NIST’s Role in Forensic Science
past, current, future

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Changes in Needs/Expectations in Forensic Science Sector

- Forensic science in the U.S. is continuing in a period of changing expectations and requirements. There is growing concern about the scientific foundation, measurement rigor, and statistical validity of many forensic analyses that is leading to renewed attention to how scientific data are presented in evidentiary settings as well as to expectations of forensic science laboratories.

- In 1993, the Supreme Court ruled that “trial judges must ensure that any and all scientific testimony or evidence admitted is not only relevant but reliable”. The Court emphasized that the admissibility of evidence be based on the experts “principles and methodology“ and “not on the conclusions that they generate.”

Helping Ensure the “Science” in Forensic Science

A landmark forensics report by U.S. National Research Council of the National Academies was issued in Feb. 2009.

“With the exception of nuclear DNA analysis, no forensic method has been rigorously shown to have the capacity to consistently, and with a high degree of certainty, demonstrate a connection between evidence and a specific individual or source.”

New Role for NIST:

• National Commission on Forensic Science  
  - Was established via MoU on Feb. 8, 2013 between DOJ and NIST  
    - to help improve the reliability of forensic science data/information and to develop policy recommendations for the U.S. Attorney General.  
    - to be comprised of forensic science practitioners, academic researchers, prosecutors, defense attorneys, judges, and other relevant stakeholders

• NIST will:  
  - Co-Chair the Commission  
  - Administer Guidance Groups of subject-matter experts for specific forensic science disciplines  
  - Validate select existing forensic science methods and guidance  
  - Develop and critically evaluate new methods
NIST has a long and rich history of work in support of law enforcement.

Currently providing research and measurement services such as validated test methods, Standard Reference Materials, and Reference Data in areas such as:

- crime scene investigations
- computer forensics
- fire investigations
- drug detection
- drunk driving testing
- biometrics (fingerprints and handwriting analysis)
- firearms/ballistics
- standards for body armor, nonlethal weapons
- explosives detection technologies
- sports integrity/fairness
- genetics and DNA-based identification

that support the Departments of Defense, Justice, and Homeland Security in carrying out their programs.
NIST’s involvement in Forensic Science began in 1930’s

NBS’s William Souder

“one of the nation’s best and least known criminologists.”

Washington Post 1954
History of Forensics at NIST

The nation’s first crime lab:

Souder helped the Division of Investigation (now the FBI) establish its crime lab in 1932.

In 1935, Souder’s testimony on handwriting samples was key to convicting Richard Hauptmann in the kidnapping and murder of Charles Lindbergh’s son.

In 1933 Letter from NBS Director Lyman J. Briggs to DoJ Division of Investigation, NBS Director J. Edgar Hoover Reports on ballistics analysis, confirms that evidential bullets match a specific Colt .45 revolver.
History of Forensics at NIST

Early 1930s:
Souder was participating in 50 to 75 federal investigations/year involving:

• extortion
• kidnapping
• theft of money orders
• raised checks
• forgeries
• stolen securities
• threatening letters

As one example:

• German agents caused an American munitions shipment bound for Europe to explode in New York harbor in July 1916.

• In the early 1930s, Souder analyzed a handwritten letter from one of the agents, a critical piece of evidence in the case that eventually forced Germany to pay the United States for damages.
History of Forensics at NIST

Late 1960s:

The FBI turned to NBS for scientific and technical support for its first computerized scanning equipment to read and record fingerprint characteristics.
1971: The National Bureau of Standards established a Law Enforcement Standards Laboratory to provide coordinated efforts to support and advance standards and technology used by law enforcement officers and agencies.

This evolved into the current NIST Office of Law Enforcement Standards (OLES) whose mission is

“to help criminal justice, public safety, emergency responder, and homeland security agencies make informed procurement, deployment, training and operating decisions by developing performance standards, measurement tools, operating procedures and equipment guidelines”.

History of Forensics at NIST
History of Forensics at NIST

Continuing in the 1980’s:

- NBS publishes the *Fire Investigation Handbook* as “a reference tool designed to be used by the beginning or the experienced fire investigator.

