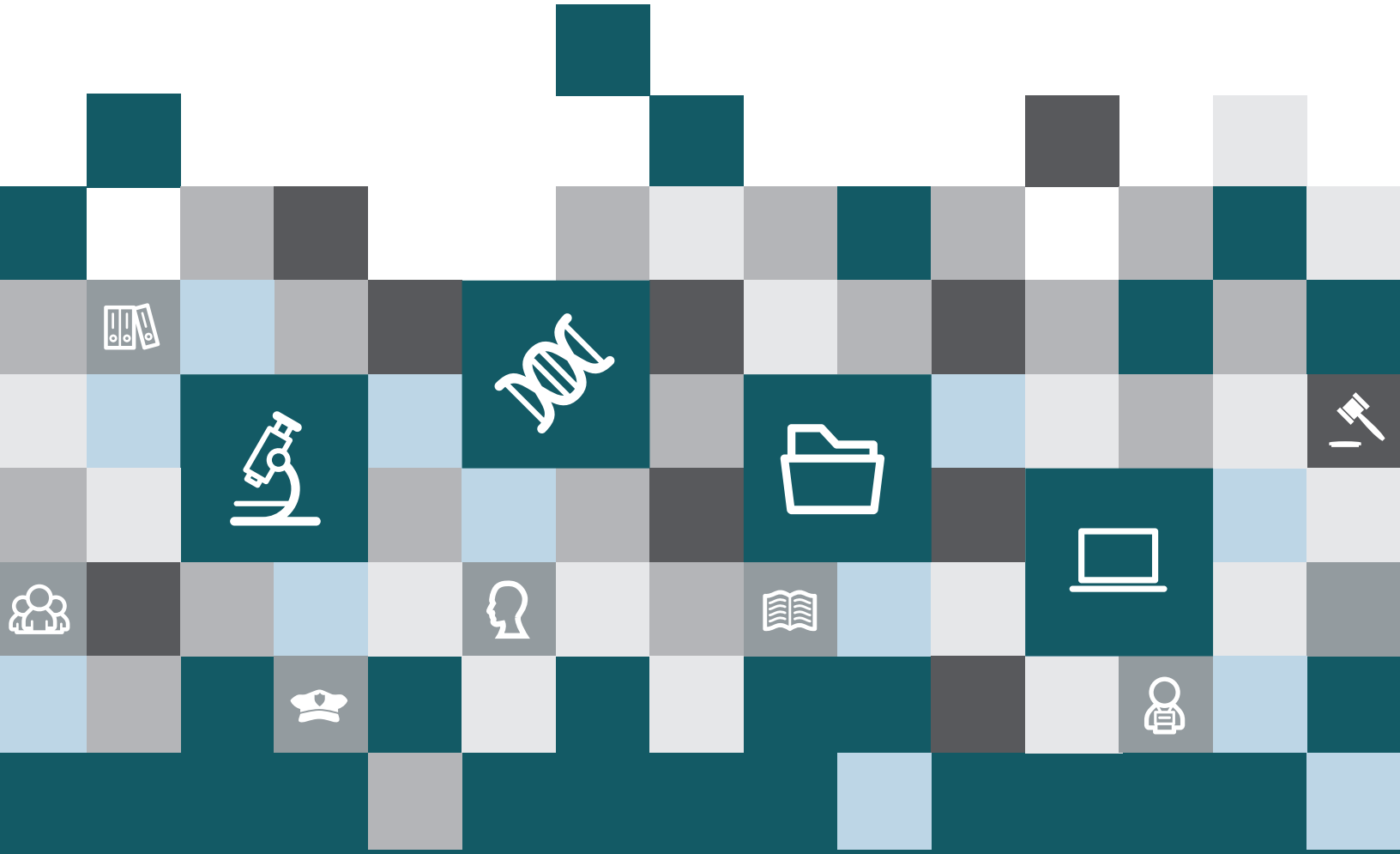
U.S. Department of Justice
Office of Justice Programs
National Institute of Justice

NATIONAL INSTITUTE OF JUSTICE

Forensic Science
Strategic Research Plan
2022-2026



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The National Institute of Justice is the research, development, and evaluation agency of the U.S. Department of Justice. NIJ's mission is to foster and disseminate knowledge and tools derived from objective and rigorous scientific research to inform efforts to promote safety and advance justice.

