Is Digital & Multimedia Science Really “Forensic Science”?

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Digital/Multimedia SAC Chair
Federal Bureau of Investigation
February 20, 2017
Agenda

• DMSAC Organization and Status

• Focus Areas and Challenges

• Framework for Harmonizing Forensic Science Practices and Digital/Multimedia Evidence
DMSAC Organization

- DMSAC Chair
  - Richard W. Vorder Bruegge, FBI
- DMSAC Vice Chair
  - Lam Nguyen, Mandiant
- Executive Secretary
  - Douglas Lacey, BEK TEK LLC
- Subcommittee Chairs
  - James Darnell, U.S. Secret Service
  - Lora Sims, Ideal Innovations Inc.
  - James Wayman, San Jose State University
  - Julie Carnes, Target
DMSAC Organization

• DMSAC Members
  • **Eoghan Casey, Ph.D.**, University of Lausanne, School of Criminal Sciences
  • **Matthew Graves**, United States Army Criminal Investigation Laboratory
  • **Abhyuday Mandal, Ph.D.**, University of Georgia
  • **P. Jonathon Phillips, Ph.D.**, National Institute of Standards and Technology
  • **Michael Piper**, Target Corporation
  • **Mark Pollitt, Ph.D.**, Digital Evidence Professional Services, Inc.
  • **Lawrence M. Solan**, Brooklyn Law School

• DMSAC Ex-Officio Members
  • **John F. Holloway**, Associate Dean and Exec. Dir., Quattrone Center for the Fair Administration of Justice, University of Pennsylvania (HFC)
  • **Henry R. Reeve**, Denver District Attorney's Office (LRC)
  • **Christopher Krug**, Quality Assurance Manager, Johnson County Sheriff's Office Criminalistics Laboratory (QIC)
DMSAC Status

Proposed New DMSAC Standards at ASTM E30


WK58704 * Facial Comparison Methods

WK60382 * Forensic Audio Laboratory Setup and Maintenance

WK61709 * Standard Practice for Data Retrieval from Digital CCTV System
DMSAC Status

Existing ASTM E30 Documents to be promoted to OSAC

E3016-15e1 Standard Guide for Establishing Confidence in Digital Forensic Results by Error Mitigation Analysis

E2825-12 Standard Guide for Forensic Digital Image Processing
DMSAC Status

Other Priorities for 2018

Posting Baseline Speaker Recognition Documents

Process Map for Speaker Recognition

Seeking Liaison Status for Speaker Recognition Subcommittee with ISO/IEC JTC1 SC37 WG

Training Standard across multiple OSAC Disciplines
Focus Areas and Challenges

• Some Key DMSAC (& OSAC) Challenges:
  • Accreditation
  • Conclusion Scales – Coordinate with P/PESAC
  • Terminology – Discipline-specific vs. Global
  • Error Rates through Testing Examiners
  • Foundations

• Scientific Paradigm for Digital/Multimedia Forensics
A Framework for Harmonizing Forensic Science Practices and Digital/Multimedia Evidence

Motivation, Background and Highlights
Mark Pollitt, Eoghan Casey, David-Olivier Jaquet-Chiffelle, Pavel Gladyshev
OSAC Task Group on Digital/Multimedia Science

• Primary Authors of this document:
  • Mark Pollitt
  • Eoghan Casey
  • David-Olivier Jaquet-Chiffelle
  • Pavel Gladyshev

• Contributing Members of the Task Group:
  • Martin Olivier, Michael Piper, Lam Nguyen, Henry Reeve, Marcus Rogers

• All of the DMSAC and Sub-committees participated

• The TG worked extensively with the FSSB and several members made substantial contributions to the final document.
TG Mission

• Answer the question: Where is the science in digital/multimedia (DM) forensics?
• Quest began at the very first public presentation at AAFS in Orlando (2015).
• The work continues both internally and in collaboration with the rest of OSAC
Motivation: demonstrate scientific basis

Case Example: Johnny Oquendo convicted of murdering Noel Alkaramla

- Defendant's attorney: “We're just asking for the courtroom to determine if this is good science”

- Judge: “[prosecution] failed to meet their burden of demonstrating that the science underlying Google location services has gained general acceptance in the relevant scientific community.”
DMSci TG Approach

Define
- Define “science” as it applies to “forensic science”

Define
- Define “forensic science” as it applies to DM forensics

Define
- Define “DM forensics” as it applies to our varying disciplines

Utilize
- Utilize the definitions to direct/measure/articulate the scientific aspects of our work
Gestalt: value of forensic science as a whole

More than intersection of each forensic area & foundational sciences

• Scientific reasoning and processes

• Address questions – specific to an event or a case – for legal contexts

• Provide decision-makers with trustworthy understanding of the traces

• Help decision-makers reach an informed decision
Goals: provide confidence and insights

Give decision-makers confidence in & understanding of forensic results

- Investigation
  - Assess evidence to guide investigative decisions

- Courtroom
  - Evaluate strength of evidence and help judge or jury reach a decision

- Research
  - Study evidence to establish generalized theories
Traces: what do we study?

