Other techniques and tools are starting to appear, such as the use of messenger RNA (ribonucleic acid) to identify body fluids and the handheld Raman infrared devices. In addition, the workshops conducted and archived by the NIJ-funded Forensic Technology Center of Excellence as well as other resources and training materials have reached many forensic scientists and repeat customers (presentations on *PI Panel on Impact of Research,* by Bruce McCord, Florida International University, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015, and on *Technology Working Groups*, by George Herrin, Georgia Bureau of Investigation, to the Committee on Strengthening Forensic Science at the National Institute of Justice, May 7, 2015). The Green Mountain DNA conference has become a prominent forum on improving research and practice and encouraging collaboration in the field of forensic science and was launched 8 years ago with funding from NIJ (presentation on *Standing Review Panels at NIJ,* by Eric Buel, State of Vermont Forensic Laboratory, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015).

provided the committee with an example of how an applied R&D project can begin to make its way into forensic practice. The study of a portable, tandem mass spectrometer for onsite identification of forensic evidence (O'Leary et al., 2015) was funded in 2011 with promising research results published in 2015. The potential commercialization and adoption of such a tool is likely still years away. This research lag makes determining the impact of research on the practice of forensic science challenging.

The committee finds that NIJ is just starting to collect information useful for assessing its research program more systematically. Beginning in fiscal 2011, NIJ-funded researchers are required to respond to non-budgetary components of the Research Performance Progress Report[19] as part of their progress reporting to the agency. This allows the agency to capture information that can help assess the impact of its research portfolio, such as dissemination activities, patent applications, licenses, and qualitative interpretations of the impact of research awards.[20] NIJ collects a list of publications, presentations, and deliverables through semi-annual reports from research grant recipients and now keeps track of publications and presentations by its research grantees and of downloads of technical reports posted to the National Criminal Justice Reference Service.[21] The reference service recently has begun assembling citation information on all NIJ-supported research reports to date.

Although the recordkeeping is useful and an improvement over the types of indicators collected before 2009, tracking citations and scholarly products can only suggest whether or not research studies are reaching the research community. Measuring impact—that is, influencing or changing the field of research and ultimately practice—is much more difficult to gauge. Program officers catalog grantee products from final summary reports, but these are not consistently compared across different time periods or analyzed across program offices or the forensic science portfolio as a whole to identify overarching conclusions or cumulative impact.

In 2015, NIJ released a report on *The Impact of Forensic Science Research and Development* (National Institute of Justice, 2015a). This

[19]See http://www.nsf.gov/bfa/dias/policy/rppr [August 2015].

[20]Written response to Question 6, provided by the NIJ's OIFS, in response to committee's questions found in Appendix C.

[21]As noted in NIJ's recent report on *The Impact of Forensic Science Research and Development*, for awards made from fiscal 2009 through 2013, there had been 77 final technical reports submitted, 255 refereed journal publications, and more than 600 conference presentations (through July 2014) (National Institute of Justice, 2015a). In a written statement to Question 7, provided by the NIJ's OIFS, in response to committee's questions found in Appendix C, NIJ reported annual downloads of all its available forensic science R&D final technical reports in the range of about 275,000 to 1,600,000 for the years 2009-2014, with several technical reports exceeding 40,000 downloads in those 5 years.

report recognizes the importance of R&D underlying forensic science and highlights several successful research investments and research initiatives under way (i.e., case studies). However, it falls short of analyzing trends and improvements and demonstrating how the agency's investments contribute to progress toward agency goals. Box 3-1 (see above) identifies NIJ's three current goals for forensic science: (1) quantifying the evidentiary value of forensic evidence, (2) developing tools and technologies, and (3) strengthening the scientific basis of forensic science disciplines. The quantitative information assembled by NIJ and presented in the 2015 *Impact* report—which includes funding distribution by discipline and total number of publications/presentations lumped together for a 6-year period (see National Institute of Justice, 2015a, p. 9)—is not easily interpreted into outcomes related to these three goals identified by NIJ for its forensic science program.

Strengthening NIJ concluded that NIJ did "not have any mechanisms in place for monitoring on a regular basis the impact of the research it funds" nor had it "adopted an assessment approach by qualified staff that integrates quantitative metrics . . . and qualitative reviews . . ." (National Research Council, 2010, p. 208). Since then, NIJ has taken steps to develop mechanisms and integrate them into its operations for the collection of information useful for assessing impact. However, much information and data have yet to be assembled. And NIJ has yet to demonstrate how it will use these data to advance its goals.

Conclusion 3-6: The National Institute of Justice has made some progress in accumulating measures for assessing the productivity of its funded researchers, but there is no evidence that measures are being collected to assess the impact on the practice of forensic science.

BUILDING THE INFRASTRUCTURE FOR THE FIELD

NIJ has the mandated roles to build and sustain a research infrastructure around forensic science and to foster improvement in the criminal justice field, working toward efficient and reliable collection and interpretation of forensic evidence. In this section the committee will review the changes NIJ has made to encourage the development of forensic science research, expand the number of people engaged in that research, and facilitate transition of new technologies and solutions to forensic science practitioners.

Supporting Researchers: Dissemination and Education

Strengthening NIJ observed that support and outreach from NIJ to researchers declined in the mid- to late 2000s. During this period, research funding decreased and research projects became a significantly smaller por-

tion of NIJ's overall portfolio of activities. In addition, dissemination and outreach to the academic community declined; notably, the NIJ research briefs and the annual NIJ research conference were discontinued, and few efforts were made to ensure the accuracy and completeness of scholarly databases (e.g., the National Archive of Criminal Justice Data) (National Research Council, 2010, pp. 182-186).

More recently, NIJ has placed a greater emphasis on developing the infrastructure for research in forensic science. Some activities supporting this emphasis include the calls for new investigators in solicitations (discussed earlier), stronger encouragement for funded researchers to disseminate their results through journal publications and conference presentations, increased support for future researchers (e.g., graduate students), and an emphasis on improving access to databases and datasets for research purposes.

Dissemination

Some previous concerns about the lack of independence of NIJ (National Research Council, 2010) in the dissemination of research findings have been addressed by returning control of its publications to NIJ. Now, the Department of Justice Scientific and Integrity Policy states (pp. 9-10):

> In keeping with National Research Council's Principles and Practices for a Federal Statistical Agency [National Research Council, 2009a], the Bureau of Justice Statistics and the National Institute of Justice retain control over the timing and content of statistical and research reports and the press releases associated with them.[22]

OIFS has hired a forensic science writer to help disseminate results. The writer is contributing articles to the *NIJ Journal* and to the trade press, writing content for the NIJ website and social media, and producing a brochure for NIJ's forensic science R&D program that can be distributed at events (e.g., major academic conferences). In addition, OIFS encourages research grantees to publish research findings in peer-reviewed journals and to present at conferences and meetings.[23]

[22]See http://www.justice.gov/sites/default/files/open/legacy/2013/07/29/doj-scientific-integrity-policy.pdf [June 2015].

[23]Presentation on *OIFS Dissemination/Strategic Plan,* by Gerry LaPorte and Danielle McLeod-Henning, OIFS, NIJ, to the Committee on Strengthening Forensic Science at the National Institute of Justice, May 7, 2015.

Education

Before 2009, NIJ did not adequately support future researchers in areas relevant to criminal justice research. For example, just an annual average of three 1-year fellowships were awarded to graduate students (National Research Council, 2010, pp. 185-186). NIJ has increased its commitment to building the field through the Graduate Research Fellowship (GRF) Program. The number of GRF awards made across NIJ has increased considerably from an average of three awards per year to almost four times that number (11 awards were made in 2014). There are now two different programs: one focused on science, technology, engineering, and mathematics (STEM) and the other focused on the social and behavioral sciences. In 2014, three STEM awards (all with forensic science projects) and eight social and behavioral science awards were made. Each fellowship now provides larger allowances: up to 3 years of support over a 5-year period, pending satisfactory progress toward the doctoral degree and the availability of funds.[24] Increased efforts to promote the GRF Program in order to attract a broader set of qualified candidates have paid off. From fiscal 2012 to 2014, OIFS received between five and seven applications for each year's awards. For fiscal 2015, the number of GRF applications received increased over six-fold.[25]

One area of continued need is the creation of a broader set of databases across the forensic disciplines for practitioners and academics conducting research to use in developing and evaluating methods. Existing databases are narrowly focused on biometrics. The absence of sufficient research data is a significant barrier to advancing technologies. Recently, NIJ sponsored NIST to catalog available datasets and host a symposium (January 2015) that discussed the adequacy of existing publicly available datasets and future needs.[26]

Conclusion 3-7: As recommended in previous National Research Council reports, the National Institute of Justice has taken positive steps to expand outreach and dissemination to the research community and has significantly increased the number of graduate student fellowships.

[24]For each year of support, NIJ now provides an allowance of $35,000 to cover salary/stipend and related costs and up to $15,000 for tuition and fees, research expenses, and related costs, compared with about $20,000 of total annual support in the past. NIJ anticipates that up to $1 million will be awarded to those applicants chosen in fiscal 2015. For more information, see http://nij.gov/funding/fellowships/graduate-research-fellowship/Pages/grf-stem.aspx [June 2015].

[25]Presentation on *OIFS Budget,* by Gerry LaPorte, OIFS, NIJ, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015.

[26]See more information at http://www.nist.gov/forensics/biometric-research-datasets-event.cfm [June 2015].

This shows promise for broadening the field of researchers engaged in forensic science. However, the agency has not yet developed a set of metrics to assess the impact of its outreach efforts.

Knowledge Transfer to the Criminal Justice Community

Technology transfer and transition of research findings into practice at forensic laboratories is a primary objective of NIJ's forensic science research portfolio. In the past, NIJ made significant contributions to the technology needs of the criminal justice community in areas where there were national attention and dedicated sources of funding, such as with DNA technologies. However, a broader set of forensic science disciplines and needs were neglected (National Research Council, 2009b, 2010).

The Forensic Technology Center of Excellence (FTCoE) has been a key component of NIJ outreach in this area. Currently, the center is hosted by Research Triangle Institute and several academic partners. It received approximately $11 million from NIJ over 4 years from fiscal 2011 through 2014.[27] FTCoE developed a technology transition management process that triages research projects to assess which merit further dissemination efforts. As a result of implementing this process, FTCoE has been able to (1) interact with principal investigators on the status and potential impact of transitioning their research to practice, (2) maintain a database on NIJ's R&D awards with performance metrics, and (3) identify projects that could benefit from additional support. An initial review of fiscal 2009-2011 research grants (about 160 awards) led to 22 projects with "go" potential (i.e., proof of user interest and identification of logical next steps for broader dissemination), with 9 of those projects being identified to receive additional planning and support toward technology transition (National Institute of Justice, 2014a). FTCoE provides additional support in several ways:

- by facilitating stakeholder round tables to discuss commercial paths and the barriers to and plans for validation and development;
- by enabling technology assistance and validation to help test emerging technologies;
- by linking users to data from NIJ-funded studies; and
- by communicating, educating, and disseminating research results and technology improvements (e.g., webinars, training, publications, case studies).

[27]For more information, see http://www.nij.gov/funding/awards/pages/award-detail.aspx?award=2011-DN-BX-K564 [June 2015].

For example, FTCoE has developed a variety of publications and workshops, both for onsite delivery and web-based, to provide a range of options for its practitioner audience. The center has disseminated NIJ-funded research and delivered technology assistance and web-based technology-transfer workshops to over 25,000 registered practitioners during the period from October 1, 2011, through December 31, 2014. It also sends out a weekly newsletter to over 12,000 subscribers and has presented and exhibited at 53 national meetings and released 11 reports (National Institute of Justice Forensic Technology Center of Excellence, 2015).

Conclusion 3-8: The Forensic Technology Center for Excellence, funded by the National Institute of Justice (NIJ), has served an important role in (1) creating a database of the agency's research projects to determine technologies in development that merit further investment, (2) delivering information and workshops to practitioners, and (3) maintaining a connection between the agency's applied research portfolio and the practice of forensic science. However, the center's efforts are reflected in neither a NIJ strategic research plan nor a NIJ strategic communications plan.