The National Institute of Justice is a program office of the Office of Justice Programs, which also includes the Bureau of Justice Assistance; the Bureau of Justice Statistics; the Office for Victims of Crime; the Office of Juvenile Justice and Delinquency Prevention; and the Office of Sex Offender Sentencing, Monitoring, Apprehending, Registering, and Tracking.

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Introduction

About the National Institute of Justice

As the research, development, and evaluation agency of the U.S. Department of Justice (DOJ), the National Institute of Justice (NIJ) is dedicated to improving knowledge and understanding of crime and justice issues through science. NIJ provides objective and independent tools to inform decision-making in the criminal justice community to reduce crime and advance justice, particularly in state, local, and tribal jurisdictions.

Forensic Science Research Mission

NIJ's forensic science mission is to strengthen the quality and practice of forensic science through research and development, testing and evaluation, technology, and information exchange.

Forensic science disciplines supported by NIJ include, but are not limited to, forensic biology and DNA, trace evidence, impression and pattern evidence, forensic toxicology, seized drugs, crime scene investigation, forensic pathology, forensic anthropology, and digital/multimedia evidence. Advancements in these forensic disciplines lead to more accurate and reliable tools, greater laboratory efficienc , and increased value of evidence for the criminal justice system. NIJ actively collects the needs of forensic science practitioners and develops knowledge to help inform policy and best practice. Forensic science research supports the DOJ mission of ensuring the fair and impartial administration of justice through the development of objective methods that support the timely investigation of crime, prosecution of persons who have perpetrated crimes, and prevention of wrongful convictions.

Strategic Research Plan Purpose

NIJ developed this Forensic Science Strategic Research Plan to communicate its research agenda and advance its forensic science research mission. The strategic priorities and objectives outlined in this plan closely parallel the opportunities and challenges faced by the forensic science community. This document should be of interest to crime laboratory and medicolegal death investigation professionals; researchers and technology developers (academia, government, and industry); the legal community (defense, prosecution, and judiciary); federal, state, local, tribal, and international partners; policymakers; and other stakeholders.

NIJ will continue to disseminate research findings esulting from this strategic research plan among these partners and constituent audiences to achieve the greatest impact over time.

Background

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One of the goals of forensic science research is to yield evidence-based solutions to real-world challenges. Our nation needs objective, effective, and creative solutions to address the issues facing an overwhelmed criminal justice system and under-resourced community of forensic practitioners. Only through research can we continue to develop accurate, reliable, cost-effective, and rapid methods for the identification, analysis, and interpretation of physical evidence and strengthen the scientific foundations of forensic practice (for more information on the impact of NIJ Forensic Science Research and Development, visit https://nij.ojp.gov/library/publications/impact-nij-forensic-science-research-and-development).

NIJ has over 50 years of experience in successfully identifying needs, funding research, and disseminating expert knowledge to the forensic science community.[1] NIJ identifies needs through regular stakeholder engagement with the forensic science community and has developed the only grant funding program in the nation that is fully dedicated to the broad spectrum of fields that make up forensic science. The program is highly competitive and receives hundreds of applications across multiple funding opportunities each year from academic, nonprofit, for-profit, federal, state, and local entities. The program's grants have led to tangible outputs and scientific advances that strengthen the fair and impartial administration of justice (to read about current solicitation programs, visit https://nij.ojp.gov/funding/current).[2]

The National Academy of Sciences (NAS) released the NIJ-commissioned report *Strengthening Forensic Science in the United States: A Path Forward* in 2009.[3] The report provided a pivotal reexamination of forensic science and, among many recommendations, pointed to standards, federal coordination, graduate education, and research as necessary prompts for institutional change. Despite progress by the community on many of these issues,

[1] National Institute of Justice, *NIJ Journal* 281, November 2019, https://nij.ojp.gov/nij-journal/nij-journal-issue-281.

