An Update on Strengthening Forensic Science in the United States – A Decade of Development at NIST

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FORENSIC SCIENCES

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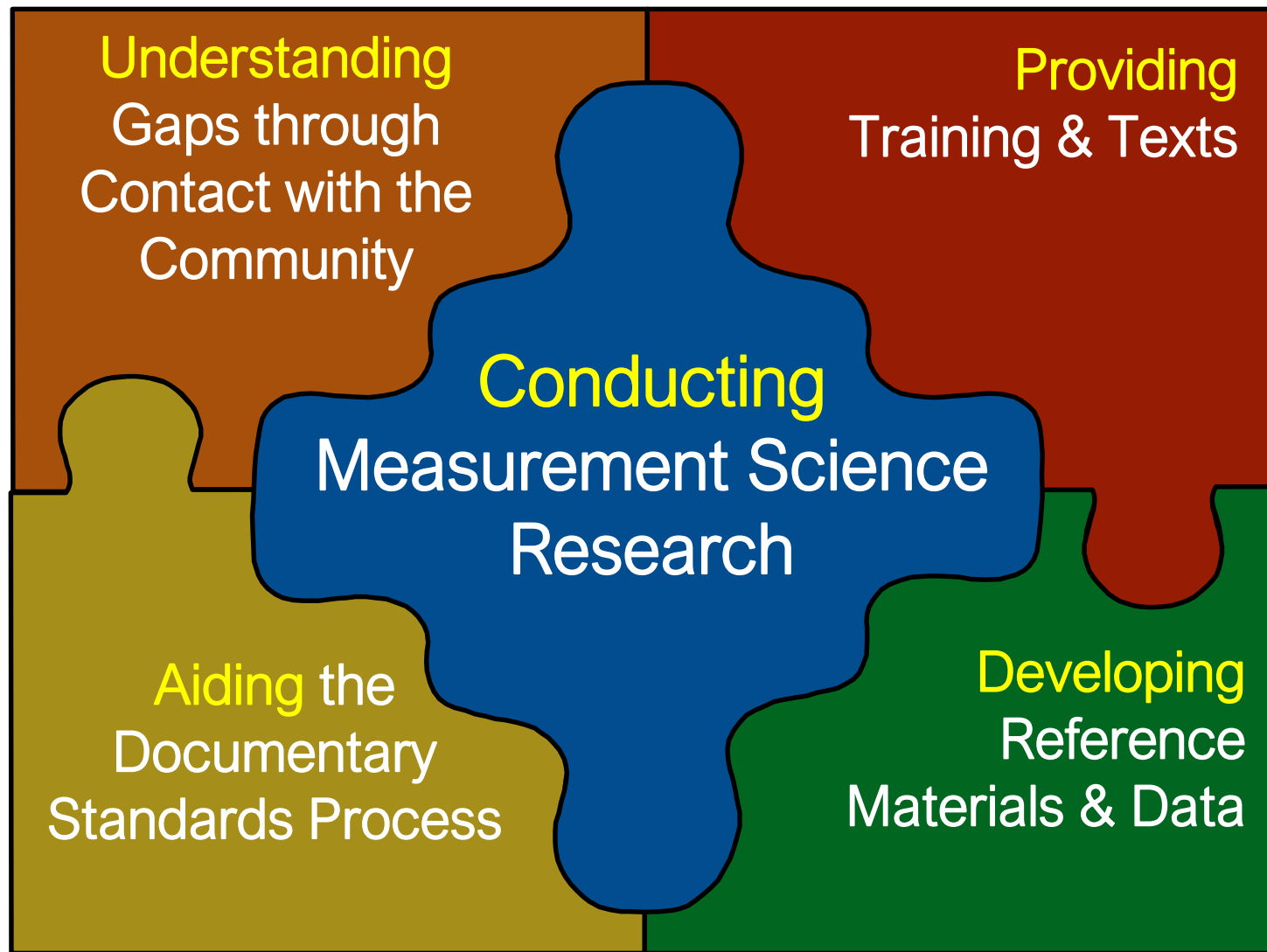
A Call to Action

"It is not, therefore, merely a question of more extensive use of instruments or of employing more instruments, but a question of determining the extent to which we can rely on a known instrument or a chemical formula to give absolute evidence. My plea is for greater knowledge of validity of such methods and the development of more valid measurements."