RESOURCES

This section discusses the changes to NIJ's resources—its budget, federal partnerships, and staffing for forensic science—in support of its research mission.

Budget for Forensic Science Research

Currently NIJ has no budget appropriated specifically for forensic science research.[28] NIJ supports its forensic science research portfolio by drawing funds from NIJ's appropriated budget in three ways: (1) from NIJ's base funding, (2) from funding set aside from OJP's assistance programs for research and statistics in NIJ and the Bureau of Justice Statistics, and (3) from funding for the DNA backlog reduction and sexual assault forensic examination programs that can be used for related purposes. In fiscal 2009, appropriations language was adjusted to acknowledge that funds under the DNA backlog reduction program could be used for reducing the backlogs and for other forensic activities. This clause has provided NIJ the authority

[28]However, in fiscal 2009, 2010, and 2011, appropriators recommended that amounts of $2.5, $5, and $5 million from NIJ's base funds, respectively, be directed to assist forensic and DNA activities. According to written response to Question 2 provided by the NIJ's OIFS, in response to committee's questions found in Appendix C, these funds supported R&D, primarily in the area of computer forensics.

to use some of this funding for R&D.[29] See Table 3-1 for a breakdown of NIJ's forensic science expenditures by funding source.

Figure 3-2 shows the amounts appropriated for each of these funding streams from fiscal 2009 through 2014. Figure 3-3 shows the amounts used to fund forensic science research. Most of the funding to support forensic science R&D has been carved out of funds appropriated to support the DNA backlog reduction program. Funding for this program has declined since fiscal 2010; as a consequence, funding for forensic science research within NIJ has also declined. In theory, NIJ could choose to pull more funds for R&D, but the agency notes that is has to continually balance the priorities of policy makers and needs of the forensic laboratories with the research mission of the institute.[30]

Although amounts used to fund forensic science research have increased in recent years relative to what they were prior to 2009, these funds are still quite limited when compared with the needs of the forensic science community, and they are relatively small compared with the research dollars available for other fields. For example, funding for drug abuse research by the National Institute on Drug Abuse or for transportation research, development, and technology by the U.S. Department of Transportation is about $1 billion annually.[31]

In addition to funding external research awards, NIJ has worked closely with a variety of federal agencies over the past 5-7 years to support the field of forensic science as envisioned by *Forensic Science: Path Forward* (see recommendations in Appendix B of this report). These partners include NIST, NSF, the Federal Bureau of Investigation (FBI) Laboratory, the Defense Forensic Science Center, and the Bureau of Alcohol, Tobacco, Firearms and Explosives. In almost all of its interagency agreements or collaborations, NIJ has provided the funding for activities. Among these activities are the following (NIJ partners shown in parentheses):

- development of standard reference materials for a number of types of forensic evidence (NIST);
- training in novel DNA mixture analysis software (Defense Forensic Science Center);

[29]Presentation on *OIFS Budget,* by Gerry LaPorte, OIFS, NIJ, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015.

[30]Presentation on *OIFS Budget,* by Gerry LaPorte, OIFS, NIJ, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015. See also U.S. Government Accountability Office (2013).

[31]See http://www.drugabuse.gov/about-nida/legislative-activities/budget-information/fiscal-year-2014-budget-information-congressional-justification-national-institute-drug-abuse for the drug abuse research funding and http://www.rita.dot.gov/sites/rita.dot.gov.rdt/files/rdt_strategic_plan_2013.pdf for transportation research funding [June 2015].

TABLE 3-1 NIJ Forensic Science Expenditures by Funding Source, 2009-2014

		Funding (in millions) by Fiscal Year					
Expenditures	Funding Sources	2009	2010	2011	2012	2013	2014
Forensic Science R&D (OIFS)	DNA analysis and capacity enhancement	23.3	31.4	15.7	13.0	12.2	18.4
	Post-conviction DNA testing	0	0	0	0	0	0
	Sexual Assault Forensic Exam Program	0	0	0.5	0	0.3	0
	Paul Coverdell	0	0	0	0	0	0
	NIJ base funds	0	0	0	0	0.3	2.5
	NIJ base forensics carve-out	0	1.0	0	0	0	0
	Research and statistics set-aside	0	0	0	1.9	2.4	2.3
	Incoming reimbursable agreements/earmarks	0	0	0	0	0	0
Computer Forensics (OST)	DNA analysis and capacity enhancement	0.5	1.2	0	0	0	0
	NIJ base forensics carve-out	2.9	3.9	3.9	0	0	0
Forensic-Related Social Science Research (ORE)	DNA analysis and capacity enhancement	2.4	0.7	2.5	0.8	0	0
	Sexual Assault Forensic Exam Program	0	0	0	0	1.3	2.6
Technical Assistance (including FTCoE)	DNA analysis and capacity enhancement	0.2	6.8	8.5	2.7	6.5	6.9
	NIJ base funds	0	0	0	0	0.9	0
	NIJ base forensics carve-out	0	0	0.1	0	1.9	0
	Incoming reimbursable agreements/earmarks	12.4	10.0	0	0	0	0

Training Development & Delivery	DNA analysis and capacity enhancement	13.8	9.4	4.6	0	0.5	0
	Sexual Assault Forensic Exam Program	0	0	0.7	0	0	0
	Incoming reimbursable agreements/earmarks	1.0	0	0	0	0	0
DNA Backlog and Other Backlog Casework	DNA analysis and capacity enhancement	89.5	84.9	93.3	85.2	76.3	72.3
	Post-conviction DNA testing	10.2	2.3	7.4	3.5	3.3	3.6
	Sexual Assault Forensic Exam Program	0	2.4	0	3.6	0.6	1.0
	NIJ base funds	0	0	0	0	0	0
	Incoming reimbursable agreements/earmarks	2.8	2.6	0	0	0	0
Laboratory Improvements	DNA analysis and capacity enhancement	3.7	0.2	0	0	0	0
	Paul Coverdell	22.7	33.3	26.7	10.6	9.7	10.5
	NIJ base funds	0	0	0	0	0	0

SOURCE: Committee created with data provided by NIJ.

NOTE: Funding sources are those related to NIJ's forensic science portfolio in its OIFS; these represent most of the types of funding appropriated to NIJ but not all. Funding from these sources was also used toward dissemination, peer review, and other program support, which are not reflected in the table.

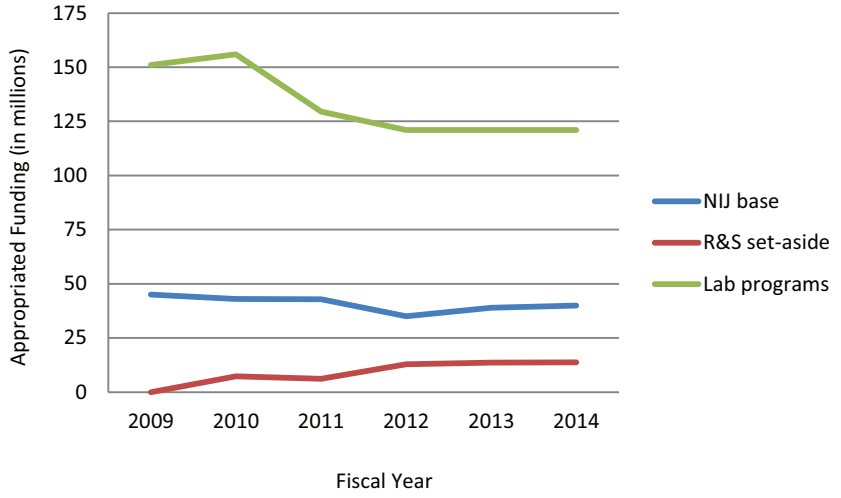

FIGURE 3-2 Funding for NIJ applicable to forensic science, fiscal 2009-2014, in millions of dollars. NIJ base = appropriated amounts for NIJ's total base budget; R&S set-aside = total funds set aside for research and statistics across OJP's programs; Lab programs = funds for programs to assist forensic laboratories, including DNA backlog reduction (DNA related and other forensics) and sexual assault forensic exam program.
SOURCE: Committee generated from data supplied by NIJ.

- expansion of DNA-related databases (Defense Forensic Science Center);
- a dual solicitation with NSF for Industry/University Cooperative Research Centers, bringing industry, university, and government organizations together to support the development of technology and research advances in forensic science (NSF);
- training at the National Firearms Examiner Academy and briefings on firearm- and toolmark-related technologies and techniques (Bureau of Alcohol, Tobacco, Firearms and Explosives); and
- an NIJ-FBI collaboration to process sexual assault kits through the FBI Laboratory with NIJ funding evaluations to gather knowledge to inform and improve training practices and testing protocols (FBI).

NIJ's funding for some of these activities has derived from the appropriated funding for the DNA backlog reduction program, which can be used for DNA analysis and other forensic activities including research, and from

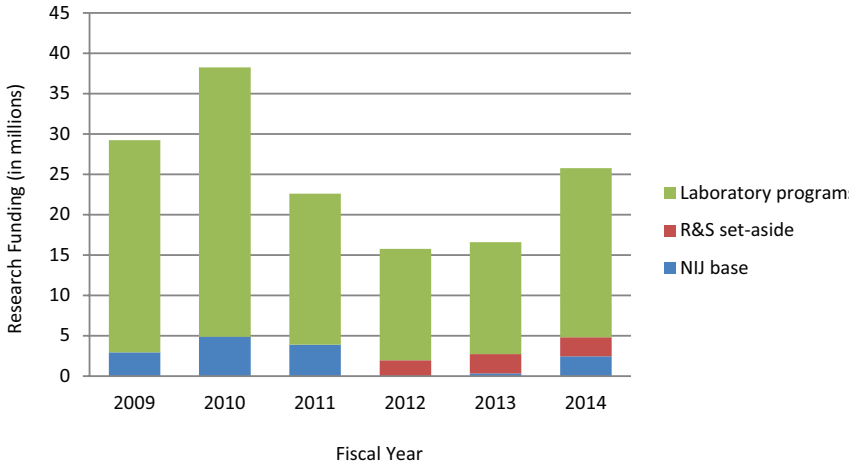

FIGURE 3-3 NIJ forensic science R&D funding by source, fiscal 2009-2014, in millions of dollars. Sources of funds include amounts from NIJ's base budget (NIJ base); funds set aside for research and statistics across OJP's programs (R&S set-aside); and funds for some programs to assist forensic laboratories, including DNA backlog reduction (DNA related and other forensics) and sexual assault forensic exam program (laboratory programs).
SOURCE: Committee generated from data supplied by NIJ.

the sexual assault forensic exam program. NIJ gave a total of $11 million to its federal partners (through interagency agreements) from fiscal 2009 to 2014 (National Institute of Justice, 2015a). In addition to those awards, NIJ was directed by Congress to transfer $16 million to NIST in fiscal 2012 through 2015.[32] In fiscal 2012 and 2013, $5 million per year was directly transferred from NIJ's base budget to NIST's Office of Law Enforcement Standards. In fiscal 2014 and 2015, Congress appropriated $3 million to NIJ to transfer to NIST for support of the Organization of Scientific Area Committees (see Chapter 2), and an additional $1 million was given to NIJ for support of the National Commission on Forensic Sciences. From fiscal 2009 through 2014, NIJ has not been the recipient of funds transferred from other agencies in support of its forensic science R&D program except as a byproduct of nondiscretionary earmarks before fiscal 2011.[33] Given NIJ's limited funding, future partnerships (initiated by the agency or legisla-

[32]See Public Laws 112-55, 113-76, and 113-235.
[33]Written response to Question 2, provided by the NIJ's OIFS, in response to committee's questions found in Appendix C.

tors) that augment rather than further deplete NIJ resources would enhance the agency's ability to advance forensic science R&D.