[2] National Institute of Justice, *The Impact of Forensic Science Research and Development,* Washington, DC: U.S. Department of Justice, National Institute of Justice, April 2021, NCJ 300422, https://www.ojp.gov/pdffiles1/nij/300422.pdf.

[3] National Research Council, *Strengthening Forensic Science in the United States: A Path Forward,* Washington, DC: The National Academies Press, 2009, https://doi.org/10.17226/12589.

subsequent reports, most notably by PCAST,[4] the AAAS,[5] and NIST,[6] have identified significant areas of need for further change through research. In parallel, NAS released the NIJ-commissioned report *Support for Forensic Science Research: Improving the Scientific Role of the National Institute of Justice*.[7] In that 2015 report, NAS found that NIJ had made considerable progress in meeting the agency's mission to advance forensic science.

The 2015 report noted that "NIJ has a unique and critical role" among the diverse federal agencies working to impact the progress of forensic science, because NIJ focuses on extramural forensic science research and development. NAS affirmed that NIJ should continue on its current path and provide a plan for building on its progress by taking strategic steps to improve its "capacity to support high-quality forensic science research." NAS also recommended that NIJ develop a strategic plan that demonstrates its research priorities and its actions to achieve them, improves transparency and communication, and retools its resources in order to prioritize research rather than capacity-building grant programs.

NIJ has acted on these recommendations, investing more than $270 million in forensic science research and development over the past 12 years. In 2020, the administration of the operational laboratory capacity-building grant programs was transferred to the Bureau of Justice Assistance.[8] This transition allows NIJ to focus on its research goals and promote the vital role that forensic science research plays in improving justice system efficiencies and outcomes. NIJ continues to respond to the NAS recommendations through this strategic plan.

The broader scientific community has identified challenges facing forensic science. NIJ's 2019 *Report to Congress: Needs Assessment of Forensic Laboratories and Medical Examiner/Coroner Offices* revealed a crime laboratory landscape in need of fundamental support to develop best practices, implement innovative tools and techniques, and analyze backlogs of evidence.[9] NIJ's research investments are designed to address those challenges. NIJ helps meet those needs, disseminating actionable research findings to academic partners and practitioners at the federal, state, and local levels.

[4] President's Council of Advisors on Science and Technology, *Report to the President: Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods,* Washington, DC: Executive Office of the President, President's Council of Advisors on Science and Technology, September 2016, https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_forensic_science_report_final.pdf.

[5] American Academy for the Advancement of Sciences, "Forensic Science Assessments: A Quality and Gap Analysis," accessed April 13, 2022, https://www.aaas.org/resources/forensic-science-assessments-quality-and-gap-analysis.

[6] NIST Forensic Science, "Scientific Foundation Reviews," last updated May 11, 2022, https://www.nist.gov/topics/forensic-science/interdisciplinary-topics/scientific-foundation-reviews.

[7] National Academies of Sciences, Engineering, and Medicine, *Support for Forensic Science Research: Improving the Scientific Role of the National Institute of Justice,* Washington, DC: The National Academies Press, 2015, https://doi.org/10.17226/21772.

[8] Capacity-building grant programs transferred to the Bureau of Justice Assistance include DNA Capacity Enhancement for Backlog Reduction Program; Paul Coverdell Forensic Science Improvement Grants Program; Postconviction Testing of DNA Evidence; Prosecuting Cold Cases using DNA Technology; Sexual Assault Forensic Evidence — Inventory, Tracking, and Reporting Program; and Strengthening the Medical Examiner-Coroner System Program.