– L.J. O'Rourke
Proceedings of the International Association of Chiefs of Police (1936)

Forensic Science at NIST

Forensic Science at NIST

National Bureau of Standards (1901-1988)

Dr. Wilmer Souder (National Bureau of Standards, Weights and Measures Division), 1911-1954

- pioneer in precision measurements for handwriting, typewriting, and ballistics

- Souder worked on 838 cases, including almost 100 for the Department of Justice

- Law Enforcement Standards Laboratory (1971)

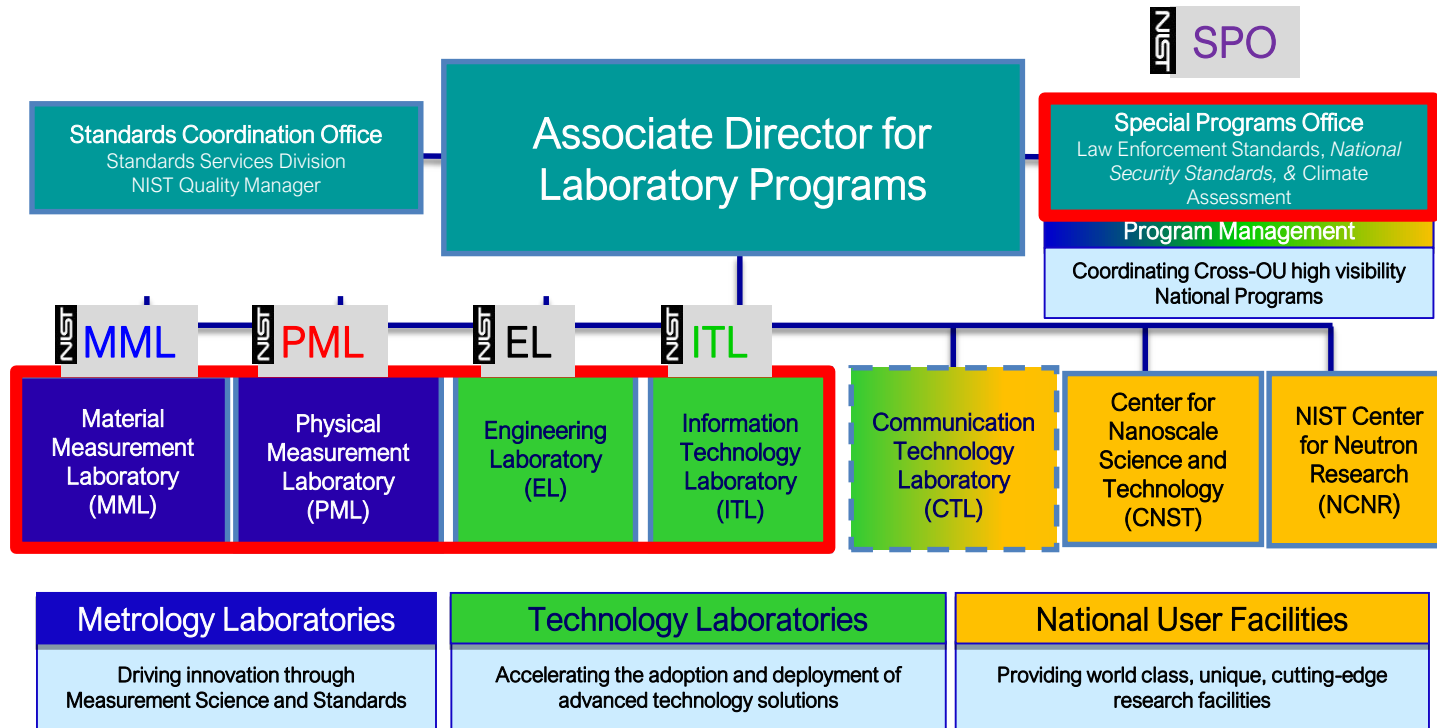- Office of Law Enforcement Standards (OLES)

