

Advanced Topics for Human Identification & Data Interpretation
Chemical Heritage Foundation, Philadelphia, PA
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Considerations in Implementing New Methods for Forensic DNA

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My Background

- PhD (**Analytical Chemistry**) from University of Virginia
Research conducted at FBI Academy under Bruce McCord doing CE for STR typing (May 1993 - Aug 1995)
- NIST Postdoc – developed STRBase website
- GeneTrace Systems – **private sector experience validating assays and developing new technologies**
- NIST Human Identity Project Leader 1999 to 2013
- Since April 2013, Special Assistant to the NIST Director for Forensic Science
- Invited guest to FBI's Scientific Working Group on DNA Analysis Methods (SWGDM) since 2000
- **Member of SWGDM Validation Subcommittee** – resulting in 2004 Validation Guidelines
- Served on WTC KADAP and helped evaluate and validate new miniSTR, mtDNA, and SNP assays

Presentation Outline

- Decision to explore/adopt a new method
- Validation and efforts to define limits of a method
- Additional thoughts and **discussion**

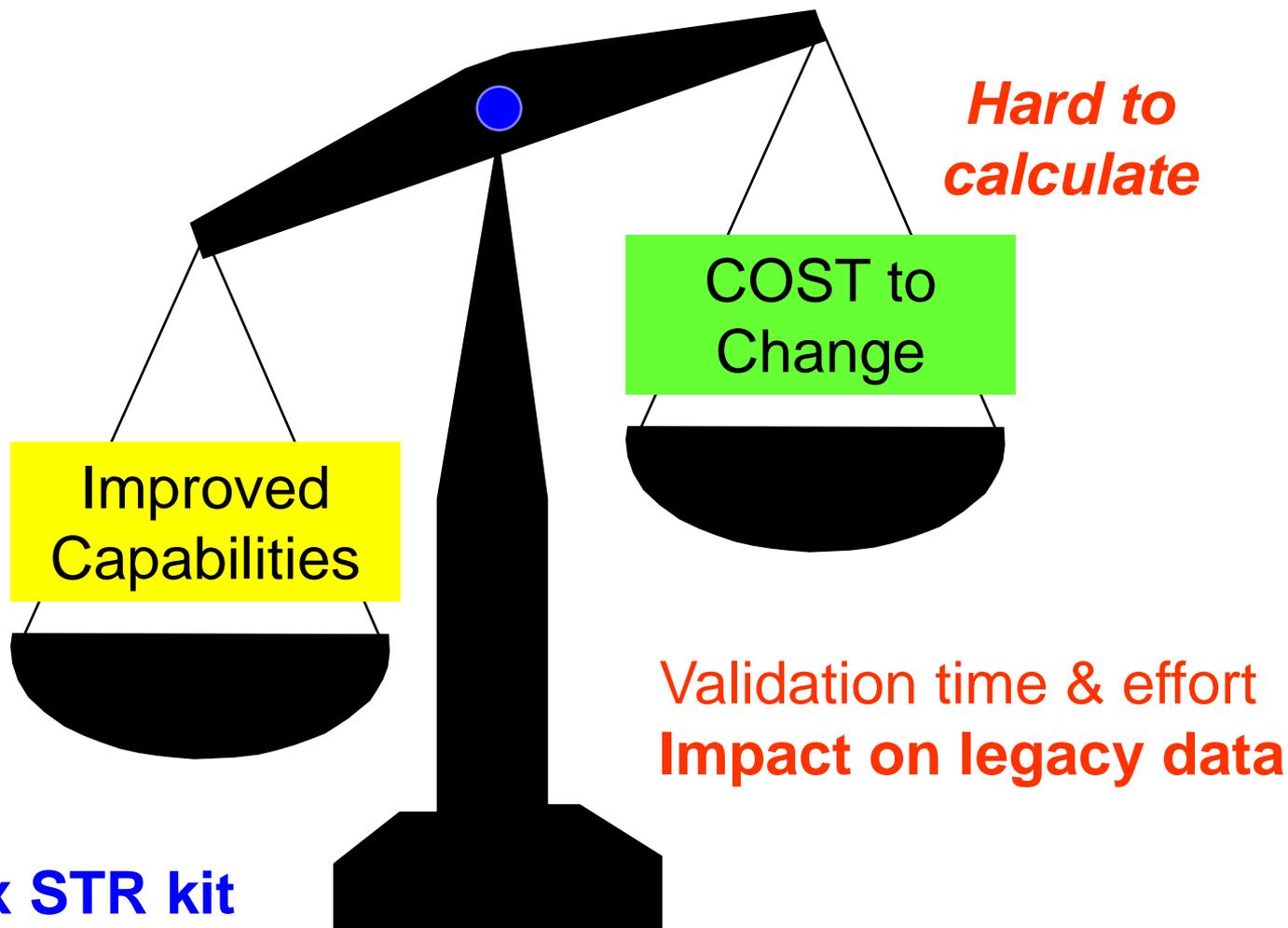
Stages of Technology for Forensic DNA Typing