[9] National Institute of Justice, *Report to Congress: Needs Assessment of Forensic Laboratories and Medical Examiner/Coroner Offices,* Washington, DC: U.S. Department of Justice, National Institute of Justice, 2019, https://www.ojp.gov/pdffiles1/nij/253626.pdf.

NIJ took a systematic approach to the development of this strategic research plan, recognizing four important factors:

I. Evolving practitioner needs within a dynamic scientific, legal, and policy envi onment.

II. NIJ's unique mission as an applied-science agency within the U.S. Department of Justice, serving the interests of the broader forensic science community.

III. The short-, medium-, and long-term investments needed to be responsive to change.

IV. The diverse forms of outputs and outcomes generated by NIJ's forensic science research, which consists of foundational, applied, and transitional projects.

Factor I: Evolving Practitioner Needs Within a Dynamic Scientific, Legal, and Policy Envi onment

The Forensic Science Research and Development Technology Working Group (FSRD-TWG) informs the first factor. This group is composed of over 50 members of the federal, state, and local forensic science community who identify, discuss, and prioritize their operational needs and requirements. The group includes practitioners representing biology/DNA, trace evidence, toxicology, crime scene examination, anthropology, pathology, impression/pattern evidence, and seized drugs. NIJ regularly publishes an updated list of the FSRD-TWG needs as a guide to researchers interested in addressing current forensic science problems. These needs, as well as those published by other federal forensic science committees, also help to inform the objectives and priorities of NIJ's research and development activities (for more information on OSAC research and development needs, visit https://www.nist.gov/osac/osac-research-and-development-needs).

Factor II: NIJ's Unique Mission

NIJ is uniquely positioned as a justice-focused science agency that serves the broader forensic science community and provides insight into future research and practice through interaction and collaboration. NIJ define collaborative spaces where practitioners and researchers can connect, exchange, and enhance ideas. These spaces also serve to build relationships and transfer knowledge between partners so that research findings can inform practice. Leaders in the community recognize these goals, believe in these benefits, and actively volunteer for NIJ working groups, where collaboration is fostered between academic researchers and publicly funded forensic laboratories. In addition to convening working groups, NIJ encourages collaboration between academic researchers and publicly funded forensic laboratories.

For additional information on:

- Connecting researchers with forensic laboratories, visit https://nij.ojp.gov/topics/forensics/connecting-researchers-forensic-laboratories.
- The Forensic Science Research and Development Technology Working Group (FSRD-TWG), visit https://nij.ojp.gov/topics/articles/forensic-science-research-and-development-technology-working-group-operational.
- The Forensic Laboratory Needs Technology Working Group (FLN-TWG), visit https://nij.ojp.gov/topics/articles/forensic-laboratory-needs-technology-working-group-opening-new-channel-improve.
- The NSF Industry-University Cooperative Research Centers (IUCRC) Program, visit https://iucrc.nsf.gov/.

Factor III: Short-, Medium-, and Long-Term Investments

NIJ supports a mix of research and development spanning from early-stage research all the way to end-stage development and implementation. Within this portfolio, NIJ maintains a diverse collection of projects at all stages of maturity, from concept to adoption, and translates and disseminates results to practitioner and policymaker audiences.

Factor IV: The Diverse Outputs and Outcomes Generated by NIJ's Forensic Science Research