National Institute of Standards and Technology (1988-present)

- Special Programs Office (SPO)

Forensic Science at NIST

NIST Laboratory Program

providing measurement solutions for industry and the nation

NIST SPO

Standards Coordination Office
Standards Services Division
NIST Quality Manager

Associate Director for Laboratory Programs

Special Programs Office
Law Enforcement Standards, *National Security Standards, &* Climate Assessment

Program Management

Coordinating Cross-OU high visibility National Programs

NIST MML   NIST PML   NIST EL   NIST ITL

| Material Measurement Laboratory (MML) | Physical Measurement Laboratory (PML) | Engineering Laboratory (EL) | Information Technology Laboratory (ITL) | Communication Technology Laboratory (CTL) | Center for Nanoscale Science and Technology (CNST) | NIST Center for Neutron Research (NCNR) |

Metrology Laboratories

Driving innovation through Measurement Science and Standards

Technology Laboratories

Accelerating the adoption and deployment of advanced technology solutions

National User Facilities

Providing world class, unique, cutting-edge research facilities

Forensic Science Research Program

Focus Areas

1. **Ballistics and Associated Toolmarks:** To produce scientifically valid mathematical and objective measurement that would ultimately support a conclusion of identification for ballistic evidence.
2. **Digital and Identification Forensics:** To promote efficient and effective use of computer technology in the investigation of crimes.
3. **Forensic Genetics:** To support accuracy and reliability in the forensic DNA typing community through the production of reference materials, characterization of forensically relevant genetic markers, and assessment of emerging technologies.
4. **Statistics:** To provide a thorough understanding of the uncertainty associated with scientific measurements or analytical techniques and a context for the interpretation of statistical results.
5. **Toxins:** To assure the quality and rigorous uncertainty determination of drug measurements while developing tools for the identification of emerging designer drugs and synthetic marijuana.
6. **Trace:** To improve trace analysis beyond class identification toward individualized interpretation, to include the application of measurement methods with defined uncertainties.

Forensic Science at NIST

MML 1. DNA

ITL 2. Digital & Fingerprints

PML 3. Firearms & Toolmarks

ITL 4. Statistics

MML 5. Toxins

MML 6. Trace

SPO

SPO invests $1.2M for each of these program areas

Ballistics and Toolmarks

Objectives: 1) Metrics, procedures, quantitative error rates and uncertainties, 2) Metrology, quality assurance, and standards, and 3) Scientific knowledge base for similarity of marks and tool mark variability.

- Quality assurance, reference artifacts, documentary standards

- Metrics and algorithms for objective identification

- Quantitative uncertainty evaluation

- Ballistics tool mark database for research and validation

- Tool mark identification for non-firearm tools

- Applications to forensic pattern matching

Digital and Identification

Objective: To provide standards and measurement to improve the quality, efficiency and understanding of digitally-based forensics

- NIST Best Practices Guide

- National Software Reference Library

- Computer Forensic Tool Testing Program - Test Reports

- Latent Fingerprint Value Prediction

Forensic Genetics Topics

Objectives: To produce reference materials to support the forensic DNA testing community, assess new technologies and genetic markers for forensic applications and support the deconvolution and interpretation of complex DNA mixtures through software exploration and inter-laboratory studies.

- Produce and maintain PCR/STR typing SRMs

- Produce and maintain a quantitation SRM

- Next Generation Sequencing

- New genetic markers

- Rapid DNA (FBI)

Statistics

Objectives: To study statistical frameworks for evaluating evidence (e.g. likelihood ratios, Bayes factors, procedural error rates), development or deployment of improved statistical models and methods for different forensics science applications, development and use of appropriate uncertainty assessments for forensic test results and use of reproducible research approaches and the common task method in forensic science research.

- Investigating Likelihood Ratios as Weight of Evidence

- Next Generation DNA Sequencing

- Likelihood Ratio Calibration

- Trace Elements in Glass SRM

Toxins

Objective: To assure the quality and rigorous uncertainty determination of drug measurements while developing tools for the identification of emerging designer drugs and synthetic marijuana.