Conclusion 3-9: The lack of adequate and stable funding for forensic science at the National Institute of Justice from year to year contributes to the difficulty of establishing a long-term research agenda for forensic science.

Conclusion 3-10: As recommended in previous National Research Council reports, the National Institute of Justice (NIJ) has formalized partnerships with other federal agencies. Although these partnerships are commendable as they are currently executed, many rely solely on NIJ for funding and therefore further deplete the agency's limited resources for funding its own projects.

Staffing

Since OIFS oversees most of the forensic science research supported by NIJ, the committee reviewed the staffing in this office. OIFS oversees both forensic science research and the programs to enhance capacity in forensic laboratories (e.g., DNA backlog reduction, Paul Coverdell Forensic Science Improvement Grants Program). With the inclusion of the latter, OIFS manages more than half of the funds allocated to NIJ (see Table 3-2). Unlike ORE and OST, OIFS oversees both research and assistance grants.

According to recent organization charts, OIFS has fewer assigned staffing positions (physical scientists or analysts) than the other two program offices. In addition, the number of assigned staff positions does not appear to have changed from 2009, when there was a division of investigative and forensic science within OST, to the current organization in which forensic sciences has its own program office parallel to OST. Currently, OIFS uses a R&D team of four physical scientists to develop and manage one solicitation for forensic science R&D (the other offices usually have a number of R&D solicitations managed by individual physical or social scientists). This team approach was implemented in order to facilitate a R&D program of foundational science, applied science, method development, and technology development across a range of disciplines in forensic science (refer to Box 2-1 in Chapter 2) within the existing limitations on staff resources.[34]

[34]Written response to Question 1, provided by the NIJ's OIFS, in response to committee's questions found in Appendix C.

TABLE 3-2 NIJ Allocation of Funds, Fiscal 2013 (total funding of $211 million)

Type of Activity	Subcategory	Percentage
Social Science (ORE)	Evaluation	3.8
	Research	13.7
Science and Technology (OST)	Research and development	3.6
	Standards development	0.5
	Technology assistance/test and evaluation	4.6
Investigative and Forensic Science (OIFS)	Forensic laboratory analysis and capacity enhancement	42.8
	Research and development	8.5
	Training and technical assistance	3.9
	National missing and unidentified persons system	1.1
Dissemination, Outreach, and Program Support		4.3
Carve-Out for Section 215 Set-Aside for Research and Statistics		1.3
OJP Management and Administration		7.2
Direct Transfer to NIST Pursuant to Public Law 112-55		2.4
Carryover		2.4
Total		100.0

SOURCE: National Institute of Justice (2013).

Conclusion 3-11: The programmatic staffing for forensic science research has not changed commensurate with the increasing scope of responsibilities for the National Institute of Justice in this area.

CONCLUSION

Since 2009, as recommended by *Strengthening NIJ*, NIJ has made changes to its process for soliciting and awarding research grants, thereby better positioning the agency in developing and implementing a forensic science research agenda. Actions taken to (1) increase the level of autonomy and independence for its scientific peer-review process, (2) return grant sign-off authority to the NIJ director, and (3) return control to NIJ for the timing and content of its publications have restored authority and independence that is appropriate for a science agency. Recent activities and programs intended to support the work of graduate students in forensic science and to attract new investigators from a broader set of scientific disciplines to the forensic science field show promise toward building a research infrastructure necessary to develop and sustain research that advances forensic

science methods. The committee believes these efforts are well worth continuing, but that NIJ also needs to explore ways to evaluate and document the impact of its activities and programs, as an integral part of promoting a robust research infrastructure.

NIJ continues to involve its established Technology Working Groups in identifying needs of practicing forensic scientists. Gathering input from the practice community is important, especially considering that NIJ's applied research portfolio is directed toward improving forensic science methods and analytic techniques at crime scenes or in forensic laboratories. In the past year, NIJ has made practitioner-identified needs more transparent to the research community through its forensic science R&D solicitation. However, the agency has yet to develop mechanisms for integrating the perspective of researchers into the process for identifying needs and scientific gaps and opportunities. Including researchers in an advisory capacity will enhance NIJ's ability to prioritize research areas and develop short- and long-term research agendas.

Forensic Science: Path Forward and *Strengthening NIJ* both concluded that there was neither a long-term research agenda to help direct researchers nor a clear overarching strategy for forensic science research across the federal agencies. Today, there is still no publicly available strategic plan for forensic science research, and there needs to be one. The committee believes that great progress can be made in the field of forensic science if NIJ develops a strategic plan that includes short- and long-term research agendas and communication goals.

Most of the funding for forensic science research is drawn from and managed by NIJ, including support to other federal agencies for their research activities. Funds for forensic science research currently come from appropriated funding streams that have been unstable from year to year. In addition, this funding has been inadequate to meet the needs facing the forensic science field. Predictable and stable funding, as well as staffing commensurate with increasing responsibilities for forensic science research, would improve NIJ's ability to establish appropriate short- and long-term research agendas for forensic science.

In conclusion, NIJ has made productive changes to the organization and operation of its R&D program since 2009. However, the committee believes the agency can do more to set priorities for forensic science research and advance the type of work that is needed to strengthen the scientific basis of forensic science.

4

Forensic Science Research at NIJ: A Blueprint for the Future

The previous chapters have established that the forensic science research and development (R&D) program of the National Institute of Justice (NIJ) has improved since 2009, but additional improvements are needed. This chapter contains the committee's recommendations to NIJ and to other policy makers who influence criminal justice and forensic science policy. The recommendations are intended to provide a blueprint for the future to substantially improve the amount and quality of forensic science research supported by NIJ. Implementing them has the potential to produce tremendous improvement in the ability of the criminal justice system to collect, identify, preserve, and interpret the forensic evidence that is so central to a fair and evidence-based criminal justice system.

When these recommendations are fully implemented, the forensic science R&D program at NIJ will improve, which the committee believes is critically important for the future of the field. The committee also believes, consistent with findings in *Forensic Science: Path Forward* (National Research Council, 2009b), that there is a need to develop standards and protocols across forensic disciplines and establish accreditation and certification requirements for forensic laboratories and practitioners, among others. However, it is important to acknowledge that because this report focuses only on strengthening forensic science research at NIJ, the committee's recommendations are not a panacea for the systemic problems facing forensic science (mentioned above; see also Chapter 1 and *Forensic Science: Path Forward*), many of which go beyond the need for a stronger scientific basis and are, ultimately, outside the scope of NIJ's R&D mission.

SUPPORT FOR NIJ BY POLICY MAKERS

In order to implement the recommendations contained in this report, commitment and support will need to be expressed throughout the executive and legislative branches and particularly at all levels of the Department of Justice. Research from the field of implementation science suggests that implementing and sustaining change within an organization is dependent upon the support of influential organization leaders and commitment from external organizational partners, such as legislators and policy makers (Durlak and DuPre, 2008; van Achterberg et al., 2008; James Bell Associates, 2013). Given this, policy makers across the government will play an important role in building a supportive infrastructure that enables NIJ to improve its forensic science R&D program.

In addition, within NIJ, an identified internal champion for implementation of this report's recommendations may need to be identified. Internal champions can keep improvements on track and build internal support for sustained change (Gold and Taylor, 2007; Kilbourne et al., 2007).

DEVELOPING A STRATEGIC PLAN

The development of a formal, comprehensive, and long-term strategic plan with articulated goals and timelines for achieving those goals is critical to any federal agency's effectiveness. Unfortunately, the current priority-setting process for forensic science R&D at NIJ is opaque and ultimately insufficient to the task. While year-to-year flexibility allows NIJ to be responsive to the field as issues arise, it provides little predictability and stability for forensic science researchers and does not allow for the development of strategies to generate meaningful change in the field, which are necessarily long term. The establishment and management of a strategic plan for the forensic science R&D program with short- and long-term objectives would help create stability for the research community (and ultimately the practice and policy associated with forensic science) and provide a roadmap for critical advancements, while still allowing for creativity and innovation. Elements generally included in a R&D strategic plan are described in Box 4-1.

A strategic plan should outline specific short-term (1-2 years), mid-term (3-5 years), and long-term (6-10 years) goals and should be made publicly available in a timely fashion. These goals should guide all internal decision making regarding NIJ's forensic science research agenda (including requests for funding, the development of research solicitations, and grant awards). Each goal identified in the strategic plan needs to be linked to outcomes. Specific elements of a research agenda designed to achieve those outcomes should be identified, and, at a minimum, the outcomes would need to in-

clude foundational research outcomes, technology transfer outcomes, laboratory efficiency outcomes, and justice system outcomes. The strategic plan can also include an "emergency response" contingency, so that the forensic science R&D program can remain responsive to new, special concerns that arise unexpectedly. Targets for this emergency response would need to be special projects that complement, rather than drive, the long-term research agenda.

The Technology Working Groups (TWGs) are currently the only mechanism through which NIJ identifies the needs of the forensic science field, and those needs appear to have a major influence on NIJ's forensic science research priorities. Although the TWGs serve an important function, they do not adequately represent the needs of the broad range of forensic science disciplines and should not be the sole mechanism NIJ uses to gather input from the forensic field to establish its research agenda. In addition, it would be useful at this time to integrate the perspectives of researchers into the needs-gathering and priority-setting process in order to more efficiently and effectively identify scientific gaps and opportunities and develop an overarching forensic science research agenda. Establishing and maintaining a research advisory board comprising a broad array of scientists, including forensic science researchers and an expanded range of practitioners, would assist NIJ leadership and qualified forensic science staff in identifying and prioritizing the research needs to be used in developing a strategic plan for its forensic science program. Such a group should report to the NIJ director and provide oversight by monitoring progress toward achieving the goals identified in the strategic plan.

The committee did not develop, nor was it tasked to develop, a forensic science research agenda for NIJ, but it is aware of activities currently being undertaken at the American Association for the Advancement of Science and at the National Institute of Standards and Technology through the Organization of Scientific Area Committees that may identify gaps and priority areas for research in a number of the forensic disciplines.[1] These recommendations could be vetted by the research advisory board recommended here and, if appropriate, integrated into its research agenda and strategic plan. It may also be appropriate for the research advisory board to consider additional inputs from other forensic science stakeholders.

The development and promulgation of a strategic plan for forensic

[1]Personal communication between Dr. Tania Simoncelli, Assistant Director for Forensic Science, White House Office of Science and Technology Policy, and Dr. Alan Leshner, chair, Committee on Strengthening Forensic Science at the National Institute of Justice, on May 19, 2015. See also http://www.aaas.org/page/forensic-science-assessments-quality-and-gap-analysis [June 2015]; and the presentation on *Standards and Practices of Forensic Science from a NIST Perspective,* by John Butler and Mark Stolorow, NIST, to the Committee on Strengthening Forensic Science at the National Institute of Justice, April 1, 2015.

BOX 4-1
Elements of a Research and Development (R&D) Strategic Plan

A meaningful and effective strategic plan for a R&D program must be consistent with the mission statement of the organization. Such a plan will outline what the program does, for whom the program executes its work, and the path by which the program will attain its goals. It needs to describe the primary purposes, topics, expected outcomes, and anticipated resources available for carrying out the plan, including R&D funding (National Research Council, 2012; Transportation Research Board, 2013).

In general, it should

1. **Articulate the role and value of R&D.** The plan should measure the value of the research program and detail how the program supports the broad organization's priorities, highlighting past successes and future prospects. A plan may explain how research supports a congressionally mandated mission as well as how research helps ensure cost-effective investment of federal resources in order to make a strong case about the value of a particular program's activities.
2. **Highlight and promote ways to overcome constraints to strategic R&D investment.** The plan needs to identify administrative and institutional hurdles to strategic research investment and suggest ways to overcome these constraints.

science R&D at NIJ will signify to stakeholders—researchers, practitioners, policy makers, and the public—the agency's dedication to advancing forensic science.