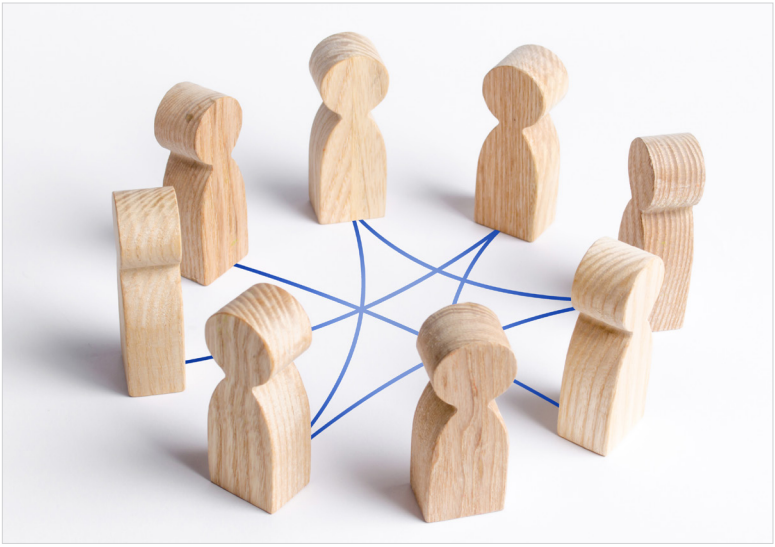
NIJ evaluates the products of its efforts and determines how well these outputs align with the priorities outlined in this strategic plan. NIJ seeks to accelerate research outcomes by maintaining a strong technology transition component. This is accomplished largely through NIJ's Forensic Technology Center of Excellence, which helps to transfer state-of-the art technology and knowledge into practice by partnering with federal, state, and local crime laboratories and medical examiner/coroner offices [10] The NIJ Forensic Laboratory Needs Technology Working Group, established in 2018, provides a forum for crime laboratory directors and academic researchers from around the country to develop coordinated approaches to addressing technology implementation challenges in the forensic laboratory.[11] The working group's ultimate goal is to increase laboratory efficienc , ensure that resources are focused appropriately and keep up with demand, and support innovative technology implementation strategies for a stronger justice system.

[10] National Institute of Justice, "NIJ Announces $4.5M in New Funding for the Forensic Technology Center of Excellence," January 7, 2022, https://nij.ojp.gov/nij-announces-45m-new-funding-forensic-technology-center-excellence; and Forensic Technology Center of Excellence, accessed April 13, 2022, https://forensiccoe.org/.

[11] "Forensic Laboratory Needs Technology Working Group (FLN-TWG)," Forensic Technology Center of Excellence, accessed April 13, 2022, https://forensiccoe.org/forensic-laboratory-needs-technology-working-group/; and "The NIJ Forensic Laboratory Needs Technology Working Group — Progress to Date and Future Plans," Forensic Technology Center of Excellence, accessed April 13, 2022, https://forensiccoe.org/nij-forensic-laboratory-report/.

Research Partners and Shared Goals

NIJ and the broader community of interest recognize that forensic science research is a challenging endeavor that can only succeed through broad collaboration between government, academic, and industry partners. Forensic science practitioners are constantly presented with increasing demands for quality services in the face of diminishing resources. As part of its long-term strategy for success, NIJ actively seeks to partner practitioners with researchers to help develop solutions to these challenging issues. NIJ coordination and funding help these partnerships bear fruit.



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NIJ and its partners have a shared goal of supporting a strong forensic science research enterprise. Building sustainable partnerships is of paramount importance, as is connecting academic, industry, federal, state, local, and international organizations that can help foster and coordinate research and development. To this end, NIJ collaborates with several outside agencies. NIJ works with the National Science Foundation (Center for Advanced Research in Forensic Science) and the National Institute of Standards and Technology (Center for Statistics and Applications in Forensic Evidence and Organization of Scientific A ea Committees for Forensic Science), as well as the Federal Bureau of Investigation (Research and Support Unit). For a summary of Federal Forensic Science Research and Development Programs, visit https://forensiccoe.org/federal-forensic-science-research-development-programs-2021/.

Definitions

The following are a few basic terms used to define and distinguish key concepts in fo ensic science. Other points of clarification a e provided throughout the document as footnotes with applicable references.

- **Quantitation** — To measure the quantity or concentration of an analyte in a sample, along with the associated measurement uncertainty.
- **Destructive** — A test that consumes, alters, or otherwise damages a sample, affecting its condition or availability for further testing.