- NIST Mass Spectral Database and Curation of SWGDRUG Library

- Field Screening Methods for Illicit Drugs (Focused on Opioids)

- Measuring Drug Background Levels on Surfaces in Forensic Laboratories

- Mass Spectral Libraries for the Opioid Crisis

- Cannabis Benchmarking by NMR Spectroscopy

- Measurements and Standards for **Δ9 THC Determination**

Trace

Objective: To improve trace analysis beyond class identification toward individualized interpretation, to include the application of measurement methods with defined uncertainties.

- Human Hair Keratin Extraction and Genetically Variant Peptide Detection

- Automotive Paint Analysis

- Validation and Performance Checks for Forensic Gunshot Residue Analysis

- Function Test Materials (FTMs) for Fingerprint Developing Reagents

- Vapor Characterization of Fire Debris and Related Matrices

- Reference Materials for Forensic Glass Analysis

Community Education

NIST has convened numerous meetings, symposia, workshops, and conferences to discuss various topics in forensic science (https://www.nist.gov/topics/forensic-science/conferences-and-events)
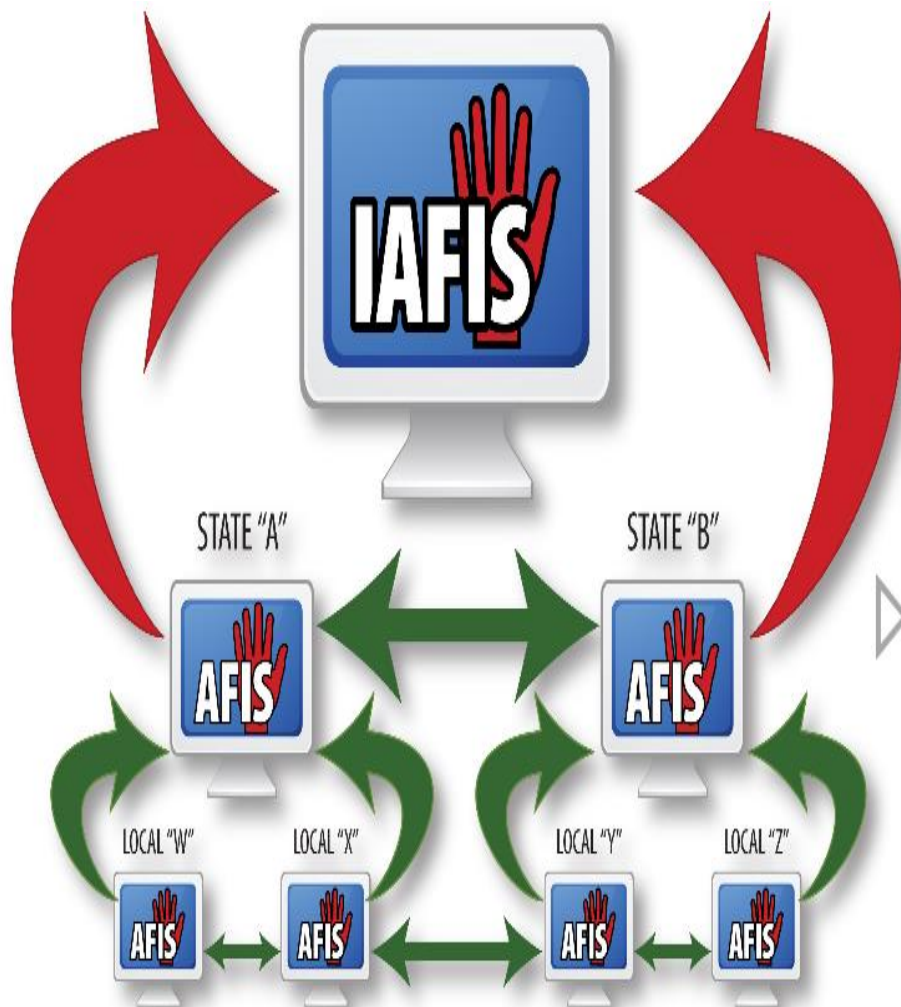
- **Measurement Science and Standards in Forensic Firearms Analysis** (July 2012)
- **Forensics@NIST** (November 2012; December 2014; November 2016; November 2018; November 2020).
- ANSI/NIST-ITL Standard Workshop (January 2013)
- DNA Analyst Training on Mixture Interpretation (April 2013)
- Emerging Trends in Synthetic Drugs Workshop (April 2013)
- Measurement Science and Standards in Forensic Handwriting Analysis (June 2013)
- Cloud Computing Forensic Science Workshop (March 2014)
- NIST Mobile Forensics Workshop (June 2014)
- ANSI/NIST-ITL 1-2011 Update (October 2014)