Recommendation 4-1: The National Institute of Justice (NIJ) should take immediate steps to develop a formal and comprehensive strategic plan for its forensic science research and development program. The strategic plan should be based on a thorough understanding of the state of the science, an analysis of NIJ's past and current research portfolios, and extensive consultation with both the research and practice communities.

Recommendation 4-2: The National Institute of Justice should establish a research advisory board that includes a broad array of scientists,

3. **Describe the R&D program in various dimensions to inform decisions.** The plan should inform decisions about priority topics that research should address and about the nature of the research that is needed to address these topics. It may provide information about allocation of past and current R&D funding toward the outlined goals, underscoring the program's priorities.
4. **Identify gaps in research.** The plan needs to identify gaps in research, by topic and type, and determine important areas for future research. It may use these identified gaps to inform policy makers about important areas that are being neglected for want of resources. The plan should also provide substantive details regarding the nature of collaborations with other research organizations that perform similar work and may be relied upon to fill these gaps.
5. **Promote efficient and effective research processes.** The plan should provide information about the development of research processes that would improve the performance of the research program. This may include information about stakeholder input and financial information. It should designate performance measures specific to the research objectives and may also include an outcome-based assessment of previous strategic plans that describes how well the program has performed against its goals (Transportation Research Board, 2013).

including forensic science researchers and practitioners, in order to better integrate their perspectives into its processes for identifying and prioritizing research needs. The research advisory board should also monitor progress in achieving the strategic plan's designated goals.

BUILDING A RESEARCH INFRASTRUCTURE

NIJ needs to be critically concerned with building the research infrastructure for forensic science, including broadening the forensic science research community and supporting the next generation of forensic science researchers. Bolstering the research infrastructure could also include internal efforts, such as building institutional knowledge of emerging, relevant technologies in related fields that may have forensic uses. In addition, NIJ

should integrate research and evaluation into all of its forensic science investments.

NIJ has conducted outreach to the broader scientific community (whose work may have a nexus with forensic science) through the dissemination of proposal solicitations, and historically it has made appearances at adjacent disciplines' scientific meetings. However, budget and travel constraints have limited NIJ's ability to engage prospective cross-field collaborators directly. There is a need for novel approaches to recruit collaborators from both the typical, current disciplines and from new areas.

NIJ should attend or have a presence at professional conferences and meetings that attract audiences from disciplines that have typically been outside the forensic disciplines. It can enlist funded researchers to participate in local and national outreach events at meetings, universities, and public forums where forensic science needs, opportunities, and challenges are shared. To facilitate these efforts, the agency could provide materials (e.g., PowerPoint slides) to NIJ-funded scientists to use in their own presentations that briefly outline NIJ's forensic science R&D interests and portfolio.

In addition, NIJ's efforts to support the next generation of forensic science researchers could include not only fellowships for doctoral students but also dissertation grant programs or funding for the inclusion of forensic science graduate students in projects led by senior scientists.

In order to build the research infrastructure, NIJ—in accordance with its scientific mission—needs to incorporate research and evaluation into all of its forensic science activities. Currently, the financial investment in programs to reduce casework backlogs and fund improvements in forensic laboratories significantly outweighs the investment in research (see Table 3-1). Historically, these programs have directly supported the purchase of equipment, training, and additional staffing (Nelson, 2010). Especially in light of shrinking resources and increased demand for services, NIJ needs a capability to invest in innovative scientific research that promises to produce increases in capability by orders of magnitude through both technology and method.

NIJ needs to structure these programs in a way designed to learn from these efforts and promote efficiency in laboratories on a large scale. NIJ is designated as the agency to distribute funding for these programs, and given its science mission, it could require these and other assistance grants to include a research component with the potential to bring marked increases in casework processing and accuracy and/or an evaluation component that will help provide an evidence base that could be used to improve the outcomes of future efforts. Though these added components may require additional resources per grant, they are critical to improving outcomes and may, in the long run, reduce the funds required to support laboratory capacity

and improvement. Future funding distributions could be contingent upon laboratories' use of evidence-based practices.[2] This requirement would better integrate NIJ's R&D program with its assistance efforts.

Recommendation 4-3: The National Institute of Justice (NIJ) should increase efforts to expand forensic science research by recruiting researchers from the broader scientific community whose work may have a nexus with forensic science. At a minimum, NIJ should promote greater cross-field collaboration, conduct more outreach to research communities in adjacent disciplines that do not currently focus on forensic science applications, and increase the institutional knowledge within NIJ of relevant technology developments in other fields that might have forensic uses.

Recommendation 4-4: In keeping with its scientific mission, all of the National Institute of Justice's (NIJ's) forensic science funding, including capacity-building investments such as backlog reduction, should include a research component and/or an evaluation component. NIJ should create a clear translation pipeline from research to implementation for promising approaches, and future capacity-building funding should be tied to the use of evidence-based practices.

FUNDING STABILITY

As stated in Chapter 1 and in prior National Research Council reports, given the challenges currently facing forensic science laboratories and practitioners, there is a national need for a sustained and extensive program of forensic science research to improve the validity, reliability, and breadth of forensic tools available to the criminal justice system. Regrettably, the committee believes that the current level of federal funding available to NIJ to support forensic science R&D is sorely inadequate to the task. The varying and unpredictable funding levels from year to year are also counterproductive to the agency's goals.

One of the hallmarks of the success of other federal research funding agencies is stability in their budgets and consistency in the kinds of research they support, even if specific priorities do vary over time. Stable and predictable funding enables agencies to build and sustain a research infrastructure: it encourages talented students to pursue scientific careers,

[2]Programs and practices are generally considered to be evidence based when their effectiveness has been demonstrated by causal evidence, generally obtained through high-quality outcome evaluations. See http://ojp.gov/funding/Explore/SolicitationRequirements/EvidenceResearchEvaluationRequirements.htm [September 2015].

keeps established researchers engaged over a career, and attracts and retains talent (National Research Council, 2014, p. 2). Therefore, funding stability, at least at some core level, would be a critical element of any effective strategy going forward.

The funds available to NIJ to support forensic science R&D should be sufficient to enable the agency to strengthen forensic science research and practice at the local, state, and federal levels. To achieve this end, policy makers will need to designate a dedicated funding stream for R&D that is of sufficient magnitude. This dedicated funding stream would have to be adequate, and stable appropriations would have to be coupled with funding flexibility to help support both short- and long-term research strategies. The addition of a dedicated funding stream for R&D would demonstrate the importance of research to strengthening forensic science and convey policy makers' prioritization and recognition of the urgent needs facing the forensic science field.

To complement these necessary budgetary actions from federal policy makers, NIJ also could ensure that some of its formalized partnerships with other federal agencies augment its limited resources. NIJ can explore ways to bolster its resources, in both size and stability, by strategically leveraging funds through partnerships with other federal agencies.

Recommendation 4-5: Federal policy makers should ensure the ability of the National Institute of Justice to advance forensic science research and development through dedicated, adequate, and stable appropriations coupled with funding flexibility to help support both short- and long-term research strategies. In order to ensure funding stability from year to year, policy makers should designate a dedicated funding stream for research and development that is of sufficient magnitude to address the challenges facing forensic science.

IMPROVING COMMUNICATION

Federal science agencies can use strategic communication as a tool to promote their investment in R&D to policy makers and the general public in order to ensure that their work is valued and supported. NIJ needs to develop a strategic communication plan for its forensic science R&D program that proactively communicates the importance of forensic science research to the advancement of a fair and effective justice system, demonstrates successes and future objectives, and estimates future savings from the creation and adoption of innovative tools and techniques. A strategic communication plan can also help the agency achieve its goal of advancing forensic science by (1) encouraging the uptake of innovative evidence-based practices by forensic science practitioners and other criminal justice stake-

holders and (2) more actively recruiting researchers from related disciplines to engage with the forensic science community of practice.

NIJ has made substantial progress in its ability to disseminate research findings to the forensic science field. It encourages its grantees to communicate their research findings by publishing in peer-reviewed forensic science journals and presenting at conferences, and the agency disseminates promising findings to practitioners and researchers through online communications. However, strategic communication needs to involve more than simply disseminating research findings to the field through traditional mechanisms such as those described above.

NIJ will need to strategically communicate its forensic science mission, vision, and strategic plan to a broad audience, including researchers, practitioners, policy makers, and the public. To do so, it can engage forensic science professional organizations, such as the American Academy of Forensic Sciences and the Society of Forensic Toxicologists, and other prominent stakeholders to distribute research findings and promote the agency's goals, activities, and accomplishments. In addition, federal officials need to recognize the value of in-person meetings and allow NIJ to convene its stakeholders through national conferences to promote the agency's goals and investments in forensic science R&D.

NIJ should serve as a clearinghouse for evidence-based solutions to persistent forensic science problems and facilitate knowledge transfer between field leaders and new adopters. The Forensic Technology Center of Excellence has served an important role in this area. However, the center's efforts have not been aligned with a NIJ strategic R&D plan or a NIJ strategic communication plan. NIJ's communication efforts will need to encourage and facilitate adoption of evidence-based practices, identified and validated through research, to advance the field of forensic science. The agency may look to the Department of Defense's Multidisciplinary University Research Initiatives or the National Science Foundation's Small Business Innovation Research/Small Business Technology Transfer programs for additional models to consider.[3]

Recommendation 4-6: In concert with the development of a strategic plan, the National Institute of Justice should develop and implement a strategic communication plan that directs its messages in ways appropriate to its various constituencies. This plan should include valuable in-person activities, such as hosting national conferences and workshops.

[3]See http://www.nsf.gov/eng/iip/sbir/home.jsp and http://www.onr.navy.mil/Science-Technology/Directorates/office-research-discovery-invention/Sponsored-Research/University-Research-Initiatives/MURI.aspx [September 2015].

Recommendation 4-7: As part of its strategic plan, the National Institute of Justice should support transfer of technologies developed in its research and development portfolio to end users.

EVALUATING IMPACT

Evaluating impact and subsequently communicating that impact is necessary to encourage support for an agency's activities and to establish and communicate the value of research investments. An assessment of impact should aim to inform by demonstrating the benefits of supported research (giving consideration to what would not have happened if the supported research had not been conducted), show that resources have been used efficiently and effectively, and provide direction for future research (Guthrie et al., 2013).

NIJ currently does not have adequate mechanisms to evaluate and communicate the impact of its forensic science research portfolio. It has recently made strides in this area: NIJ now routinely tracks publications and presentations, dissemination activities, and technology-transition activities that result from its supported research. However, in order to fully assess the impact of its forensic science R&D program, NIJ will need to develop a set of metrics that go beyond primarily tracking outputs to a process that also measures the outcomes that result from the activities it supports (e.g., increased accuracy of particular forensic methods, the use of NIJ-sponsored research to set legal precedent, and the implementation of new methods and techniques in laboratories).[4] The metrics, measuring both outputs and outcomes, must then be used to routinely evaluate NIJ's impact. A 2012 National Research Council report provides examples of some outputs and outcomes that a R&D program could measure; these are included in Box 4-2.

Given NIJ's mission, it would be beneficial to measure impact on criminal justice system outcomes like suspect identification, arrest, case clearance, and convictions, especially in those places that have demonstrated gains in competencies, productivity, and/or efficiency. Outcome measures that show trends, such as increases in the reproducibility, reliability, and accuracy of forensic analyses, would also be critical indicators.

The committee recognizes that measuring impact will be a challenging task. Attempts to trace major innovations back to their original supporting research rarely reveal a direct flow from original investment to final impact

[4]The committee defines outputs as activities or accomplishments delivered by research programs, such as papers published or methods validated. It defines outcomes as the benefits resulting from a research program (both short and long term); see also National Research Council (2008b, p. 4).