- The National Bureau of Standards participates on the International Committee on Forensic Hair Comparisons to advance forensic hair comparison as a science.
Forensic Standard Reference Materials

- Arson
  - SRM 2285 - calibration of chromatographic instrumentation used for the classification of an ignitable liquid residue

- Alcohol in Blood
  - SRM 1828b – Ethanol in Water

- Bullet/Firearms
  - SRM 2460 – Standard Bullet
  - SRM 2461 – Standard Cartridge Case

- Drugs of Abuse:
  - SRM 1507b – THC in Urine
  - SRM 1508a - Cocaine Metabolite in Urine
  - SRM 1959 – Drugs of Abuse in Serum
  - SRM 2379, 2380 – Drugs of Abuse in Human Hair
  - SRM 2381 – Morphine and Codeine in Urine

- DNA:
  - SRM 2391c – PCR-based DNA Profiling Standard
  - SRM 2392-1 – Mitochondrial DNA Sequencing
  - SRM 2395 – Human Y-Chromosome DNA Profiling Standard

- Explosive Simulants
  - SRM 2905, 2906, 2907 – Explosives
  - RM 8107 – Additives in smokeless powder

- Microscopy Standards for Trace Evidence
  - SRM 1961, 1963a, 1965 – Particle Size Standards

- Laboratory Instrument Calibration:
  - SRM 1543 – Gas Chromatography/Mass Spec Performance Standard
  - SRM 935a – Ultraviolet absorbance Standard
  - SRM 1921b – IR Transmission Wavelength
NIST Forensics-related Databases

- **Biotechnology**
  - Special DB 130 Short Tandem Repeat DNA Internet Database

- **Chemistry**
  - SRD 1a NIST/EPA/NIH Mass Spectral Library: with Search Software NIST '11
  - SRD 115 Hydrocarbon Spectral Database

- **Fire Investigation**
  - Fire Modeling Programs
  - NIST FASTData Fire Test Database

- **Computer**
  - Special DB 28 NIST National Software Reference Library
  - Computer Forensics Tool Testing (CFTT) Project Web Site

- **Biometrics**
  - Special DB 4 - 8-Bit Gray Scale Images of Fingerprint Image Groups
  - Special DB 9, 14 - Mated Fingerprint Card Pairs
  - Special DB 10 - Supplemental Fingerprint Card Data
  - Special DB 27 - Fingerprint Minutiae from Latent Matching Tenprint Images
  - Facial Recognition Technology Database (FERET)
  - Special DB 29, 30 - Images from Paired Fingerprint Cards
  - Special DB 18 NIST Mugshot Identification Database
## Current NIST Research Activities in Support of Forensic Science

### Forensic DNA

<table>
<thead>
<tr>
<th>Funds</th>
<th>Project</th>
<th>Proj.Period</th>
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<tbody>
<tr>
<td>NIST/FBI</td>
<td>DNA extraction efficiency evaluation from various swabs</td>
<td>Continuing</td>
</tr>
<tr>
<td>NIST/FBI</td>
<td>U.S. population data with Insertion/Deletion (InDel) markers</td>
<td>Continuing</td>
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<tr>
<td>NIST/FBI</td>
<td>Evaluation of Abbott’s Plex-ID system for mtDNA base composition</td>
<td>Continuing</td>
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<tr>
<td>NIST/FBI</td>
<td>Evaluation of rapid DNA testing instruments</td>
<td>Continuing</td>
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<tr>
<td>NIJ/OLES</td>
<td>DNA stability on treated and untreated paper with room temperature storage</td>
<td>Continuing</td>
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<tr>
<td>NIJ/OLES</td>
<td>DNA extraction method improvement (collaboration with David Ross at NIST)</td>
<td>Continuing</td>
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<tr>
<td>NIJ/OLES</td>
<td>Quantitative PCR and digital PCR method evaluation for DNA quantitation</td>
<td>Continuing</td>
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<tr>
<td>NIJ/OLES</td>
<td>Concordance studies on commercial STR kits</td>
<td>Continuing</td>
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<tr>
<td></td>
<td>(with Promega, Life Technologies, &amp; Qiagen)</td>
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<tr>
<td>NIJ/OLES</td>
<td>Characterizing new autosomal and Y-chromosome STR loci</td>
<td>Continuing</td>
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<tr>
<td>NIJ/OLES</td>
<td>U.S. population data on 23 Y-STR loci (PowerPlex Y23)</td>
<td>Continuing</td>
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<tr>
<td>NIJ/OLES</td>
<td>U.S. population data on rapidly mutating (RM) Y-STR loci</td>
<td>Continuing</td>
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<tr>
<td></td>
<td>(part of international collaboration)</td>
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<tr>
<td>NIJ/OLES</td>
<td>U.S. population data on 29 autosomal STR loci (all commercial STR kit loci)</td>
<td>Continuing</td>
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<tr>
<td>NIJ/OLES</td>
<td>STR allele sequencing for variant characterization</td>
<td>Continuing</td>
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<tr>
<td>NIJ/OLES</td>
<td>Evaluation of probabilistic genotyping TrueAllele software for DNA mixture interpretation</td>
<td>Continuing</td>
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<tr>
<td>NIJ/OLES</td>
<td>Validation studies on ABI 3500 Genetic Analyzer</td>
<td>Continuing</td>
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<tr>
<td>NIJ/OLES</td>
<td>Data analysis for FBI-coordinated Consortium Validation</td>
<td>Continuing</td>
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<td></td>
<td>Project with new STR kits</td>
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Current NIST Research Activities in Support of Forensic Science (cont’d)