Community Education

- Improving Biometric and Forensic Technology: The Future of Research Datasets (January 2015)
- International Symposium on Forensic Science Error Management: Detection, Measurement, and Mitigation (July 2015; July 2017)
- Technical Colloquium: Quantifying the Weight of Forensic Evidence (May 2016; June 2017)
- Trace Evidence Data Workshop: Improving Technology and Measurement in Forensic Science (July 2016)
- Symposium on Synthetic Opioids and the Overdose Epidemic (October 2017)
- A Collaborative Exploration of Crime Laboratory Quality Infrastructure (May 2019)
- Research Innovation to Implementation Symposium (June 2019)
- Evidence Management Conference (October 2019)

AFIS Interoperability

STATE "A" STATE "B"

LOCAL "W" LOCAL "X" LOCAL "Y" LOCAL "Z"

Recommendation 12 of the report notes "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."

- NBS reports the feasibility of automated fingerprint matching in the 1960s

- First ANSI/NIST standard for fingerprint exchanges (ANSI/NBS-ICST 1-1986)

https://www.nist.gov/programs-projects/ansinist-itl-standard

NCFS (2013-2017)

In 2013, the Department of Justice (DOJ) established the NCFS as a Federal Advisory Committee, in partnership with the National Institute of Standards and Technology (NIST), to enhance the practice and improve the reliability of forensic science. This unique partnership drew upon each agency's core strengths to promote scientific validity, reduce fragmentation, and improve federal coordination of forensic science.

Dr. John M. Butler, Special Assistant to the NIST Director for forensic science, served as a vice-chair.

Main commission website: https://www.justice.gov/archives/ncfs

NCFS (2013-2017)

National Commission on
Forensic Science

Reflecting Back—
Looking Toward the Future

April 11, 2017

13 meetings resulted in 43 work products – 20 recommendations to the Attorney General and 23 views of the Commission
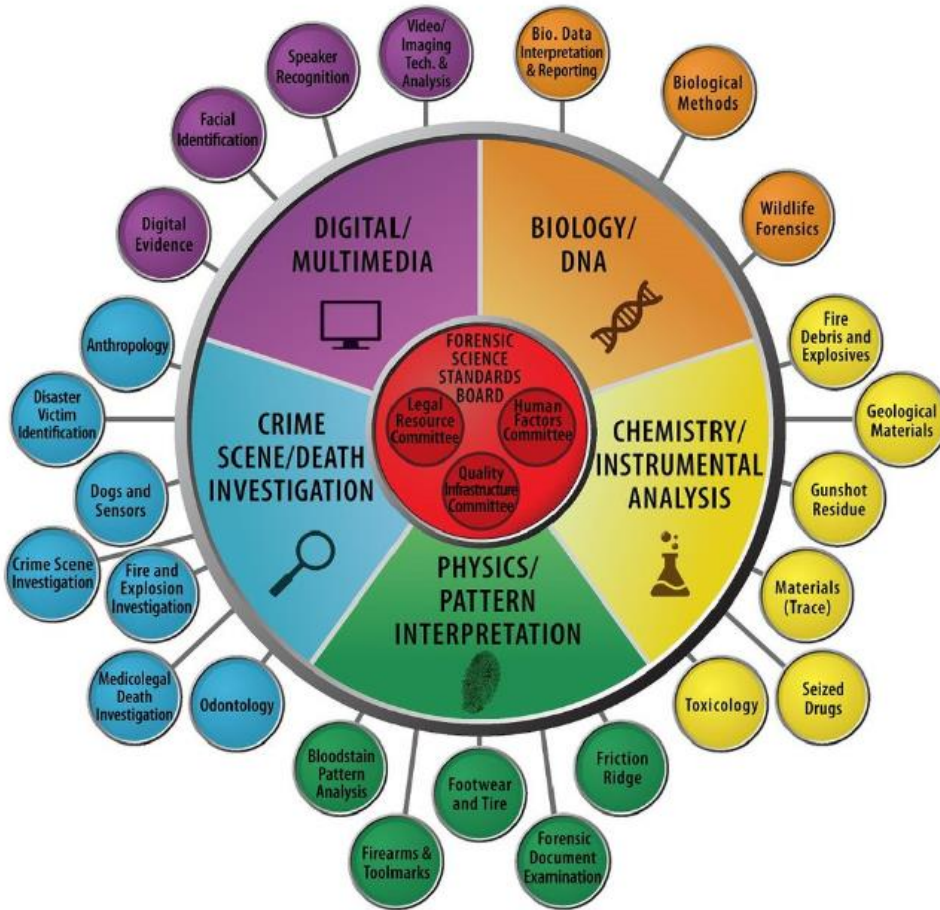
- The summary report is available (https://www.justice.gov/archives/ncfs/page/file/959356/download)