BOX 4-2
Examples of Output and Outcome Measures

Outputs

- Publications, patents, reports, and the citations garnered
- Technical assistance provided to end users, customers, and stakeholders
- Invited presentations (e.g., conferences and workshops)
- Training and mentoring of personnel
- New and improved products, materials, and processes
- Patents leading to new products
- Development of test and evaluation protocols, codes, and standards
- Technology transfer
- Maintained competencies
- New competencies

Outcomes

- Cost savings (e.g., in materials or processes)
- Increased productivity
- Increased efficiency
- Safety practices and culture
- Effectiveness of management structure and strategy
- Recognition of the R&D organization as best, among the best, or unique

SOURCE: National Research Council (2012, p. 34).

but rather a complex and tangled path (Martin and Tang, 2006; National Research Council, 2014). Before considering the best metrics, methods, and indicators to use and how to use them, NIJ will first need to determine what is to be measured and why. This determination (that is, which outputs and outcomes to measure) should flow from the strategic plan recommended above and should allow for comparison of the portfolio to the agency's mission and the community's expressed needs in terms of both substance and priorities (National Research Council, 2012). These decisions need to be made in consultation with those who have formal evaluation research expertise both internal and external to NIJ.

In general, measures should include leading and lagging indicators that can be measured beyond the award period, as there can be a considerable time lag between completed research and impact. They should be both quantitative and qualitative, consider failures and successes, and enable analysis of researchers and clusters of researchers, so that intangible factors such as opportunities and relationships that spur innovation and discovery may be considered (Lane and Bertuzzi, 2011; National Research Council, 2011, 2012, 2014).

In order to improve its ability to measure the impact of its R&D program, NIJ may also consider requiring laboratory assistance grantees to capture and report specific outcomes as part of its new performance management system for the DNA Capacity Enhancement and Backlog Reduction Program and to structure implementation so that necessary control situations exist.[5] NIJ could evaluate those measures to identify the impact of previous research (i.e., if research findings—such as more efficient processes—are implemented into practice).

Recommendation 4-8: The National Institute of Justice should develop an appropriate set of procedures and metrics to measure outcomes regularly and evaluate the impact of its forensic science research and capacity-building portfolio.

CONCLUSION

These recommendations are designed to strengthen the role, capacity, and commitment of NIJ as a major science agency whose role is to improve forensic science research. However, NIJ will only be successful if it is given broad support by both the executive and legislative branches of government. This is particularly important throughout the Department of Justice, given that NIJ's placement within the department has been perceived as a potential source of conflict of interest in the past (National Research Council, 2009b, pp. 79-80).

If these recommendations are fully implemented and any potential barriers overcome, the committee believes there will be tremendous improvement in the criminal justice system's ability to collect, identify, preserve, and interpret forensic evidence. As a result, the public's confidence in a fairer and more credible criminal justice system will be enhanced.

[5]A counterfactual situation could be experimental (a randomly assigned control group) or quasi-experimental (a comparison group). For examples, see http://betterevaluation.org/plan/understandcauses/compare_results_to_counterfactual [September 2015].

References

Bureau of Justice Statistics. (2012). *Census of Publicly Funded Forensic Crime Laboratories, 2009*. Washington, DC: U.S. Department of Justice, Office of Justice Programs.

Campbell, S. (2010). *Deliberative Priority Setting—A CIHR KT Module*. Available: http://www.cihr-irsc.gc.ca/e/documents/deliberative_priority_setting_module_e.pdf [June 2015].

Durlak, J., and DuPre, E. (2008). Implementation matters: A review of research on the influence of implementation on program outcomes and the factors affecting implementation. *American Journal of Community Psychology*, *41*, 327-350.

Ernst, T., Berman, T., Buscaglia, J., Eckert-Lumsdon, T., Hanlon, C., Olsson, K., Palenik, C., Ryland, S., Trejos, T., Valadez, M., and Almirall, J.R. (2012). Signal-to-noise ratios in forensic glass analysis by micro X-ray fluorescence spectrometry. *X-Ray Spectrometry, 43*(1), 13-21.

Executive Office of the President. (2014a, February). *Strengthening Forensic Science: A Progress Report*. Executive Office of the President of the United States. Available: https://www.whitehouse.gov/sites/default/files/microsites/ostp/forensicscience_progressreport_feb-2014.pdf [June 18, 2015].

Executive Office of the President. (2014b, May). *Strengthening the Forensic Sciences*. Washington, DC: Executive Office of the President, National Science and Technology Council, Committee on Science, Subcommittee on Forensic Science. Available: https://www.whitehouse.gov/sites/default/files/microsites/ostp/NSTC/forensic_science___may_2014.pdf [May 2015].

Expert Working Group on Human Factors in Latent Print Analysis. (2012). *Latent Print Examination and Human Factors: Improving the Practice Through a Systems Approach*. Washington, DC: U.S. Department of Commerce, National Institute of Standards and Technology.

Gabel, J.D. (2014). Realizing reliability in forensic science from the ground up. *Journal of Criminal Law and Criminology*, *104*(2), 283-352.

Gold, M., and Taylor, E. (2007). Moving research into practice: Lessons from the U.S. Agency for Healthcare Research and Quality's IDSRN program. *Implementation Science, 2*(9).

Guthrie, S., Wamae, W., Diepeveen, S., Wooding, S., and Grant, J. (2013). *Measuring Research: A Guide to Research Evaluation Frameworks and Tools*. Santa Monica, CA: RAND Corporation. Available: http://www.rand.org/content/dam/rand/pubs/monographs/MG1200/MG1217/RAND_MG1217.pdf [August 2015].

James Bell Associates. (2013). *Lessons Learned Through the Application of Implementation Science Concepts to Children's Bureau Discretionary Grant Programs*. Arlington, VA: James Bell Associates. Available: http://www.jbassoc.com/ReportsPublications/CB_ImpScienceReport_Final_012413.pdf [August 2015].

Kilbourne, A., Neumann, M., Pincus, H., Bauer, M., and Stall, R. (2007). Implementing evidence-based interventions in health care: Application of the replicating effective programs framework. *Implementation Science, 2*(42), doi:10.1186/1748-5908-2-42.

Lane, J., and Bertuzzi, S. (2011). Measuring the results of science investments. *Science, 331*, 678-680.

Laub, J.H. (2011). Strengthening NIJ: Mission, science, and process. *NIJ Journal, October*(268), 16-21. Available: https://www.ncjrs.gov/pdffiles1/nij/235891.pdf [September 2015].

Lenaway, D., Halverson, P., Sotnikov, S., Tilson, H., Corso, L., and Millington, W. (2006). Public health systems research: Setting a national agenda. *American Journal of Public Health*, *96*(3), 410-413.

Lovrich, N.P., Pratt, T.C., Gaffney, M.J., Johnson, C.L., Asplen, C.H., Hurst, L.H., and Schellberg, T.M. (2004). *National Forensic DNA Study Report, Final Report*. Pullman: Washington State University.

Martin, B., and Tang, P. (2006). *The Benefits from Publicly Funded Research*. Brighton, UK: University of Sussex, Science and Technology Policy Research. Available: https://www.sussex.ac.uk/webteam/gateway/file.php?name=sewp161.pdf&site=25 [August 2015].

National Institute of Justice. (2009). *Fundamental Research to Improve Understanding of the Accuracy, Reliability, and Measurement Validity of Forensic Science Disciplines*. Solicitation SL# 000878. Washington, DC: U.S. Department of Justice, Office of Justice Programs.

National Institute of Justice. (2010). *Fundamental Research to Improve Understanding of the Accuracy, Reliability, and Measurement Validity of Forensic Science Disciplines*. Solicitation SL# 000909. Washington, DC: U.S. Department of Justice, Office of Justice Programs.

National Institute of Justice. (2011a). *The National Institute of Justice Response to the Report of the National Research Council: Strengthening the National Institute of Justice*. Special Report. Washington, DC: Department of Justice, Office of Justice Programs.

National Institute of Justice. (2011b). *Electronic Crime and Digital Evidence Recovery.* Solicitation No. NIJ-2011-2798. Washington, DC: U.S. Department of Justice, Office of Justice Programs. Available: https://www.ncjrs.gov/pdffiles1/nij/sl000957.pdf [June 2015].

National Institute of Justice. (2011c). *Basic Scientific Research to Support Forensic Science for Criminal Justice Purposes*. Solicitation No. NIJ-2011-2806. Washington, DC: U.S. Department of Justice, Office of Justice Programs.

National Institute of Justice. (2011d). *Applied Research and Development in Forensic Science for Criminal Justice Purposes*. Solicitation No. NIJ-2011-2807. Washington, DC: U.S. Department of Justice, Office of Justice Programs.

National Institute of Justice. (2013). *National Institute of Justice Annual Report 2013*. Washington, DC: U.S. Department of Justice, Office of Justice Programs. Available: https://www.ncjrs.gov/pdffiles1/nij/248568.pdf [June 18, 2015].

National Institute of Justice. (2014a). *NIJ R&D Portfolio Management and Technology Transition Support*. Washington, DC: National Institute of Justice, U.S. Department of Justice.

National Institute of Justice. (2014b). *Research and Development in Forensic Science for Criminal Justice Purposes*. Solicitation No. NIJ-2014-3744. Washington, DC: U.S. Department of Justice, Office of Justice Programs.

National Institute of Justice. (2015a). *The Impact of Forensic Science Research and Development*. Washington, DC: U.S. Department of Justice, Office of Justice Programs. Available: https://www.ncjrs.gov/pdffiles1/nij/248572.pdf [April 2015].

National Institute of Justice. (2015b). *Research and Development in Forensic Science for Criminal Justice Purposes*. Solicitation No. NIJ-2015-3985. Washington, DC: U.S. Department of Justice, Office of Justice Programs.

National Institute of Justice Forensic Technology Center of Excellence. (2015). *National Institute of Justice—The Forensic Technology Center of Excellence: Activities and Deliverables 2011 (Q4) Through 2015 (Q1)*. Washington, DC: U.S. Department of Justice, Office of Justice Programs, National Institute of Justice.

National Institute of Standards and Technology. (2015a). New NIST Center of Excellence to improve statistical analysis of forensic evidence. *NIST Tech Beat*. Washington, DC: U.S. Department of Commerce. Available: http://nist.gov/forensics/center-excellence-forensic052615.cfm [June 2015].

National Institute of Standards and Technology. (2015b). *Organization of Scientific Area Committee Organization Chart*. Washington, DC: U.S. Department of Commerce. Available: http://www.nist.gov/forensics/osac/upload/OSAC-Block-Org-Chart-3-17-2015-2.pdf [June 2015].

National Research Council. (2004). *Forensic Analysis Weighing Bullet Lead Evidence*. Committee on Scientific Assessment of Bullet Lead Elemental Composition Comparison. Board on Chemical Science and Technology, Division on Earth and Life Studies. Washington, DC: The National Academies Press.

National Research Council. (2008a). *Ballistic Imaging*. Committee to Assess the Feasibility, Accuracy and Technical Capability of a National Ballistics Database. Committee on Law and Justice and Committee on National Statistics, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

National Research Council. (2008b). *Evaluating Research Efficiency in the U.S. Environmental Protection Agency.* Committee on Evaluating the Efficiency of Research and Development Programs at the U.S. Environmental Protection Agency. Committee on Science, Engineering, and Public Policy. Board on Environmental Studies and Toxicology. Washington, DC: The National Academies Press.

National Research Council. (2009a). *Principles and Practices for a Federal Statistical Agency: Fourth Edition*. Committee on National Statistics. C.F. Citro, M.E. Martin, and M.L. Straf, Editors. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

National Research Council. (2009b). *Strengthening Forensic Science in the United States: A Path Forward*. Committee on Identifying the Needs of the Forensic Science Community. Committee on Science, Technology, and Law and Committee on Applied and Theoretical Statistics. Washington, DC: The National Academies Press.

National Research Council. (2010). *Strengthening the National Institute of Justice*. Committee on Assessing the Research Program of the National Institute of Justice. Committee on Law and Justice, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

National Research Council. (2011). *Measuring the Impacts of Federal Investments in Research: A Workshop Summary.* Committee on Measuring Economic and Other Returns on Federal Research Investments. Board on Science, Technology, and Economic Policy. Committee on Science, Engineering, and Public Policy. Washington, DC: The National Academies Press.