- 
- Idea
 - Demonstration of feasibility
 - Research and development
 - Commercialization
 - **Validation by forensic labs**
 - Routine use by the community

TIME

MONEY

Decision to Switch/Upgrade to New Technology



New multiplex STR kit
New detection technology
New DNA markers

Thoughts on Technology Adoption

- Just because new technology exists does not mean that people should or will be able to adopt it (e.g., new iPhone 6 announced recently); many factors impact decisions besides scientific issues
- **Keep collecting data** so the community can make data-driven decisions (make the case for why a move to this new technology is beneficial)
- Stable R&D funding is required!
 - NIST Center of Excellence (\$20M)
 - NSF funding also available in addition to NIJ grants
 - Scientific prizes are being considered as well

NSF Dear Colleague Letter regarding forensic science proposals



The image is a screenshot of the National Science Foundation (NSF) website. At the top left is the NSF logo with the tagline "WHERE DISCOVERIES BEGIN". To the right is a "QUICK LINKS" button and a search bar. Below the header is a navigation menu with links for HOME, FUNDING, AWARDS, DISCOVERIES, NEWS, PUBLICATIONS, STATISTICS, ABOUT NSF, and FASTLANE. The main content area features the title "NSF 13-120" and the heading "Dear Colleague Letter: Forensic Science - Opportunity for Breakthroughs in Fundamental and Basic Research and Education". The date is listed as August 12, 2013. The text begins with "Dear Colleagues:" followed by a paragraph stating the NSF's interest in receiving proposals for existing programs in forensic sciences. A "BACKGROUND" section follows, citing a 2009 report from the National Academy of Sciences. A "DETAILS" section then explains the purpose of the letter to alert basic science and engineering communities.

NSF 13-120

Dear Colleague Letter: Forensic Science - Opportunity for Breakthroughs in Fundamental and Basic Research and Education

Date: August 12, 2013

Dear Colleagues:

The National Science Foundation (NSF) is interested in receiving proposals to existing programs in any directorate across the Foundation that address fundamental research questions which might simultaneously advance activities related to research and education in forensic sciences. Supplement requests to existing awards may also be submitted.

BACKGROUND

In 2009 the National Academy of Sciences published "[Strengthening Forensic Science in the United States: A Path Forward](#)." While the report acknowledges that "the forensic science disciplines have produced valuable evidence that has contributed to the successful prosecution and conviction of criminals as well as to the exoneration of innocent people," it cites a need for systematic research to validate the various disciplines' underlying assumptions and methodologies, adding that the "forensic science ... communities will be improved by opportunities to collaborate with the broader science and engineering communities." NSF is the only Federal agency whose mission is to support basic research at the forefront of all fields of fundamental science and engineering. It is therefore appropriate for the Foundation to support *basic* research that can inform research and education in forensic science.