- NIST maintains an archive of video recordings of the NCFS meetings (https://www.nist.gov/topics/forensic-science/national-commission-forensic-science)

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Organization of Scientific Area Committees

"Strengthening the nation's use of forensic science by facilitating the development of technically sound standards and guidelines and encouraging their use throughout the forensic science community."

Administered by NIST, the Organization of Scientific Area Committees (OSAC) for Forensic Science is a collective body of more than 550+ forensic science practitioners and other experts representing all levels of the government, academia, and industry.
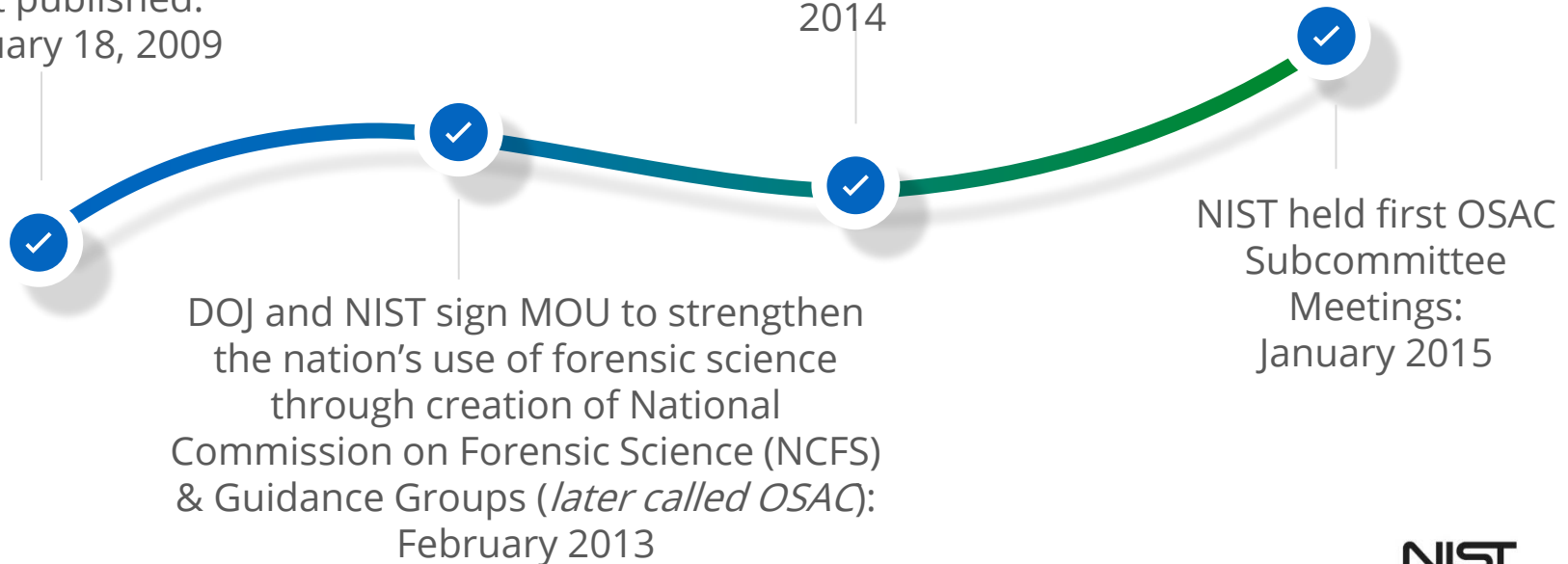
5 Scientific Area Committees