- **Uncertainty** — A parameter, associated with the result of a measurement, that characterizes the range of the values that could reasonably be attributed to what is being measured.
- **Decision analysis** — A formalized approach to assessing the accuracy, reliability, and reproducibility of expert conclusions, in aggregate, using a given method, test, or workflo .
  - **Black box testing** — A method of testing the performance of a system that focuses exclusively on the ultimate outcome (correct or incorrect), without regard to the internal details of the process. In a forensic science context, this often refers to measurement of the rates of examiner error when employing typical current practices.
  - **White box testing** — A method of testing the performance of a system that focuses on how specific inte nal processes impact the overall outcome. This can be used to identify the most significant factors contributing t error.
  - **Error** — The tendency of a set of measurements to deviate from the true value.
- **Human factors research** — A multidisciplinary field that examines ways in which human performance (e.g. the judgments of experts) can be influenced by cognitive, pe ceptual, organizational, social, cultural, and other factors.
- **Technology transition** — Efforts to facilitate the transfer of the results of research and development into operational use and practice. This can include the demonstration, testing, evaluation, adoption, implementation, and general use and acceptance of a technology.

Forensic Science Strategic Research Plan: Priorities and Objectives

NIJ sponsors research, development, and evaluation to bring innovation to forensic science, better understand the limits of current forensic methods, and inform forensic science policy and practice.

NIJ has identified five strategic research priorities for the Forensic Science Strategic Research Plan, under which a comprehensive set of objectives and action items are organized:

I. Advance Applied Research and Development in Forensic Science.

II. Support Foundational Research in Forensic Science.

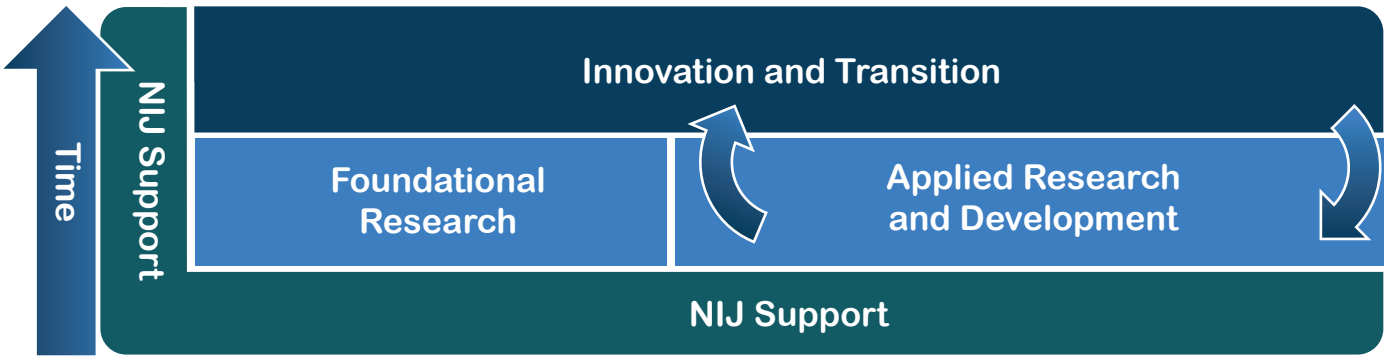
III. Maximize the Impact of Forensic Science Research and Development.

IV. Cultivate an Innovative and Highly Skilled Forensic Science Workforce.

V. Coordinate Across the Community of Practice.

Research and development in the natural sciences generally builds on a foundation of basic research, extends acquired knowledge into applied research and development, and culminates in the successful transition of promising technologies into practice. NIJ's criminal justice mission prioritizes applied science and technology transition with the potential to benefit the forensic science enterprise. NIJ supports the research infrastructure necessary for innovation to blossom (see Exhibit 1). This includes development of the forensic science workforce as well as partnerships to promote information and resource sharing.

Exhibit 1. NIJ's role in forensic science innovation and technology transition



Strategic Priority I: Advance Applied Research and Development in Forensic Science

The objective of NIJ's applied research and development in forensic science is to meet the needs of forensic science practitioners. NIJ supports applied research and development that aids the forensic science community through the development of methods, processes, devices, and materials. Applied research and development may result in improved procedures or otherwise resolve current barriers. It may not always provide immediate solutions but can move the state of the art forward and optimize the implementation of available technologies.

