NIST FORENSIC SCIENCES NEWS

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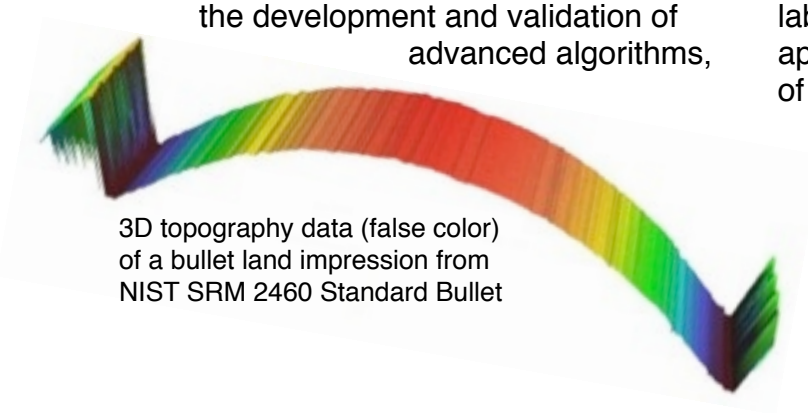
NIST Forensic Topography Analysis Project Seeks to Improve Ballistics Identification

by Robert M. Thompson and Xiaoyu Alan Zheng

The NIST Forensic Topography Analysis Project team, with funding from the National Institute of Justice, is developing the world's first open-access research database of fired bullet and cartridge casing reference data, consisting of traditional reflectance microscopy images and three-dimensional surface topography. The database will support objective ballistics identification as it fosters the development and validation of advanced algorithms, mathematical similarity criteria and quantitative confidence limits. A 2009 National Research Council (NRC) report called into question, amongst other issues, the objectivity of visual toolmark identification by firearms examiners. This report recommended development of objective toolmark identification criteria and error rate estimates. Industry, academia and government laboratories are pursuing two promising approaches towards this goal: 1) development of mathematical criteria and advanced algorithms for the objective and automated identification and scoring of potential matches, and 2) supplementing traditional reflectance microscopy images with three-



3D topography data (false color) of a bullet land impression from NIST SRM 2460 Standard Bullet

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NIST Names First Forensic Science Standards Board Members

On June 26, NIST named 17 academic researchers and forensic science experts to the Forensic Science Standards Board (FSSB), a key component of NIST's Organization of Scientific Area Committees (OSAC), a new organization to help standardize and strengthen forensic science. The FSSB will oversee three resource committees and five scientific area committees. Subcommittees will focus on specific disciplines, including DNA, toxicology. medico-legal

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NIST Digital Forensic Resource Honored with a National Innovation Award

The National Digital Stewardship Alliance Innovation Working Group is honoring NIST for a software archive that has proven highly valuable to digital forensic investigators and is also paying off in other unimagined ways.

The group announced its third annual NDSA Innovation Awards on May 12. The awards committee selected four award recipients from 30 nominees including the NIST National Software Reference Library (NSRL).

NIST's NSRL was selected for "substantial leadership in building a national collection of software, developing and sharing workflows and approaches for software preservation, and for modeling approaches to corpus analysis of born digital collections," according to the award announcement.

In addition to its value in criminal investigations, the NSRL has become a valuable asset to the digital preservation community. Last year NIST and Stanford University Libraries collaborated on a project to expand the NSRL collection and increase its value as a cultural collection including early 1980s era software and video game titles.

Each year the Innovation Working Group solicits nominations for projects, individuals and organizations doing innovative and substantive work in digital preservation. The group recently interviewed Doug White, the NIST NSRL project leader, and posted a write-up about the NSRL in its blog.

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The blog relays another unexpected benefit of the NSRL. In 2004, the Food and Drug Administration contacted White's team for assistance in tracking a potentially dangerous lot of Botox that had been mixed incorrectly. The FDA had information on which clinics received shipments of the bad lot, but it was locked in a file created with an older version of a popular business software. The FDA asked if NIST could provide the older version of the software from the NSRL, which it did. The FDA was able to open the file and trace the bad Botox, averting possible deaths.

The 2014 NDSA Innovation Awards was presented at the Digital Preservation 2014 meeting which was held by the Library of Congress, July 22-24, in Washington D.C. The National Digital Stewardship Alliance is a consortium launched by the Library of Congress' National Digital Information Infrastructure and Preservation Program.