25 subcommittees

Organization of Scientific Area Committees

OSAC
Organization of Scientific Area
Committees for Forensic Science

National Academy of Sciences (NAS) Report published: February 18, 2009

NIST announces creation of OSAC at NCFS: February 4, 2014

DOJ and NIST sign MOU to strengthen the nation's use of forensic science through creation of National Commission on Forensic Science (NCFS) & Guidance Groups (*later called OSAC*): February 2013

NIST held first OSAC Subcommittee Meetings: January 2015

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Organization of Scientific Area Committees

What OSAC...

DOES

Facilitates development of science-based standards through the formal SDO processes ✓

Evaluates existing standards published by SDOs for placement on the OSAC Registry ✓

Endorses standards on the Registry & **promotes** their implementation ✓

DOESN'T

✕ Publish standards

✕ Have the authority to enforce standards

Slide from John Paul Jones (October 2019 OSAC New Member Training

NIST Foundation Reviews

NATIONAL COMMISSION ON FORENSIC SCIENCE

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Views of the Commission
Technical Merit Evaluation of
Forensic Science Methods and Practices

June 21, 2016

1) All forensic science methodologies should be evaluated by an independent scientific body to characterize their capabilities and limitations in order to accurately and reliably answer a specific and clearly defined forensic question. The independent scientific body should evaluate how forensic science test methods and practices meet the standards of technical merit as defined in the OSAC Technical Merit Worksheet.

2) The National Institute of Standards and Technology (NIST) should assume the role of independent scientific evaluator within the justice system for this purpose.

3) Additional resources should be made available to support this new capacity.

NIST Foundation Reviews

NISTIR 8225 DRAFT

NIST Scientific Foundation Reviews

John M. Butler
Melissa K. Taylor
Sheila Willis*
Special Programs Office
Associate Director of Laboratory Programs

Hari Iyer
Statistical Engineering Division
Information Technology Laboratory

Peter M. Vallone
Biomolecular Measurement Division
Material Measurement Laboratory

Rich Press
Public Affairs
Director's Office

*International Associate under contract; former director of Forensic Science Ireland

This publication is available free of charge from:
https://doi.org/10.6028/NIST.IR.8225-draft