**Forensic Biometrics**
- NIST Face Recognition Research and Testing Continuing
- NIST Speaker Recognition and Voice Biometrics Continuing
- NIST ANSI/NIST-ITL Standard for the Interchange of Biometric Data Continuing
- NIST Conformance Testing for Biometric Data Interchange Formats Continuing

**Microbial Forensics/Detection**
- DHS, OoS Metrics for Microbial Material Characterization to Support Biological Agent Detection and Test and Evaluation 8/2012-9/2013

**Toxicology**
- NIST Urine, Blood and Breath Chemical Analysis Measurements & Standards Research(ethanol, drugs, etc.) Continuing

**Controlled Substances**
- NIST Controlled Substance Measurement & Standards Research Continuing

**Nuclear Forensics**
- DHS/DNDO/NTNFC Radiological Reference Material Development Support 04/2012-03/2013
- DHS/DNDO/NTNFC Expertise Development Post-Doctoral Fellowship 04/2012-03/2013
- DHS/DNDO/NTNFC Radiological Reference Material Development Support 04/2013-03/2014
- DHS/DNDO/NTNFC Isotopic and Assay Characterization of Ba-134 IDMS Tracer 04/2013-03/2014
- NIST Forensics Nuclear Forensic Reference Materials (RM) for Attribution of Urban Nuclear Terrorism 04/2012-10/2012

Challenge
<table>
<thead>
<tr>
<th>Category</th>
<th>Activity</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forensic Biometrics</td>
<td>NIST Face Recognition Research and Testing</td>
<td>Continuing</td>
</tr>
<tr>
<td>Crime Scene</td>
<td>NIST Sensor Research; trace gas, scent, smell, canine, etc.</td>
<td>Continuing</td>
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<td></td>
<td>NIST Sampling for Trace Biological and Other Particulate</td>
<td>Continuing</td>
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<tr>
<td>Digital Evidence</td>
<td>NIST/OLES/OAs Computer Forensics Tool Testing (CFTT)</td>
<td>Continuing</td>
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<td></td>
<td>NIST/OLES/OAs National Software Reference Library (NSRL)</td>
<td>Continuing</td>
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<tr>
<td></td>
<td>NIST/OLES/OAs Computer Forensics Reference Data Set (CFReDS)</td>
<td>Continuing</td>
</tr>
<tr>
<td>Digital Forensics</td>
<td>NIST Cloud Forensics</td>
<td>Continuing</td>
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<tr>
<td></td>
<td>NIST Rapid DNA Analysis Research and Development</td>
<td>Continuing</td>
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<tr>
<td></td>
<td>NIST Microbial DNA Analysis Research and Development</td>
<td>Continuing</td>
</tr>
<tr>
<td>Engineering Forensics</td>
<td>NIST Materials fatigue and failure analysis</td>
<td>Continuing</td>
</tr>
<tr>
<td>Environmental Forensics</td>
<td>NIST Measurement &amp; Standards Research for contaminants in the environment</td>
<td>Continuing</td>
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<tr>
<td>Explosives</td>
<td>NIST Explosive Measurements &amp; Standards Research</td>
<td>Continuing</td>
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</tbody>
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## Current NIST Research Activities in Support of Forensic Science (cont’d)