National Research Council. (2012). *Best Practices in Assessment of Research and Development Organizations*. Panel for Review of Best Practices in Assessment of Research and Development Organizations. Laboratory Assessments Board. Washington, DC: The National Academies Press.

National Research Council. (2014). *Furthering America's Research Enterprise*. Committee on Assessing the Value of Research in Advancing National Goals. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

National Research Council and Federal Judicial Center. (2011). *Reference Manual on Scientific Evidence: Third Edition*. Committee on the Development of the Third Edition of the Reference Manual on Scientific Evidence; Committee on Science, Technology, and Law; Policy and Global Affairs. Washington, DC: The National Academies Press.

National Science Foundation. (2014). *Investing in Science, Engineering, and Education for the Nation's Future: Strategic Plan for 2014-2018*. Washington, DC: National Science Foundation. Available: http://www.nsf.gov/pubs/2014/nsf14043/nsf14043.pdf [May 2015].

Nelson, M. (2010). Making sense of DNA backlogs—Myths vs. reality. *NIJ Journal, 266*. Available: http://www.nij.gov/journals/266/Pages/backlogs.aspx [June 2015].

Office of Investigative and Forensic Sciences. (2015). *Reviewer's Checklist: FY2015 Research and Development in Forensic Science for Criminal Justice Purposes Application Rating Sheet*. Washington, DC: Office of Investigative and Forensic Sciences, National Institute of Justice, U.S. Department of Justice.

Office of Justice Programs. (2013). *OJP Standard Operation Procedure of OJP Peer Review.* Washington, DC: U.S. Department of Justice, Office of Justice Programs.

O'Leary, A.E., Oberacher, H., Hall, S.E., and Mulligan, C.C. (2015). Combining a portable tandem mass spectrometer with automated library searching: An important step toward streamlined, onsite identification of forensic evidence. *Analytical Methods, 7*, 3331-3339.

Transportation Research Board. (2013). *Letter Report on Review of the U.S. DOT Strategic Plan for Research, Development, and Technology 2013-2018*. Committee for Review of the U.S. Department of Transportation Strategic Plan for Research, Development, and Technology. Washington, DC: The National Academies Press.

U.S. Department of Justice. (2013). *Charter: National Commission on Forensic Science*. Washington, DC: U.S. Department of Justice. Available: http://www.justice.gov/sites/default/files/ncfs/legacy/2014/05/13/ncfs-charter.pdf [June 2015].

U.S. Government Accountability Office. (2013). *DOJ Could Improve Decision-Making Documentation and Better Assess Results of DNA Backlog Reduction Program Funds*. GAO-13-605. Washington, DC: U.S. Government Accountability Office.

van Achterberg, T., Schoonhoven, L., and Grol, R. (2008). Nursing implementation science: How evidence-based nursing requires evidence-based implementation. *Journal of Nursing Scholarship, 40*(4), 302-310.

Appendixes

Appendix A

Speakers

FIRST COMMITTEE MEETING, FEBRUARY 25-26

Committee Charge and Sponsor Expectations for Study

- Howard Spivak, Deputy Director, National Institute of Justice
- Gerry LaPorte, Director, Office of Investigative and Forensic Sciences, National Institute of Justice

Strengthening Forensic Science in the United States Report Brief

- Anne-Marie Mazza, Director, Committee on Science, Technology, and the Law, the National Academies of Sciences, Engineering, and Medicine

Strengthening the National Institute of Justice Report Brief

- Jay Siegel, Member, Committee on Strengthening the National Institute of Justice
- George Sensabaugh, Vice Chair, Committee on Strengthening the National Institute of Justice (via telecom)

SECOND COMMITTEE MEETING, APRIL 1-2

Strengthening Science at NIJ

- John Laub, Distinguished University Professor, Department of Criminology and Criminal Justice, University of Maryland

Standards and Practices of Forensic Science from a NIST perspective

- John Butler, NIST Fellow and Special Assistant to the Director for Forensic Science, National Institute of Standards and Technology
- Mark Stolorow, Director, Law Enforcement Standards Office, National Institute of Standards and Technology

Research, Development, Testing, and Evaluation Process

- Gerry LaPorte, Director, Office of Investigative and Forensic Sciences, National Institute of Justice
- Danielle McLeod-Henning, Program Manager, Office of Investigative and Forensic Sciences, National Institute of Justice

PI Panel on Impact of Research

- Bruce McCord, Professor, Department of Chemistry and Biochemistry, Florida International University (video conference)
- John Nelson, Principal Scientist, General Electric Global Research

Office of Investigative and Forensic Sciences Budget

- Gerry LaPorte, Director, Office of Investigative and Forensic Sciences, National Institute of Justice

NIJ Peer Review Panels

- Phillip Danielson, Professor, Department of Biological Sciences, University of Denver
- Eric Bartelink, Associate Professor of Anthropology, Department of Anthropology, California State University, Chico (teleconference)

Standing Review Panels at NIJ

- Eric Buel, Laboratory Director, State of Vermont Forensic Laboratory (retired)
- Brooke Weinger Kammrath, Associate Professor, Henry C. Lee College of Criminal Justice and Forensic Sciences, University of New Haven (video conference)
- Martin Wells, Professor and Chair, Cornell University (video conference)

Advancing Forensic Science at NIJ (video conference)

- Greg Ridgeway, Associate Professor of Criminology, Director of the M.S. Program in Criminology, University of Pennsylvania

PI Panel

- Ann Bunch, Interim Chair, Associate Professor, Department of Criminal Justice, State University of New York–Brockport
- Cedric Nuemann, Associate Professor, South Dakota State University (video conference)
- Hanlee Ji, Associate Professor, Department of Medicine, Stanford University (video conference)

THIRD COMMITTEE MEETING, MAY 7-8

Conversation with the NIJ Director

- Nancy Rodriguez, Director, National Institute of Justice

Past NIJ Director Discussion (via video conference)

- Jeremy Travis, President, John Jay College of Criminal Justice

Federal Forensic Sector

- Mark Weiss, Division Director, National Science Foundation (retired)
- Kelsey Cook, Program Director, National Science Foundation
- Thomas Callaghan, Chief Biometrics Scientist, Federal Bureau of Investigation
- Rick Tontarski, Chief Scientist, Defense Forensic Science Center

Center of Excellence—Transitioning Products Out to the Community

- John Morgan, Senior Director, RTI International Center for Forensic Sciences
- Nicole McCleary, Forensic Technology Center of Excellence Project Manager, RTI International
- Jeri Ropero-Miller, Forensic Technology Center of Excellence Project Director, RTI International (via telecom)

Technology Working Groups

- George Herrin, Deputy Director, Georgia Bureau of Investigation, Division of Forensic Science
- Mike Gorn, Supervisor, Forensic Services Unit, Sarasota County Sheriff
- Steve Renteria, CODIS Administrator/DNA Tech Lead, Los Angeles County Sheriff's Department

OIFS Dissemination/Strategic Plan

- Gerry LaPorte, Director, Office of Investigative and Forensic Sciences, National Institute of Justice
- Danielle McLeod-Henning, Program Manager, Office of Investigative and Forensic Sciences, National Institute of Justice

Perspectives of Forensic Labs

- Peter Stout, Chief Operations Officer, Houston Forensic Science Center
- Kristine Olsson, Forensic Scientist, Johnson County Sheriff's Office Crime Laboratory

Appendix B

Previous Report Recommendations

STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD

Recommendation 1: To promote the development of forensic science into a mature field of multidisciplinary research and practice, founded on the systematic collection and analysis of relevant data, Congress should establish and appropriate funds for an independent federal entity, the National Institute of Forensic Science (NIFS). NIFS should have a full-time administrator and an advisory board with expertise in research and education, the forensic science disciplines, physical and life sciences, forensic pathology, engineering, information technology, measurements and standards, testing and evaluation, law, national security, and public policy. NIFS should focus on

(a) establishing and enforcing best practices for forensic science professionals and laboratories;
(b) establishing standards for the mandatory accreditation of forensic science laboratories and the mandatory certification of forensic scientists and medical examiners/forensic pathologists—and identifying the entity/entities that will develop and implement accreditation and certification;
(c) promoting scholarly, competitive peer-reviewed research and technical development in the forensic science disciplines and forensic medicine;

(d) developing a strategy to improve forensic science research and educational programs, including forensic pathology;
(e) establishing a strategy, based on accurate data on the forensic science community, for the efficient allocation of available funds to give strong support to forensic methodologies and practices in addition to DNA analysis;
(f) funding state and local forensic science agencies, independent research projects, and educational programs as recommended in this report, with conditions that aim to advance the credibility and reliability of the forensic science disciplines;
(g) overseeing education standards and the accreditation of forensic science programs in colleges and universities;
(h) developing programs to improve understanding of the forensic science disciplines and their limitations within legal systems; and
(i) assessing the development and introduction of new technologies in forensic investigations, including a comparison of new technologies with former ones.

Recommendation 2: The National Institute of Forensic Science (NIFS), after reviewing established standards such as ISO 17025, and in consultation with its advisory board, should establish standard terminology to be used in reporting on and testifying about the results of forensic science investigations. Similarly, it should establish model laboratory reports for different forensic science disciplines and specify the minimum information that should be included. As part of the accreditation and certification processes, laboratories and forensic scientists should be required to utilize model laboratory reports when summarizing the results of their analyses.

Recommendation 3: Research is needed to address issues of accuracy, reliability, and validity in the forensic science disciplines. The National Institute of Forensic Science (NIFS) should competitively fund peer-reviewed research in the following areas:

(a) Studies establishing the scientific bases demonstrating the validity of forensic methods.
(b) The development and establishment of quantifiable measures of the reliability and accuracy of forensic analyses. Studies of the reliability and accuracy of forensic techniques should reflect actual practice on realistic case scenarios, averaged across a representative sample of forensic scientists and laboratories. Studies also should establish the limits of reliability and accuracy that analytic methods can be expected to achieve as the conditions of forensic evidence

vary. The research by which measures of reliability and accuracy are determined should be peer reviewed and published in respected scientific journals.

(c) The development of quantifiable measures of uncertainty in the conclusions of forensic analyses.

(d) Automated techniques capable of enhancing forensic technologies.

Recommendation 4: To improve the scientific bases of forensic science examinations and to maximize independence from or autonomy within the law enforcement community, Congress should authorize and appropriate incentive funds to the National Institute of Forensic Science for allocation to state and local jurisdictions for the purpose of removing all public forensic laboratories and facilities from the administrative control of law enforcement agencies or prosecutors' offices.

Recommendation 5: The National Institute of Forensic Science (NIFS) should encourage research programs on human observer bias and sources of human error in forensic examinations. Such programs might include studies to determine the effects of contextual bias in forensic practice (e.g., studies to determine whether and to what extent the results of forensic analyses are influenced by knowledge regarding the background of the suspect and the investigator's theory of the case). In addition, research on sources of human error should be closely linked with research conducted to quantify and characterize the amount of error. Based on the results of these studies, and in consultation with its advisory board, NIFS should develop standard operating procedures (that will lay the foundation for model protocols) to minimize, to the greatest extent reasonably possible, potential bias and sources of human error in forensic practice. These standard operating procedures should apply to all forensic analyses that may be used in litigation.

Recommendation 6: To facilitate the work of the National Institute of Forensic Science (NIFS), Congress should authorize and appropriate funds to NIFS to work with the National Institute of Standards and Technology (NIST), in conjunction with government laboratories, universities, and private laboratories, and in consultation with Scientific Working Groups, to develop tools for advancing measurement, validation, reliability, information sharing, and proficiency testing in forensic science and to establish protocols for forensic examinations, methods, and practices. Standards should reflect best practices and serve as accreditation tools for laboratories and as guides for the education, training, and certification of professionals. Upon completion of its work, NIST and its partners should report findings and recommendations to NIFS for further dissemination and implementation.