September 2018

U.S. Department of Commerce
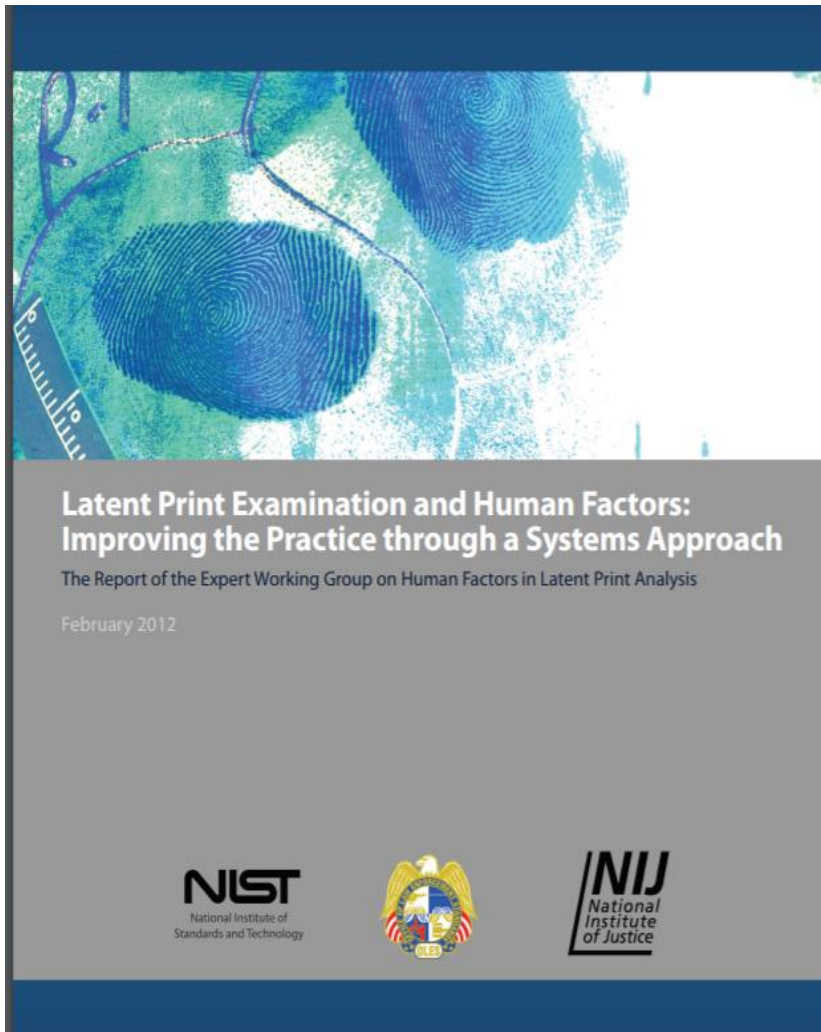*Wilbur L. Ross, Jr., Secretary*

National Institute of Standards and Technology
Walter Copan, NIST Director and Undersecretary of Commerce for Standards and Technology

Do we understand principles behind how things work and why things are done?

What data demonstrate what we think we know about the performance of a particular methodology or interpretation approach?

- **DNA mixture interpretation** (September 2017)

- **Bitemark analysis** (October 2018)

- **Firearms evidence** (October 2019)

- **Digital evidence** (an inter-laboratory study is being planned)

Human Factors Working Groups

Latent Print Examination and Human Factors: Improving the Practice through a Systems Approach

The Report of the Expert Working Group on Human Factors in Latent Print Analysis

February 2012

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National Institute of Standards and Technology

NIJ
National Institute of Justice

Errors in pattern-based forensic science disciplines can be mitigated through management of potentially biasing information

- **Latent Print Examination** (February 2012) https://nvlpubs.nist.gov/nistpubs/ir/2012/NIST.IR.7842.pdf

- Handwriting Analysis

- DNA Mixture Interpretation

- Firearms Examination

Standard Reference Materials

SRM 2460
Serial #024

NIST offers tools that help forensic crime laboratories validate their analytical methods and ensure accuracy in their test results.

- Blood alcohol (ethanol-water solutions)

- DNA (PCR-based DNA standard; Human DNA quantitation standard; mitochondrial DNA sequencing)

- Drugs of abuse (THC-COOH in urine; drugs of abuse in human hair; morphine and codeine in urine)

- Crime scene investigation (trace explosives solutions)

Center of Excellence (FSCOE)

- NIST has committed to invest $20M over 5 years (2015-2019) in the Forensic Science Center of Excellence (FSCOE)

- Goals: (1) improve the statistical foundation for pattern evidence (fingerprints, firearms, tool marks, etc.) and digital evidence (computer, video, and audio analyses) and (2) develop education and training on probabilistic methods for practitioners and other relevant stakeholders

CSAFE Projects

- Towards a Score-based Likelihood Ratio for Handwriting Evaluation

- Blind Proficiency Testing: Designing a Methodology for Forensic Laboratories

- Develop Methods for Comparisons of Cartridge Breech Face Images

- Statistical and Algorithmic Approaches to Shoeprint Analysis

- Research on Lawyers, Jurors, and the Evaluation of Forensic Evidence

- Training Forensic Practitioners in Uncertainty Measurement Error and Statistical Presentation of Forensic Evidence

- Training Statisticians in Forensic Science

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https://www.nist.gov/topics/forensic-science