Objectives

I.1. Application of Existing Technologies and Methods for Forensic Purposes

- Tools that increase sensitivity and specificity of forensic analysis.
- Methods to maximize the information gained from forensic evidence.
- Nondestructive or minimally destructive methods that maintain evidence integrity.
- Technologies to improve the identification and collection of evidence.
- Machine learning methods for forensic classification.
- Reliable and robust fieldable technologies.
- Rapid technologies to increase efficiency.
- Imaging technologies to visualize evidence.

I.2. Novel Technologies and Methods

- Identification and quantitation of forensically relevant analytes (e.g., seized drugs, gunshot residue).
- Differentiation techniques for biological evidence (e.g., body fluid identification).
- Investigation of novel or nontraditional aspects of evidence (e.g., microbiome, nanomaterials).
- Reliable and robust fieldable technologies.
- Increased efficiency of evidence analysis with rapid technologies.
- Crime scene documentation and reconstruction technologies.

I.3. Methods To Differentiate Evidence From Complex Matrices or Conditions

- Detection and identification of evidence during collection or analysis.
- Differentiation of compounds or components of interest in complex matrices.
- Identification of clandestine graves.

I.4. Technologies That Expedite Delivery of Actionable Information

- Methods and workflows to enhance or inform investigations.
- Enhanced data aggregation, integration, and analysis within and across datasets.
- Expanded triaging tools and techniques to develop actionable results.
- Technologies and workflows for forensic operations at the scene.

I.5. Automated Tools To Support Examiners' Conclusions

- Objective methods to support interpretations and conclusions.
- Technology to assist with complex mixture analysis.
- Evaluation of algorithms for quantitative pattern evidence comparisons.
- Library search algorithms to assist in the identification of unknown compounds.
- Systems that quantitatively weigh results when performing biological profile analysis of unidentified human remains.
- Computational methods to support bloodstain pattern analysis.

I.6. Standard Criteria for Analysis and Interpretation

- Standard methods for qualitative and quantitative analysis.
- Evaluation of expanded conclusion scales.
- Evaluation of the use of methods to express the weight of evidence (e.g., likelihood ratios, verbal scales).
- Assessment of the causes and meaning of artifacts in a forensic context.

I.7. Practices and Protocols

- Optimization of analytical workflows, methods, and technologies
- Effectiveness of communicating reports, testimony, and other laboratory results.
- Implementation of new technologies and methods, including cost-benefit analyses
- Laboratory quality systems effectiveness.
- Research regarding proficiency tests that eflect complexity and workflow
- Connectivity and standards for laboratory information management systems.

I.8. Databases and Reference Collections

- Development of reference materials/collections.
- Databases that are accessible, searchable, interoperable, diverse, and curated.
- Databases to support the statistical interpretation of the weight of evidence.

Strategic Priority II: Support Foundational Research in Forensic Science

NIJ supports research to assess the fundamental scientific basis of fo ensic analysis. If forensic methods are demonstrated to be valid and the limits of those methods are well understood, then investigators, prosecutors, courts, and juries can make well-informed decisions. This can exclude the innocent from investigation and help prevent wrongful convictions.

Objectives

II.1. Foundational Validity and Reliability of Forensic Methods

- Understanding of the fundamental scientific basis of fo ensic science disciplines.
- Quantification of measu ement uncertainty in forensic analytical methods.

II.2. Decision Analysis in Forensic Science

- Measurement of the accuracy and reliability of forensic examinations (e.g., black box studies).
- Identification of sou ces of error (e.g., white box studies).
- Research and evaluation of human factors.
- Interlaboratory studies.

II.3. Understanding the Limitations of Evidence

- Understanding the value of forensic evidence beyond individualization or quantitation to include activity level propositions.