Recommendation 7: Laboratory accreditation and individual certification of forensic science professionals should be mandatory, and all forensic science professionals should have access to a certification process. In determining appropriate standards for accreditation and certification, the National Institute of Forensic Science (NIFS) should take into account established and recognized international standards, such as those published by the International Organization for Standardization. No person (public or private) should be allowed to practice in a forensic science discipline or testify as a forensic science professional without certification. Certification requirements should include, at a minimum, written examinations, supervised practice, proficiency testing, continuing education, recertification procedures, adherence to a code of ethics, and effective disciplinary procedures. All laboratories and facilities (public or private) should be accredited, and all forensic science professionals should be certified, when eligible, within a time period established by NIFS.

Recommendation 8: Forensic laboratories should establish routine quality assurance and quality control procedures to ensure the accuracy of forensic analyses and the work of forensic practitioners. Quality control procedures should be designed to identify mistakes, fraud, and bias; confirm the continued validity and reliability of standard operating procedures and protocols; ensure that best practices are being followed; and correct procedures and protocols that are found to need improvement.

Recommendation 9: The National Institute of Forensic Science (NIFS), in consultation with its advisory board, should establish a national code of ethics for all forensic science disciplines and encourage individual societies to incorporate this national code as part of their professional code of ethics. Additionally, NIFS should explore mechanisms of enforcement for those forensic scientists who commit serious ethical violations. Such a code could be enforced through a certification process for forensic scientists.

Recommendation 10: To attract students in the physical and life sciences to pursue graduate studies in multidisciplinary fields critical to forensic science practice, Congress should authorize and appropriate funds to the National Institute of Forensic Science (NIFS) to work with appropriate organizations and educational institutions to improve and develop graduate education programs designed to cut across organizational, programmatic, and disciplinary boundaries. To make these programs appealing to potential students, they must include attractive scholarship and fellowship offerings. Emphasis should be placed on developing and improving research methods and methodologies applicable to forensic science practice and on funding research programs to attract research universities and students in fields

relevant to forensic science. NIFS should also support law school administrators and judicial education organizations in establishing continuing legal education programs for law students, practitioners, and judges.

Recommendation 11: To improve medicolegal death investigation:

(a) Congress should authorize and appropriate incentive funds to the National Institute of Forensic Science (NIFS) for allocation to states and jurisdictions to establish medical examiner systems, with the goal of replacing and eventually eliminating existing coroner systems. Funds are needed to build regional medical examiner offices, secure necessary equipment, improve administration, and ensure the education, training, and staffing of medical examiner offices. Funding could also be used to help current medical examiner systems modernize their facilities to meet current Centers for Disease Control and Prevention–recommended autopsy safety requirements.

(b) Congress should appropriate resources to the National Institutes of Health (NIH) and NIFS, jointly, to support research, education, and training in forensic pathology. NIH, with NIFS participation, or NIFS in collaboration with content experts, should establish a study section to establish goals, to review and evaluate proposals in these areas, and to allocate funding for collaborative research to be conducted by medical examiner offices and medical universities. In addition, funding, in the form of medical student loan forgiveness and/or fellowship support, should be made available to pathology residents who choose forensic pathology as their specialty.

(c) NIFS, in collaboration with NIH, the National Association of Medical Examiners, the American Board of Medicolegal Death Investigators, and other appropriate professional organizations, should establish a Scientific Working Group (SWG) for forensic pathology and medicolegal death investigation. The SWG should develop and promote standards for best practices, administration, staffing, education, training, and continuing education for competent death scene investigation and postmortem examinations. Best practices should include the utilization of new technologies such as laboratory testing for the molecular basis of diseases and the implementation of specialized imaging techniques.

(d) All medical examiner offices should be accredited pursuant to NIFS-endorsed standards within a timeframe to be established by NIFS.

(e) All federal funding should be restricted to accredited offices that meet NIFS-endorsed standards or that demonstrate significant and

measurable progress in achieving accreditation within prescribed deadlines.

(f) All medicolegal autopsies should be performed or supervised by a board-certified forensic pathologist. This requirement should take effect within a timeframe to be established by NIFS, following consultation with governing state institutions.

Recommendation 12: Congress should authorize and appropriate funds for the National Institute of Forensic Science (NIFS) to launch a new broad-based effort to achieve nationwide fingerprint data interoperability. To that end, NIFS should convene a task force comprising relevant experts from the National Institute of Standards and Technology and the major law enforcement agencies (including representatives from the local, state, federal, and, perhaps, international levels) and industry, as appropriate, to develop

(a) standards for representing and communicating image and minutiae data among Automated Fingerprint Identification Systems. Common data standards would facilitate the sharing of fingerprint data among law enforcement agencies at the local, state, federal, and even international levels, which could result in more solved crimes, fewer wrongful identifications, and greater efficiency with respect to fingerprint searches; and

(b) baseline standards—to be used with computer algorithms—to map, record, and recognize features in fingerprint images, and a research agenda for the continued improvement, refinement, and characterization of the accuracy of these algorithms (including quantification of error rates).

Recommendation 13: Congress should provide funding to the National Institute of Forensic Science to prepare, in conjunction with the Centers for Disease Control and Prevention and the Federal Bureau of Investigation, forensic scientists and crime scene investigators for their potential roles in managing and analyzing evidence from events that affect homeland security, so that maximum evidentiary value is preserved from these unusual circumstances and the safety of these personnel is guarded. This preparation also should include planning and preparedness (to include exercises) for the interoperability of local forensic personnel with federal counterterrorism organizations.

STRENGTHENING THE NATIONAL INSTITUTE OF JUSTICE

Recommendation 1: The committee recommends that Congress provide for the requisite independence and authority of the National Institute of Justice

(NIJ) while retaining its organizational placement within the Office of Justice Programs and the U.S. Department of Justice. Among the key issues to be considered in pursuit of this goal are a statutory advisory board, a set term of office and minimum qualifications for the NIJ director, and clear authority for NIJ to make awards and control its budget and resources.

Recommendation 2: To strengthen its science mission, the National Institute of Justice (NIJ) should direct its efforts toward building a body of cumulative knowledge that will assist the criminal justice field in its effort to prevent and control crime and improve the criminal justice system; sponsoring research that will improve and upgrade current scientific methods used to study crime; and supporting new areas that have heretofore been neglected due to NIJ's incapacity to commit resources required to support projects of long duration, great complexity, and substantial expense. To improve NIJ's ability to support research, the committee recommends that Congress remove responsibility for forensic capacity-building programs and reinstate them in other U.S. Department of Justice and Office of Justice Program agencies, such as the Bureau of Justice Assistance and the Community Oriented Policing Services office, that have a clearly defined technical assistance mission, are closely linked to state and local criminal justice agencies, and have larger financial reserves to draw on.

Recommendation 3: The National Institute of Justice should undertake efforts to nurture and grow the pool of researchers involved in criminal justice research as well as activities that support the research endeavor itself. These efforts should include increasing the resources devoted to supporting graduate education for persons pursuing a career in criminology and criminal justice studies and other disciplines engaged in research and teaching on criminal justice topics, such as the Graduate Research Fellowship Program and the W.E.B. Du Bois Program, and enhancing the Data Archive Program.

Recommendation 4: The National Institute of Justice (NIJ) should revise its research operations to allow for greater transparency, consistency, timeliness, and appropriate involvement of the research and practitioner communities. In particular, NIJ should make information about its research operations and activities publicly available, easily understood, and consistent with the highest standards found in other high-quality federal research agencies.

Recommendation 5: The National Institute of Justice should measure the influence of its programs on research and practice and assess the quality of operations and program-level technical and managerial matters.

Appendix C

Committee Questions to NIJ

AFTER MEETING 1, FEBRUARY 25-26, 2015

1. What was the effect of moving OIFS out of OST?
   - Is there a memo describing this process and the rationale? Why was digital forensics left with OST?
   - What are the benefits of OIFS having its own office? How is it different than the other offices at NIJ? What processes and operations are the same?
2. Provide budgetary figures fiscal 2009 to 2014 including
   - appropriated funding with sources;
   - forensic science expenditures breakdown for NIJ by R&D, Testing & Evaluation, Technical Assistance, Capacity Building, and Standards Development or other categories if they have changed;
   - forensic science expenditures breakdown for NIJ by discretionary and nondiscretionary; and
   - transfers to ORE, OST, and other federal agencies.
3. Provide a list of R&D projects awarded over the last 5 years, including PI(s), PI Affiliation (laboratory, university, private laboratory, etc.), abstract, award amount, project status (ongoing or completed), and length of duration.
   - What is the percentage of applications funded?
   - What is the average amount and length of award?
4. Provide a list of R&D projects awarded from 2004 through 2009, including PI(s), PI Affiliation (laboratory, university, private labo-

ratory, etc.), abstract, award amount, project status (ongoing or completed), and length of duration.

5. Provide a description of the peer-review process and procedures, both the standing scientific review panels and the ad hoc committees.
   - Provide description of composition—academia versus practitioners, variations and requirements in expertise.
   - Is there a written Standard Operating Procedure?
   - Provide a description of the scoring system.
6. Provide a description of process for setting research priorities.
   - Identify how research priorities in forensic science are assigned to ORE and OST.
7. Does NIJ have a mechanism to measure the impact of their R&D portfolio on actual forensic practice? Can NIJ show impact for scholarly community, publications, and citation downloads?
8. Do you have a communications and dissemination strategic plan and process? What is it and what are your goals?
   - How do you currently disseminate research to the field?
   - How do you track impact?
9. Provide a list of partnerships/MOUs/collaborations with other federal agencies and the nature of those relationships (including budgetary support).
   - If releasable provide the MOU for each organization.
10. Description of the Forensic Technology Center for Excellence and its activities.
    - What funding stream supports the center?
    - What is the length of the current award?
    - Does it issue solicitations and give awards?
11. Provide an OIFS and NIJ current organization chart, including vacant positions.
12. Provide a breakdown of graduate student support for last 5-7 years including fellowships and those supported through grants.
13. Is there a feedback mechanism? How does OIFS receive feedback from the various stakeholders?
14. Independence—Can you discuss how independent OIFS, as an office within NIJ, is in regard to ability to (1) establish research and evaluation priorities; (2) control the grant making process, from solicitation to grant approval; (3) make budgetary recommendations to the highest level of the parent agency; (4) make staffing decisions including recruitment and hiring; and (5) issue reports and other dissemination activities.

AFTER MEETING 2, APRIL 1-2, 2015

15. Does NIJ and/or OIFS have a research strategic plan or goals? If so, please provide. How is the plan/goals communicated to researchers? Communicated to practitioners in the field? Do you have a strategic plan for capacity building?
16. The FTCoE has developed a process for collecting information on R&D awards over time and for supporting technology transition (response to Question 7). How is or will this information be used by OIFS staff? Are there plans to maintain this database if it is useful?
17. It seems most of OIFS grants to researchers are considered research and development (basic or applied research). Have there been any projects/grants in the last 4-5 years that would have been considered testing or evaluation? Does the FTCoE currently conduct any testing or evaluation in-house or do they just make connections when applicable?
18. Of the funding available for awards, how much money expired for fiscal 2010 to 2014?
19. Of the funds awarded, how much was not used by awardees for fiscal 2010 to 2014?

FINAL QUESTION, APRIL 27, 2015

20. Grant managers in the DNA Capacity Enhancement and Backlog Reduction Program are now asked to use a new Performance Measurement Tool (PMT) when submitting progress reports to NIJ. Please describe the PMT—both its quantitative and qualitative components and the process for the collection and reporting of the data gathered.