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dimensional surface topography measurement data.

However, almost a decade prior to the NRC report, the researchers at NIST were already having success in the development and production of Standard Reference Material (SRM) Bullets and Cartridge Cases. In partnership with the Bureau of Alcohol, Tobacco, Firearms and Explosives, these standards were tested nationwide and are now the quality assurance control reference standards for the National Ballistic Information Network (NIBIN) in the United States. These SRMs enabled the development and refinement of microscopic 2D and 3D surface profile and topography measurement systems to qualify the accuracy of the individualizing detail born on the bullets and cartridge cases. These same analytical methods have been tested on actual fired bullets and cases in blind comparison studies with remarkable accuracy. These objective methods are being employed to document the surface feature "ground truth" for the fired bullets and cartridge cases in the growing research database.

The land impression on NIST SRM 2460 Standard Bullet

In the past, development and validation of both of these approaches to objective toolmark identification were hindered by a lack of access to toolmark data sets. A useful data set would need to represent the large variety of ballistic toolmarks encountered by firearm examiners. It would also need to represent challenging identification scenarios, such as those posed by consecutively manufactured firearms components. It is very expensive for individual companies or institutions to

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generate their own data sets and to objectively evaluate their solutions. During an international symposium held at NIST entitled *Measurement Science and Standards in Forensic Firearms Analysis 2012*, one of the top priority requests from the attendees was the construction of a research database where bullet, cartridge case and toolmark surface data can be shared between researchers to facilitate testing, refinement and comparison of new systems, methods and algorithms.

The ballistic surface database is being constructed to contain a variety of representative toolmark data, ranging from crime lab test fires to ones fired with consecutively manufactured barrels, firing pins, slides and other firearm surfaces. The database will contain both microscope images and three-dimensional surface topography data. To maintain an accurate ground truth, the database will consist of indexed surface data acquired at NIST using state-of-the-art instruments and measurement procedures. A portion of the data will also be collected and stored in a closed database for later validation tests and comparison of correlation software methods.

The database will enable researchers to test and validate new approaches in objective, mathematics-based, toolmark identification while easing the transition to three-dimensional surface topography data. The database will provide a scientific knowledge base of the degree of similarity that can be found between marks made by different firearms and the variability in marks made by an individual firearm. In the future, examiners in court will not only present their subjective opinion of identification, but also will have an independent objective measurement of similarity between the evidence items. In the future, objective measurement methods will have a strong foundation of data built by this NIST team and national forensic science partners.

NIST to Hold DNA Analyst Webinar Series

On Aug. 6, two NIST scientists along with academic and government experts will present *NIST DNA Analyst Webinar Series: Validation Concepts and Resources – Part 1.* John Butler and Becky Hill of the NIST Applied Genetics Group will be among the presenters. Forensic DNA analysts and other interested stakeholders are invited to participate in this free NIST webinar on validation concepts and resources which takes place from 1:00 p.m. to 5:00 p.m., ET, on Aug. 6 In recent years, instrument manufacturers and software companies have created new technologies to analyze challenging DNA samples. Examples include new quantification kits, STR multiplexes, instruments for CE separation, and an increasing number of available software programs for interpreting complex mixtures. These new technologies must be tested and validated before they can be reliably used in a forensic laboratory. During the webinar, NIST, Boston University and California Department of Justice experts will cover validation concepts and NIST software tools to assist in the validation process. See http://www.nist.gov/forensics/nist-dna-analyst-webinar-series-validation-concepts-and-resources-part-1.cfm for more information.