DETAILS

This Dear Colleague Letter is to alert all basic science and engineering communities, including education researchers, to the Foundation's interest in receiving proposals that, while investigating fundamental questions, seek to pose and test hypotheses that could inform research in forensic sciences. The interest spans both disciplinary and interdisciplinary research. Additionally, the wide public interest in forensics can provide an effective vehicle for basic research in science education. International partnerships, where appropriate, are encouraged, as are synergistic interactions with forensics and/or law enforcement agencies and organizations. Proposals for workshops to explore fundamental science drivers and their relevance to forensics are also welcome. Proposers may review reports of recent workshops that exemplify collaborative approaches:

<http://www.nsf.gov/pubs/2013/nsf13120/nsf13120.jsp>

NSF Industry/University Research Centers



National Science Foundation
4201 Wilson Boulevard
Arlington, Virginia 22230



NSF 14-066

Dear Colleague Letter - I/UCRCs in Areas Relevant to the Forensic Sciences

May 7, 2014

Dear Colleagues,

The National Science Foundation (NSF) and the National Institute of Justice (NIJ) have partnered as co-sponsors to welcome proposals for establishment of Industry/University Cooperative Research Centers (I/UCRCs; see NSF 13-594; http://www.nsf.gov/publications/pub_summ.jsp?org=ENG&ods_key=nsf13594) in areas relevant to the forensic sciences. With permission from the Principal Investigator (PI), NIJ will share in evaluation of forensics-related I/UCRC proposals, and may co-sponsor successful proposals.

<http://www.nsf.gov/pubs/2014/nsf14066/nsf14066.pdf>

Where Is the Future Going for DNA Technology That Can Be Applied to Forensic DNA Typing?

Constant state of evolution (like computers)

- Higher levels of multiplexes
- More rapid DNA separations
- Better data analysis software
- New DNA Markers

Validating new technologies will always be important in progressive forensic DNA labs...

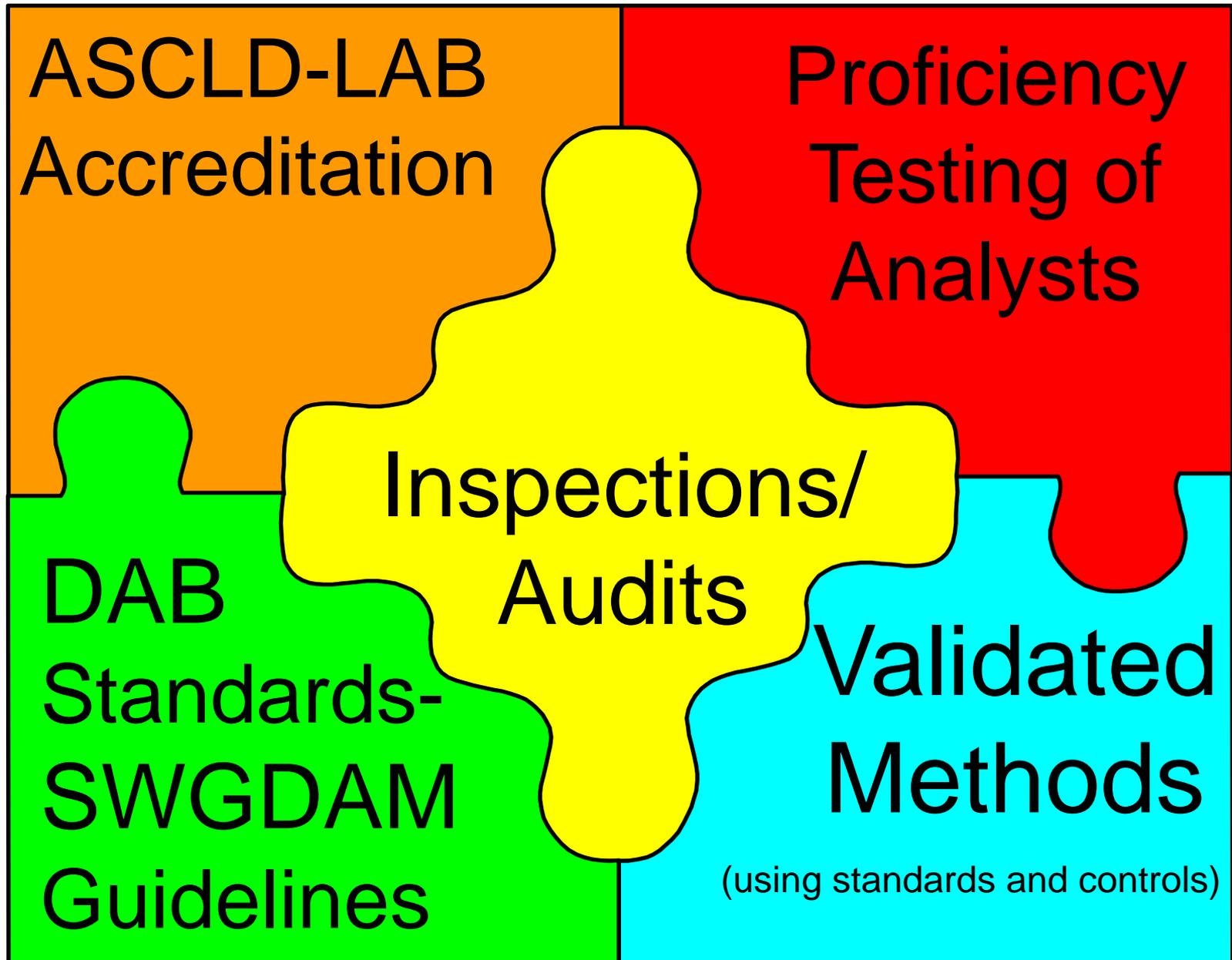
A Question We Need to Ask Ourselves...