### Impression Evidence

<table>
<thead>
<tr>
<th>Organization</th>
<th>Activity Description</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIJ/OLES</td>
<td>NIST National Ballistics Imaging Comparison Proj (using SRM 2460/2461)</td>
<td>2008-2013</td>
</tr>
<tr>
<td>NIJ/OLES</td>
<td>Toolmark Indentification Proficiency Test Using Electroform Replicas</td>
<td>2008-2013</td>
</tr>
<tr>
<td>NIJ/OLES</td>
<td>The National Ballistics Imaging Comparison (NBIC) Project Utilizing SRM 2460/2461</td>
<td>2010-2015</td>
</tr>
<tr>
<td>NIJ/OLES</td>
<td>Technological Refreshment and Production of NIST SRM 2460 Standard Bullets</td>
<td>2010-2015</td>
</tr>
<tr>
<td>NIJ/OLES</td>
<td>Toolmark Identification Interlaboratory Study: Electroform Replicas</td>
<td>2010-2015</td>
</tr>
<tr>
<td>NIJ/OLES/PSU</td>
<td>Working Group on Presenting Forensic Science Evidence Using Quantitative and Qualitative Terms (QQWG)</td>
<td>November 2012 – April 2014</td>
</tr>
<tr>
<td>OLES/Cadre</td>
<td>Three-dimensional Topography System for Firearm Identification using GelSight</td>
<td>9/2012 -8/2013</td>
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</tbody>
</table>

### Trace Evidence

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<thead>
<tr>
<th>Organization</th>
<th>Activity Description</th>
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</thead>
<tbody>
<tr>
<td>NIST</td>
<td>Particle Population Chemical Composition and Morphology Analysis</td>
<td>Continuing</td>
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<tr>
<td>NIST</td>
<td>Improved Methods for Soil/Mineral, Man-Made Materials, Fiber, Particle, Dust and other Analysis</td>
<td>Continuing</td>
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<tr>
<td>NIST</td>
<td>Gunshot residue analysis research</td>
<td>Continuing</td>
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<tr>
<td>NIST</td>
<td>Nuclear and radioisotope detection and analysis</td>
<td>Continuing</td>
</tr>
</tbody>
</table>
Current NIST Research Activities in Support of Forensic Science (cont’d)

General Forensics

NIST Developing Hyperspectral Imaging Methods with visible, x-ray, EELS, Raman, IR, Mass Spec., etc. Continuing
NIST Microscopy and Microanalytical Spectroscopy and Imaging Continuing
NIST Spectroscopy: Mass, X-ray, IR, UV-Vis, Raman, Electron Energy Loss Continuing
NIST Databases: Including Mass Spec; IR; Auger; XPS; Physical and Chemical Properties; Phase Diagram; Diffraction Continuing
NIST Crystallographic, Morphologic, Molecular, Elemental, and Isotopic Composition Methods Continuing
NIST Measurement & Standards Research for chemical, biological, radiological, nuclear, explosive weapons Continuing
NIST Reference Materials for Forensic Analysis Continuing
NIJ/OLES/ Managing Shiftwork and Fatigue in Law Enforcement and Forensic Laboratories Clemson Univ 9/2011 - 12/1/2012
Helping Ensure the “Science” in Forensic Science

A landmark forensics report by U.S. National Research Council of the National Academies was issued in Feb. 2009.

“With the exception of nuclear DNA analysis, no forensic method has been rigorously shown to have the capacity to consistently, and with a high degree of certainty, demonstrate a connection between evidence and a specific individual or source.”

NIST and the Netherlands Forensic Institute (NFI) sign an MOU on Nov. 29, 2012

They agreed to collaborate through activities focused on the following areas:

- Research and development
- Development of forensic standards
- Education and training
- Forensic governance (measures to ensure the ethical, transparent and accountable practice of forensic science)
Two presentations and tours of selected labs will provide further details as to NIST’s current and anticipated role in Forensic Science

- **Memorandum of Understanding on Forensic Science between NIST and the Department of Justice**
  Mark Stolorow, Director, Law Enforcement Standards Office (OLES)

- **Forensic Science and the NIST Laboratory Programs**
  Richard Cavanagh, Director, Office of Special Programs

- **Forensic Science Lab Tours**
  Led by: Mark Stolorow, Director, OLES
  - **Fire Dynamics**: Dan Madrzykowski, EL
  - **The NIST Trace Contraband Detection Program**: Greg Gillen, MML
  - **Physical Standards and Scientific Methods for Ballistics Identification**: Richard Silver, PML