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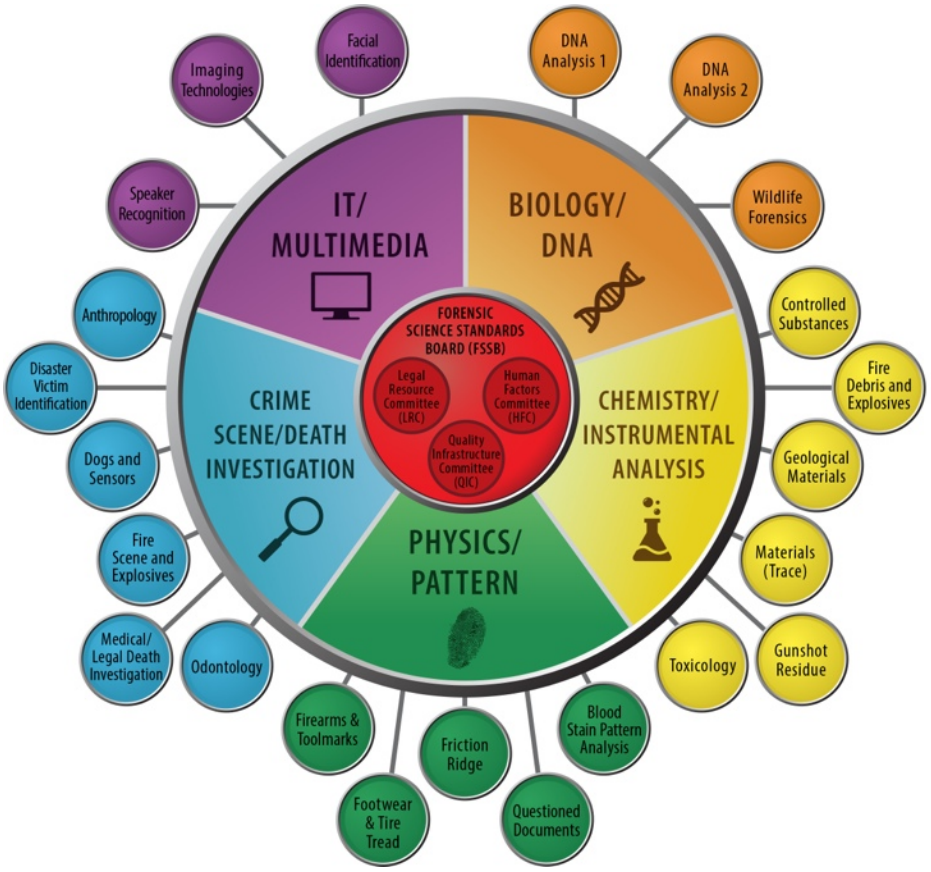
death investigation, facial identification, latent fingerprints and firearms and toolmarks, among others. The subcommittees will propose consensus documentary standards, for adoption by the board, to improve quality and consistency of work in the forensic science community. To see the NIST news release on the FSSB, go to www.nist.gov/forensics/first-forensic-science-standards-board-062614.cfm To see the NIST forensic science webpage listing FSSB members, go to www.nist.gov/forensics/osac/fssb.cfm.



The structure of the NIST Organization of Scientific Area Committees

On July 16, NIST announced the selection of 35 additional OSAC members who will serve on the resource committees. The new members, selected for their expertise in law, psychology and quality assurance, will serve on three OSAC Resource Committees. Members will play a critical support role by advising the FSSB, the scientific area committees and subcommittees focused on specific forensic science disciplines as they adopt, develop and review standards.

“As our science-focused committees and subcommittees work to support the development of forensic science standards and guidelines, we expect that there will be many questions related to law, work flow processes and quality control. These resource committees will help address those,” said John Paul Jones II, associate director for OSAC affairs. See the full resource committee announcement at www.nist.gov/forensics/osca-rc.cfm.

A NIST-DOJ membership selection team is in the process of reviewing more than 1,300 applications for the remaining OSAC positions. Later this summer, NIST expects to announce members of the Scientific Area Committees within OSAC.

National Commission of Forensic Science Discusses Cognitive Bias

The National Commission on Forensic Science (NCFS), a federal advisory committee to the U.S. Department of Justice and jointly chaired by DOJ and NIST, held its second meeting on May 12-13, 2014. The second NCFS meeting featured panel discussions on the topics of cognitive bias and ethics. Attendees also heard reports from the six NCFS subcommittees:

- accreditation and proficiency testing,
- medicolegal death investigation,
- reporting and testimony,
- scientific inquiry and research,
- training on science and law, and
- interim solutions.

Mark Stolorow, director of the NIST Organization of Scientific Area Committees (OSAC), and Willie May, NIST acting director, discussed NIST efforts with OSAC and future plans to fund a NIST Center of Excellence in Forensic Science.