- Do we set the bar of work in the forensic community at levels required for court or do we use a scientific bar of pursuing excellent work?

Lessons from a Recent Admissibility Hearing

- U.S. District Court Southern District of New York
 - *United States v. Johnny Morgan* (filed 3 Oct 2014)
- Attacks made against low copy number DNA testing performed by NYC OCME lab
- Court denied Morgan's motion to exclude evidence at trial of LCN test results
 - Cited *United States v. Zajac* (D. Ut. 2010) decision: "...*Daubert* does not require a validation study on every single compound tested..."

Ensuring Accurate Forensic DNA Results



Checks and Controls on DNA Results



Community	FBI DNA Advisory Board's Quality Assurance Standards (<i>also interlaboratory studies</i>)	ISO17025
Laboratory	ASCLD/LAB Accreditation and Audits	
Analyst	Proficiency Tests & Continuing Education	
Method/Instrument	Validation of Performance <i>(along with traceable standard sample)</i>	
Protocol	Standard Operating Procedure is followed	
Data Sets	Allelic ladders, positive and negative amplification controls, and reagent blanks are used	
Individual Sample	Internal size standard present in every sample	
Interpretation of Result	Second review by qualified analyst/supervisor	
Court Presentation of Evidence	Defense attorneys and experts with power of discovery requests	

Validation

Why Perform Validation Studies?

Reliability

1. Validation is part of a good quality system and is required as part of ISO 17025 accreditation

Reproducibility

2. Validated methods lead to more reliable results that in turn enable obtained results to be comparable between laboratories

Robustness

3. We want the correct answer when collecting data and we want no false negatives (if we fail to get a result from a sample, we want to have confidence that the sample contains no DNA rather than there might have been something wrong with the detection method)

Method validation is good science!

Purpose of Validation Studies

- “The purpose of validation studies is **to observe, document, and understand variation in the data generated under specific laboratory conditions**. **Validation helps define the scope or range of conditions under which reliable results may be obtained**. ... By operating within validated ranges, uncertainty in measurements made on evidentiary samples with the technique can be accurately conveyed in laboratory reports.”

There are many laboratory activities to validate...

- New STR kits
- CE instruments
- Quantitation kits or assays
- Genotyping software
- Rapid DNA instrument
- DNA extraction robotic process
- Probabilistic genotyping software

General Levels of Validation

- **Developmental Validation** – commonly performed by commercial manufacturer of a novel method or technology (more extensive than internal validation)
- **Internal Validation** – performed by individual lab when new method is introduced
- **Performance Checks** – verification of instrument or method reliability
 - With capillary electrophoresis methods, a lab can effectively do a performance check with every set of samples using the allelic ladder and internal size standard results

Validation Guidance for Forensic DNA



November 2010 ENFSI DNA Working Group Guidelines

http://www.enfsi.eu/sites/default/files/documents/minimum_validation_guidelines_in_dna_profiling_-_v2010_0.pdf