II.4. Stability, Persistence, and Transfer of Evidence

- Effects of environmental factors and time on evidence.
- Primary versus secondary transfer.
- Impact of laboratory storage conditions and analysis on evidence.

Strategic Priority III: Maximize the Impact of Forensic Science Research and Development

The ultimate goal of NIJ's research and development is to make a positive impact on forensic science practice. For this to happen, the products of research and development must reach the community. These products include peer-reviewed publications, presentations, databases, patents and inventions, software, best practice guides, and more. Implementation of new technology and methods into practice can be aided by NIJ stewardship, in partnership with researchers and practitioners. This can ultimately result in better accuracy, increased efficienc , and improved workflows.

Objectives

III.1. Disseminate Research Products to Communities of Interest

- Communicate with new and existing audiences across diverse media.
- Improve access to research publications (e.g., open access, public access).
- Support data sharing and accessibility.

III.2. Support the Implementation of Methods and Technologies

- Assist technology transition for NIJ-funded research and development.
- Demonstrate, test, and evaluate new methods and technology.
- Pilot implementation and adoption into practice.
- Develop evidence-based best practices.

III.3. Assess the Impact of NIJ Forensic Science Programs

- Identify and collect measures of program performance (e.g., publications, citations, patents).
- Analyze program impact over time.
- Act on findings to optimize p ogram effectiveness.
- Communicate findings to the public

III.4. Examine the Role and Value of Forensic Science in the Criminal Justice System

- Understand how forensic science impacts the criminal justice system.
- Evaluate the implementation of new and innovative policies and practices.
- Understand the costs and benefits of forensic science services.

Strategic Priority IV: Cultivate an Innovative and Highly Skilled Forensic Science Workforce

NIJ supports the development of current and future forensic science researchers and practitioners through laboratory and research experience. Student engagement and the promotion of new scientific perspectives and pioneering approaches within the forensic science workforce are critical elements of this effort.

Objectives

IV.1. Foster the Next Generation of Forensic Science Researchers

- Enrich undergraduate experiences.
- Support graduate research in forensic science.
- Provide postgraduate opportunities.
- Support early-career new investigators.

IV.2. Facilitate Research Within Public Laboratories

- Create opportunities for research.
- Cultivate a workforce of researchers within public laboratories.
- Promote partnerships with academia.

IV.3. Advance the Forensic Science Workforce

- Assess and evaluate staffing and esource needs.
- Examine the use and efficacy of fo ensic science training and certification p ograms.
- Research best practices for recruitment and retention.
- Support workforce development (e.g., leadership, public speaking, mentorship) and continuing education.

- Evaluate the workforce and workforce pipeline.
- Research the safety, wellness, health, and workplace needs of forensic practitioners.

IV.4. Implement a Process for Workforce Assessment, Outreach, and Sustainability

- Collect workforce education, training, and employment data through NIJ programs.
- Identify and engage in actions to attract new applicants.

Strategic Priority V: Coordinate Across the Community of Practice

The forensic science enterprise benefits f om collaboration across academic, industry, and government sectors. NIJ serves as a coordination point within the forensic science community to help meet the challenges caused by high demand and limited resources.

Objectives

V.1. Assess and Address the Needs of the Field

- Engage with forensic practitioners and laboratory leadership to understand their evolving needs.
- Communicate engagement outcomes to researchers, educators, and policymakers.
- Implement programs that address needs and build connections among stakeholders.

V.2. Engage Federal Partners To Maximize Resources

- Understand agencies' current activities and priorities.
- Establish agreements and partnerships.
- Coordinate to leverage agencies' resources and strengths and avoid duplication.

V.3. Facilitate Information Sharing

- Promote the sharing of information (e.g., data, methods, validation plans) among NIJ's federal, state, and local partners.
- Employ various platforms (e.g., symposia, webinars, working groups) for information sharing.
- Serve as a central agency for the collection and distribution of information on evidence-based solutions.

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