NIST and DOJ established the NCFS in March 2013 with the signing of a memorandum of understanding. The commission includes representatives from federal, state and local forensic science labs; research scientists and academicians; prosecutors, defense attorneys and judges; law enforcement; and other relevant stakeholders.

Meeting summaries and a link to a webcast of the meeting can be found on the NCFS website at http://www.justice.gov/ncfs/meetings.html. The next NCFS meeting will be held on Aug. 26-27, 2014.

NIST and Netherlands Forensic Scientists Collaborate

For three weeks in May, two visitors from the Netherlands Forensic Institute (NFI) worked on collaborative projects with NIST researchers. Arian van Asten, Ph.D., worked with the NIST Surface and Trace Chemical Analysis Group studying trace chemical detection methods with direct analysis in real-time mass spectrometry. Ate Kloosterman, Ph.D., worked with Mike Coble of the Applied Genetics Group evaluating probabilistic genotyping software approaches to DNA mixture analysis. Kloosterman and van Asten are professors at the University of Amsterdam as well as leading forensic scientists within the NFI.

This collaboration resulted from a 2012 agreement between NIST and the NFI to work together to advance technologies, methods, practices and standards in forensic science. See http://www.nist.gov/oles/mou-121212.cfm.

May 19 – Dutch officials, including Secretary General Pieter Cloo of the Netherlands Ministry of Security and Justice, visited NIST for a briefing and exchange on forensics and cybersecurity. Pictured above: NIST's Mark Stolorow (left) and Marcel van der Steen (middle) and Arian van Asten of the Netherlands Forensic Institute participated in the briefing. Photo: NIST

Supreme Court Cites NIST Guide in Ruling on Cell Phone Searches

As digital technology transforms 21st century life, questions about privacy rights abound. The U.S. Supreme Court ruled on one such question in late June: if you are arrested, can the police search your cell phone without first obtaining a warrant? No, according to the June 25, 2014, ruling in Riley v California. In considering the question, the court had to mesh established policy on search warrants together with an understanding of cell phone technology.

To help with that challenge, the justices turned to a variety of sources, among them the *NIST Guidelines on Mobile Device Forensics*. The unanimous court opinion, written by Chief Justice John Roberts, cites this document three times. The ruling focuses on two separate cases in which police arrested suspects and searched their cell phones without first obtaining a search warrant. In both cases, state and federal prosecutors argued that the searches were justified to prevent the suspects from destroying evidence. Courts have long upheld police officers' right to search an area within the suspect's immediate reach without a warrant.

The prosecutors argued that information on a cell phone may be vulnerable to two types of evidence destruction unique to digital data – remote wiping and encryption. The Supreme Court opinion cites the *NIST Guidelines on Mobile Device Forensics* to explain remote wiping. "Remote wiping occurs when a phone connected to a wireless network receives a signal that erases stored data. This can happen when a third party sends a remote signal or when a phone is preprogrammed to delete data upon entering or leaving certain geographic areas (so-called 'geofencing')," the opinion explains, citing the NIST guidelines authored by Rick Ayers of NIST, Sam Brothers of the Department of Homeland Security, and Wayne Jansen of Booz Allen Hamilton. The justices ruled that neither the remote-wiping nor encryption concerns were relevant. The arresting officers can turn the phone off or remove its battery to prevent remote wiping, the opinion says.

Rick Ayers, one of the authors of the *NIST Guidelines on Mobile Device Forensics.*
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They cited the NIST guide two more times in elaborating on the technical issues. "If they are concerned about encryption or other potential problems, they can leave a phone powered on and place it in an enclosure that isolates the phone from radio waves. See Ayers 30-31," the opinion says. However, it also notes that such enclosures "may not be a complete answer to the problem. See Ayers 32."

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After digesting these and other technical and societal issues, the opinion concludes that police officers need a warrant to search a cell phone. “Modern cell phones are not just another technological convenience. With all they contain and all they may reveal, they hold for many Americans ‘the privacies of life,’ … The fact that technology now allows an individual to carry such information in his hand does not make the information any less worthy of the protection for which the Founders fought,” the opinion concludes.

NIST developed its *Guidelines on Mobile Device Forensics* to help investigators make decisions about the best ways to gather, preserve and report on data from cell phones and other mobile devices.