Recommended Minimum Criteria for the Validation of Various Aspects of the DNA Profiling Process

DOCUMENT TYPE :	REF. CODE:	ISSUE NO:	ISSUE DATE:
POLICY	ENFSI DNA WORKING GROUP	001	November 2010

ISO 17025
Section 5.4.5
*discusses validation
of methods*

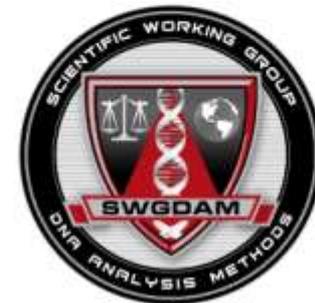
December 2012 SWGDAM Guidelines

http://swgdam.org/SWGDAM_Validation_Guidelines_APPROVED_Dec_2012.pdf

**Supersedes 2004
SWGDAM Revised
Validation
Guidelines and builds
on FBI Quality
Assurance Standards
(QAS) Section 8**

Scientific Working Group on
DNA Analysis Methods

Validation Guidelines for
DNA Analysis Methods



SWGDM 2012 Validation Guidelines

- From p. 2: “Because these are guidelines and not minimum standards, in the event of a conflict between the QAS and these guidelines, the QAS and the QAS Audit Documents have precedence over these guidelines.”

What do the FBI Quality Assurance Standards (QAS) state regarding validation?

FBI Quality Assurance Standards Section 8 on Validation

<http://www.fbi.gov/about-us/lab/biometric-analysis/codis/qas-standards-for-forensic-dna-testing-laboratories-effective-9-1-2011>

Standard 8.1 The laboratory shall use validated methodologies for DNA analyses. There are two types of validations: developmental and internal.

Standard 8.2 Developmental validation shall precede the use of a novel methodology for forensic DNA analysis.

8.2.1 **Developmental validation studies** shall include, where applicable, characterization of the genetic marker, species specificity, sensitivity studies, stability studies, reproducibility, case-type samples, population studies, mixture studies, precision and accuracy studies, and PCR-based studies. PCR-based studies include reaction conditions, assessment of differential and preferential amplification, effects of multiplexing, assessment of appropriate controls, and product detection studies. **All validation studies shall be documented.**

8.2.2 Peer-reviewed publication of the underlying scientific principle(s) of a technology shall be required.

Standard 8.3 Except as provided in Standard 8.3.1.1, internal validation of all manual and robotic methods shall be conducted by each laboratory and reviewed and approved by the laboratory's technical leader prior to using a procedure for forensic applications.

8.3.1 **Internal validation studies** conducted after the date of this revision shall include as applicable: known and non-probative evidence samples or mock evidence samples, reproducibility and precision, sensitivity and stochastic studies, mixture studies, and contamination assessment. Internal validation studies shall be documented and summarized. **The technical leader shall approve the internal validation studies.**

8.3.1.1 Internal validation data may be shared by all locations in a multi-laboratory system. Each laboratory in a multi-laboratory system shall complete, document and maintain applicable precision, sensitivity, and contamination assessment studies. The summary of the validation data shall be available at each site.

8.3.2 **Internal validation shall define quality assurance parameters and interpretation guidelines**, including as applicable, guidelines for mixture interpretation.

8.3.3 A complete change of detection platform or test kit (or laboratory assembled equivalent) shall require internal validation studies.

Standard 8.4 Before the introduction of a methodology into the laboratory, the analyst or examination team shall successfully complete a competency test to the extent of his/her/their participation in casework analyses.

Standard 8.5 The performance of a modified procedure shall be evaluated by comparison with the original procedure using similar DNA samples.

Standard 8.6 Each additional critical instrument shall require a performance check. Modifications to an instrument, such as a detection platform, that do not affect the analytical portion of the instrument shall require a performance check.

Standard 8.7 Modifications to software, such as an upgrade, shall require a performance check prior to implementation. New software or significant software changes that may impact interpretation or the analytical process shall require a validation prior to implementation.

Thank you for your attention

STRBase validation information available at:
<http://www.cstl.nist.gov/strbase/validation.htm>

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