Appendix D

Biographical Sketches of Committee Members

Alan I. Leshner (NAM) (*Chair*) is the chief executive officer (emeritus) of the American Association for the Advancement of Science (AAAS) and former executive publisher of the journal *Science*. Previously, he was director of the National Institute on Drug Abuse at the National Institutes of Health, served as deputy director and acting director of the National Institute of Mental Health, and held several positions at the National Science Foundation. Before joining the government, he was a professor of psychology at Bucknell University. He has held visiting appointments at the Wisconsin Regional Primate Research Center and was a Fulbright Scholar at the Weizmann Institute of Science. Dr. Leshner is an elected fellow of AAAS, the American Academy of Arts and Sciences, the National Academy of Public Administration, and other professional societies; he has received seven honorary D.Sc. degrees. He is a member and served on the Governing Council of the National Academy of Medicine. He was appointed by President Bush to the National Science Board in 2004 and then reappointed by President Obama in 2011. He received Ph.D. and M.S. degrees in physiological psychology from Rutgers University and an A.B. in psychology from Franklin and Marshall College.

Jane E. Buikstra (NAS) is the founding director of the Center for Bioarchaeological Research at Arizona State University and Regents' professor of bioarchaeology in the School of Human Evolution and Social Change. A member of the National Academy of Sciences since 1987, Dr. Buikstra is credited with forming the discipline of bioarchaeology, which applies biological anthropological methods to archaeology. Her international re-

search, which spans the Americas and the Mediterranean, encompasses bioarchaeology, paleopathology, forensic anthropology, and paleodemography. Current research includes the evolutionary history of ancient tuberculosis in the Americas based on archaeologically recovered pathogen DNA. She received the T. Dale Stewart Award from the American Academy of Forensic Sciences, the Charles R. Darwin Lifetime Achievement Award from the American Association of Physical Anthropologists, an honorary D.Sc. degree from Durham University (UK), and the Eve Cockburn Award for Service from the Paleopathology Association. She is president of the Center for American Archeology; past president of the American Association of Physical Anthropologists, the American Anthropological Association, and the Paleopathology Association; and inaugural editor-in-chief of the *International Journal of Paleopathology*. She has published more than 20 books and 150 articles and has mentored more than 50 doctoral students. She holds a B.A. from DePauw University in anthropology and an M.A. and Ph.D. in anthropology from the University of Chicago.

Todd R. Clear is provost of Rutgers University-Newark and formerly dean of the School of Criminal Justice. He was a professor at Ball State University, professor and associate dean of the School of Criminology and Criminal Justice at Florida State University, and distinguished professor at John Jay College of Criminal Justice. He has authored 13 books and over 100 articles and book chapters on subjects including community justice, correctional classification, prediction methods in correctional programming, community-based correctional methods, intermediate sanctions, and sentencing policy. He is currently studying the criminological implications of "place" and the economics of justice reinvestment. He was president of the American Society of Criminology, Academy of Criminal Justice Sciences, and Association of Doctoral Programs in Criminology and Criminal Justice. He has received awards from the American Society of Criminology, Academy of Criminal Justice Sciences, Rockefeller School of Public Policy, American Probation and Parole Association, American Correctional Association, and International Community Corrections Association. He was founding editor of *Criminology & Public Policy*, published by the American Society of Criminology. He received his Ph.D. in criminal justice from the State University of New York at Albany.

J. Jerome Holton is chief engineer with the Tauri Group, where he supports clients in the private sector, the Department of Homeland Security (DHS), and the Department of Defense (DOD). He provides analysis, advice, and counsel to senior government decision makers on policy, technology, and operations issues related to weapons of mass destruction and their effects on civilian infrastructure, first responders, military forces, and tactical op-

erations. Previously he held leadership positions in private sector companies ranging from a scientific research start-up to a large management consulting firm. Past clients include chemical and biological defense entities within DOD, DHS, and the Department of Energy. His work encompasses the field of chemical, biological, radiological, nuclear, and conventional explosives detection and countermeasures, with a focus on counterproliferation of, counterterrorism/domestic preparedness issues for, and the detection, identification, and decontamination of chemical and biological weapons. Recent accomplishments include fielding information operations tools and enhancing intelligence, surveillance, and reconnaissance capabilities to detect and defeat improvised explosive devices, as well as the development of applique armor solutions to counter explosively formed penetrators. He earned his B.S. in physics from Mississippi State University and holds M.S. and Ph.D. degrees in experimental physics from Duke University.

Daniel S. Isenschmid is a forensic toxicologist at NMS Labs, with more than 20 years of experience in forensic toxicology. Previously, he was chief toxicologist at the Wayne County Medical Examiner's Office in Detroit. He has received the Irving Sunshine Award and Alexander O. Gettler Award from the American Academy of Forensic Sciences (AAFS) for his research on cocaine. He is a fellow of the American Board of Forensic Toxicology, Secretary of the International Association of Forensic Toxicologists, member and past president of the Society of Forensic Toxicologists (SOFT) and a fellow and former member of the Board of Directors of AAFS. He has published and presented on topics related to postmortem forensic drug testing, medical examiner case reports, the interpretation of postmortem cocaine concentrations, the stability and analysis of cocaine and its metabolites, and the effects of cocaine on human performance. His lectures on the forensic toxicology of cocaine include the Borkenstein course on the Effects of Drugs on Human Performance and Behavior at Indiana University in Bloomington. He has received several Educational Research Awards from SOFT. He holds an M.S. in pathology and Ph.D. in forensic toxicology from the University of Maryland at Baltimore, School of Medicine.

Joseph F. Petrosino is associate professor of molecular virology and microbiology and founding director of the Alkek Center for Metagenomics and Microbiome Research at Baylor College of Medicine. He holds joint appointments in the Human Genome Sequencing Center and the Department of Ophthalmology and participates in graduate student training in integrative molecular and biomedical sciences and in translational biology and molecular medicine. He has more than 15 years of experience in microbial genomics and metagenomics and was a principal investigator for the National Institutes of Health Human Microbiome Project, where he

helped lead consortium efforts for standardized clinical sample preparation, sequencing, and analysis. He recently founded Diversigen, a start-up providing microbiome wet bench, bioinformatics, and biobanking services. He has coauthored more than 80 papers and has spoken at numerous institutions and meetings internationally. He was a 2013 honoree of Houston Men of Distinction for his research on type 1 diabetes and an American Society for Microbiology Distinguished Lecturer for 2012-2014. He received a career development award from the Western Regional Center of Excellence for Biodefense and Emerging Infectious Disease. He holds an undergraduate degree in microbiology and immunology from the University of Rochester and a Ph.D. in microbiology and immunology from Baylor College of Medicine.

Alex R. Piquero is the Ashbel Smith professor of criminology and associate dean of graduate programs in the School of Economic, Political, and Policy Sciences at the University of Texas at Dallas and adjunct professor with the Key Centre for Ethics, Law, Justice, and Governance at Griffith University. Previously, he was coeditor of the *Journal of Quantitative Criminology*. He has published more than 300 peer-reviewed articles in the areas of criminal careers, criminological theory, and quantitative research methods and has collaborated on several books. He is on the editorial boards of a number of journals in criminology and sociology and has served as executive counselor with the American Society of Criminology. He is a member of the Racial Democracy, Crime and Justice Network at Ohio State University, member of the MacArthur Foundation's Research Network on Adolescent Development and Juvenile Justice, fellow of both the American Society of Criminology and the Academy of Criminal Justice Sciences, and the recipient in 2014 of the University of Texas System Regents' Outstanding Teaching Award. He received his Ph.D. in criminology and criminal justice from the University of Maryland at College Park.

Cassia Spohn is foundation professor and director of the School of Criminology and Criminal Justice at Arizona State University (ASU). Previously, she was a professor in the School of Criminology and Criminal Justice at the University of Nebraska at Omaha, serving as director of graduate studies there for 12 years and as department chair for 1 year. She is author or coauthor of six books and has published more than 100 articles on the effects of race/ethnicity and sex on state and federal sentencing decisions, sentencing of drug offenders, case processing decisions in sexual assault cases, and the deterrent effect of imprisonment. Her research interests include prosecutorial and judicial decision making, the intersections of race, ethnicity, crime and justice, and sexual assault case processing decisions. In 2013, she received ASU's Award for Leading Edge Research in the Social

Sciences and was elected a fellow of the American Society of Criminology. Her work has been supported by the National Science Foundation, the National Institute of Justice, and the Robert Wood Johnson Foundation. In 1987, her research was cited by the U.S. Supreme Court in *McCleskey v. Kemp*. She received her Ph.D. in political science from the University of Nebraska at Lincoln.

Dawnie Wolfe Steadman has been the director of the Forensic Anthropology Center (FAC) and professor of anthropology at the University of Tennessee since 2011. She oversees the Body Donation Program and FAC resources including the Anthropology Research Facility, Bass Donated Skeletal Collection, McCormick Pathology Collection, and the forensic collections. She also supervises the research, training, and outreach programs and forensic casework. Her research and publications focus on forensic anthropology, bioarchaeology, and forensic human rights. Previously she was a professor of anthropology at Binghamton University, SUNY, and at Iowa State University. She is a diplomate of the American Board of Forensic Anthropology and serves on its Board of Directors. She is an elected fellow of the American Association for the Advancement of Science and a fellow of the American Academy of Forensic Sciences. Her international work includes human rights investigations in Argentina, Cyprus, Spain, and Uganda. Dr. Steadman received her Ph.D. from the University of Chicago.

Hal Stern is professor of statistics and dean of the Donald Bren School of Information and Computer Sciences at the University of California, Irvine. He was founding chair of the Department of Statistics in 2002 and was named dean of the Bren School in 2010. Previously, he was professor of statistics and Laurence H. Baker chair in biological statistics at the Department of Statistics of Iowa State University and before that was on the Harvard University faculty. His statistics research focuses on developing Bayesian statistical methodology and model assessment techniques. He has authored more than 100 publications, including more than 80 in refereed journals, and is a coauthor of the graduate-level statistics text *Bayesian Data Analysis*. His work includes interdisciplinary research collaboration wherein modern statistical methodology is developed to address needs of ongoing scientific research; current areas of interest include forensic statistics and biological/health sciences. He is a fellow of the American Statistical Association (ASA) and the Institute of Mathematical Statistics. He served recently as editor of ASA's flagship journal and previously as editor of ASA's *Chance*. He received his B.S. in mathematics from the Massachusetts Institute of Technology and his M.S. and Ph.D. in statistics from Stanford University.

Jarrad Wagner is an associate professor of forensic sciences at the Oklahoma State University (OSU) Center for Health Sciences, where he specializes in research and instruction in forensic toxicology and chemistry. He also supervises research in trace evidence and chemical residue analysis, particularly in clandestine laboratory and post-blast scenarios. He recently founded the OSU Forensic Toxicology and Trace Laboratory, where his principal focus is working with triple quadrupole LC/MS/MS instruments. He supports forensic and clinical laboratories in method development and validation while also providing training in these areas. Previously, he was a chemist in the Hazardous Materials Response Unit of the FBI Laboratory, where he specialized in crime scene investigations involving hazardous materials throughout the world. His law enforcement experience also includes time as a forensic scientist in the toxicology section of the Orange County (CA) Sheriff-Coroner's Office and service as a reserve police officer in the City of Irvine, CA. He has a Ph.D. in environmental toxicology from the University of California, Irvine, and undergraduate degrees in biology and chemistry.

Kelly A. Walsh is a senior research associate in the Justice Policy Center and the Policy Advisory Group at the Urban Institute. Previously, she was an instructor at John Jay College of Criminal Justice and was employed by the Center for Modern Forensic Practice. Her work focuses on social science in forensic science and innovative financing models such as social impact bonds. She served as a principal investigator for several research projects, including the Motor Vehicle DNA Field Experiment, a randomized controlled trial on the cost-effectiveness of using DNA to aid theft investigations, and the 2014 Census of Publicly Funded Forensic Crime Laboratories. She has presented her work to the American Society of Crime Laboratory Directors, the American Academy of Forensic Sciences, the Northeastern Association of Forensic Scientists, the American Society of Criminology, the National Institute of Justice, and the White House Subcommittee on Forensic Science. She is a member of the Northeastern Association of Forensic Scientists and certified in general criminalistics by the American Board of Criminalistics. She holds a B.S. in chemistry from the University of Scranton and a Ph.D. in criminal justice, with a specialization in forensic science, from the City University of New York Graduate Center.