“As this ruling illustrates, it is important that policy decisions are based on a sound understanding of technological issues,” says Barbara Guttman, manager of the Software Quality Group in NIST’s Information Technology Laboratory. “We're glad the Supreme Court found our guidelines helpful in answering this important question.”

NIST Webinar on Analyzing Complex Mixed DNA Samples Reaches More Than 1000

Webinar participants (clockwise from left): consultant and presenter Charlotte Word, Mike Coble, Gladys Arrisueno and John Paul Jones, all of NIST; Todd Bille of ATF, and Ate Kloosterman of the Netherlands Forensic Institute. Photo: NIST

Mike Coble, a forensic scientist in the NIST Applied Genetics Group, recently organized a webinar for forensic DNA analysts on probabilistic genotyping software for complex DNA mixtures. This 4-hour webinar, held on May 28 with the assistance of John Paul Jones of the NIST Office of Special Programs and Gladys Arrisueno of NIST Conference Services, included presentations from forensic DNA scientists at the Denver Police Department, the New York City Office of Chief Medical Examiner, the Netherlands Forensic Institute, and the Alcohol, Tobacco, Firearms, and Explosives Laboratory. More than 1,000 viewers tuned into the webinar to learn about overcoming the challenges associated with interpreting mixed DNA samples. Slides from the eight presentations and the webinar recording are available online at http://www.nist.gov/forensics/nist-dna-analyst-webinar-series-pt1.cfm.

NIST Provides DNA Training to FBI Laboratory

On June 10, the NIST Applied Genetics Group provided the third annual all-day training session to more than 100 FBI Laboratory DNA analysts. NIST scientists Becky Hill, Mike Coble, Kevin Kiesler, Erica Butts, Katherine Gettings and Peter Vallone gave presentations. Topics included Standard Reference Materials, probabilistic genotyping methods, Y-chromosome short tandem repeat statistics, single nucleotide polymorphism typing with next-generation sequencing instrumentation, rapid DNA testing and forensic applications of next-generation instruments.

Shown here are the tools for testing arson samples using NIST's new PLOT capillary method. Credit: NIST

Fire Debris Detection Technique Developed to Aid Arson Investigations

NIST researchers have demonstrated a new method for detecting ignitable liquids that could change the way arson fires are investigated. They describe the method in a recent paper in the *Journal of Chromatography A.* An arson investigation typically requires collecting one or two liters of ashes and debris from various locations within a fire scene in metal cans similar to those used for paint, and sending the material to a lab. The testing methods typically include gas and liquid chromatography or various versions of spectroscopy, with gas chromatography being the most widely used in fire debris analysis, according to the lead NIST researcher Tom Bruno. When the fire debris is received at the testing facility, samples are taken for testing. Sometimes this will involve suspending a strip with activated charcoal in the air or "headspace" directly above the sample in the paint can for a period of time that can vary, depending on the judgment of the analyst, for 2-3 hours or up to 16 hours.

Other testing methods include "dynamic purge and trap" of the headspace. And still another sampling method involves a newer solid-phase microextraction (SPME) method that does not destroy the sample. This later method, however, has a high displacement rate of heavier over lighter ignitable liquid components, is difficult to automate, makes preserving and archiving samples difficult and has not shown a consistent ability to obtain repeatable and quantitative results. Also, the SPME sampling method requires expensive equipment, and the SPME fibers are easily damaged. Still other methods are less sensitive and produce large amounts of chemical waste.

The vapor collection method developed by Bruno's group involves the dynamic adsorption of headspace vapors on short porous layer open tubular (PLOT) columns maintained at low temperature (as low as -40 C). The benefits of this method are many. The collection sensitivity is high; below 1 part per billion (ppb). The low temperature is achieved using a vortex tube connected to compressed air; it has no moving parts, and is attractive for use in environments with explosive or flammable materials.

To learn more, see the NIST news release at http://www.nist.gov/mml/acmd/arson-061714.cfm.

Reference: Nichols, J.E., et al. (2014) Analysis of arson fire debris by low temperature dynamic headspace adsorption porous layer open tubular columns. *Journal of Chromatography A* 1334: 126-138.

NIST Report Invites Public Comment on Challenges of Cloud Computing for Forensic Investigators

NIST has issued a draft report summarizing 65 challenges that cloud computing poses to forensic investigators who use digital evidence to solve crimes. The working group, which prepared the report *NIST Cloud Computing Forensic Science Challenges*, is an international body of cloud and digital forensic experts from industry, government and academia.

Through the report, the working group aims to initiate a dialogue on forensic science concerns in cloud computing ecosystems. "The long-term goal of this effort," explains NIST's Martin Herman, co-chair of the working group, "is to build a deeper understanding of, and consensus on, the high-priority challenges so that the public and private sectors can collaborate on effective responses."

The characteristics that make cloud computing so attractive also create challenges for forensic investigators who must track down evidence in the ever-changing cloud computing environments. Even if they seize a tablet or laptop computer at a crime scene, digital crime fighters could come up empty handed if these devices are linked to pooled resources in the cloud.

The draft report is available at http://csrc.nist.gov/publications/PubsDrafts.html.

NIST Mobile Device Forensics Workshop Helps Investigators Keep Pace with Technology

More than 1,000 people attended an all-day mobile forensics workshop held at NIST on June 18 – most of them via an online webcast. While about 50 people came to Gaithersburg., Md., for the workshop, 989 people viewed it online on June 18. Since then, nearly 400 additional people have visited the webcast archive page.

During the workshop, nine presenters covered topics such as mobile forensics tool testing at NIST, acquisition techniques from various smart phones including iPhone, Android and Blackberry devices; mobile malware and spyware apps, and the current state of mobile forensics in academia and industry. Rick Ayers, a researcher in the Software Quality Group in NIST's Information Technology Laboratory, and John Paul Jones, a program manager in Office of Special Programs, organized the workshop. Presentations and video of the event are archived and can be accessed at www.nist.gov/forensics/mobile_forensics2.cfm and www.nist.gov/forensics/nist-mobile-forensics-webcast.cfm. For more information on the NIST Computer Forensics Tool Testing Program, see www.cftt.nist.gov.

NIST Evaluates Facial Recognition Algorithms

Following the Boston Marathon bombing in April 2013, investigators pored through a vast amount of digital imagery and video in order to identify suspects. They turned to automated facial recognition systems to speed the task and were able to identify the perpetrators in a matter of days. Automated facial recognition systems can be very useful in solving crimes and maintaining security. Work at NIST is helping to ensure that these systems are accurate and reliable.

In NIST's one-to-many tests of facial recognition software, algorithms attempt to match an unknown image such as the one on the left to a different image of the same individual (right) in a large collection of 1.6 million known images. Credit: NIST

A NIST Information Access Division effort led by Patrick Grother recently released results from a Face Recognition Vendor Test that evaluated one-to-many face recognition algorithms. The 138-page NIST Interagency Report 8009, which is online at http://biometrics.nist.gov/cs_links/face/frvt/frvt2013/NIST_8009.pdf, provides core technical performance of face recognition algorithms. Face recognition algorithms were tested on reasonable quality law enforcement mugshot images as well as poor quality webcam images collected in similar detention operations and moderate quality visa application images. The webcam images were used to show how face recognition accuracy degrades in non-ideal, poorly-controlled condition such as may be found in some surveillance situations. This evaluation found that "when mugshot images from 1.6 million individuals are enrolled by the most accurate algorithm, 4.1 percent of subsequent mated searches fail to yield the correct mate in the rank one position." This study also noted that for the four developers who submitted algorithms to NIST in 2010 and 2013, accuracy improved in all cases. Read more in a NIST news story online at www.nist.gov/itl/iad/face-060314.cfm.

End Notes

The National Science Foundation has issued a call for proposals to establish industry/university cooperative research centers relevant to forensic science. The call for proposals is online at http://www.nsf.gov/pubs/2014/nsf14066/nsf14066.pdf (PDF).

A new report summarizes the efforts of the Subcommittee on Forensic Science to address concerns about the validity of forensic science methods and practices. A February 2009 National Academy of Sciences report, *Strengthening Forensic Science in the United States: A Path Forward*, raised the concerns. The White House-sanctioned Subcommittee on Forensic Science organized under the National Science and Technology Council's Committee on Science issued the new report in May. The report is available at http://www.whitehouse.gov/sites/default/files/microsites/ostp/NSTC/forensic_science___may_2014.pdf (PDF).