Surveyed forensic practitioners & developed generalized definition

Any modification, subsequently observable, resulting from an event

<table>
<thead>
<tr>
<th>The nature of the modification can be</th>
<th>The trace can reveal itself</th>
</tr>
</thead>
<tbody>
<tr>
<td>• physical or virtual</td>
<td>• as a presence or</td>
</tr>
<tr>
<td>• material or immaterial</td>
<td>• as an absence</td>
</tr>
<tr>
<td>• analog or digital</td>
<td></td>
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</tbody>
</table>
Forensic questions: what are we asked?

Surveyed forensic practitioners & categorized the questions (appendix)

⇒ Systematic and coherent study of traces to address questions for a legal context:

• Authentication
• Identification
• Classification
• Reconstruction
• Evaluation
Addressing questions: scientific reasoning

1) Abductive Reasoning
   Testimony: State claims
   Investigation: Develop scenarios
   Research: Form hypotheses

2) Deductive Reasoning
   T) Fact-check claims
   I) Fact-check scenarios
   R) Test hypotheses

3) Inductive Reasoning
   T) Evaluate traces apropos of the claims
   I) Make investigative decisions
   R) Establish general theories
Scientific reasoning in forensic science

Takes into account uncertainties in activities, traces, or knowledge
Processes and activities in forensic science

Reasoning applied to core forensic process, fed by forensic activities

(*Don’t get hung up on labels! Please refer to paper for context!)
Core forensic processes: (1) Authentication

⇒ Decision process attempting to establish sufficient confidence in the truth of some claim

• The other four core forensic processes rely on the authentication of the trace(s) to be examined

• Example authentication claims:
  • This photograph is unaltered
  • This photograph was taken in Seattle
  • This photograph was taken on 30 January 2018
  • These two photos are identical at a binary level
Core forensic processes: (2) Identification

⇒ Decision process attempting to establish sufficient confidence that some identity-related information describes
  • a specific entity
  • in a given context
  • at a certain time

• Used within the authentication, classification, evaluation processes
• Applies to animate or inanimate entities, physical or virtual
  • The person in the images are the same person
  • This camera (specific) was used to take this photograph
Core forensic processes: (3) Classification

⇒ Development of taxonomies of traces and the decision process attempting to ascribe a trace with sufficient confidence to its class on the basis of characteristics that are common among traces of the same class, distinguishing them from traces of other classes.

<table>
<thead>
<tr>
<th>Taxonomy</th>
<th>Ascription</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Scientific process that creates and defines classes</td>
<td>• Process that recognizes an element as belonging to a specific class</td>
</tr>
</tbody>
</table>

• Ascription can be considered as trace identification within the context of a taxonomy.
Core forensic processes: (4) Reconstruction

⇒ Organize observed traces to disclose the most likely
  • operational conditions or capabilities (functional analysis)
  • patterns in time (temporal analysis)
  • linkages between entities - people, places, objects - (relational analysis)

• To ensure completeness & correctness, reconstruction typically relies on results from the other core forensic processes

• Reconstruction can support authentication, identification, classification, and evaluation
Core forensic processes: (5) Evaluation

⇒ Produce a value that can be fed into a decision

• Evaluation precedes every decision in the forensic lifecycle, including the other core forensic processes

• In a forensic context, at least two competing claims need to be evaluated and compared in order to prevent some forms of bias

<table>
<thead>
<tr>
<th>Evaluating Claim</th>
<th>Evaluating opposing claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The observed traces are more likely given one claim</td>
<td>• The observed traces are less likely given the other claims</td>
</tr>
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</table>
Expressing probative value of forensic findings

Strength of evidence (appropriate)

“The observed traces are more likely under the claim that the person depicted in image X is the same as the person depicted in image Y.”

Strength of hypothesis (inappropriate)

“It is more likely that the person depicted in image X is the same as the person depicted in image Y given the observed traces.”

In courtroom contexts, to avoid encroaching upon the role of decision-maker, forensic scientists must exercise caution when expressing the probative value of forensic findings, concentrating on the well-established knowledge of traces in their domain of expertise rather than on the claim under consideration.
Supporting activities and techniques

<table>
<thead>
<tr>
<th>Forensic activities</th>
<th>Operational techniques</th>
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<tbody>
<tr>
<td>(feed core forensic processes)</td>
<td>(support forensic activities)</td>
</tr>
<tr>
<td>• Survey</td>
<td>• Preservation</td>
</tr>
<tr>
<td>• Preservation</td>
<td>• Recovery</td>
</tr>
<tr>
<td>• Examination</td>
<td>• Enhancement &amp; restoration</td>
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<tr>
<td>• Documentation</td>
<td></td>
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<tr>
<td>• Analysis</td>
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<tr>
<td>• Integration</td>
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<tr>
<td>• Interpretation</td>
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Digital paradigm in forensic science

The digital paradigm provides a unique opportunity

• To revisit traditional and fundamental concepts in forensic science

• To harmonize forensic science disciplines
  • with common core principles and concepts
  • with unifying processes and definitions

• To strengthen the identity of forensic science as a whole
Recommendations

• There were seven specific recommendations articulated in this document. They revolve around three themes:
  • Discuss and develop the core concepts and terminology to further improve the framework described in this document.
  • Further explicate the scientific foundations of the processes, activities, and techniques utilized in forensic science.
  • Examine ways to minimize bias, improve the characterization of results, while improving the quality of the results.
Return to: Focus Areas and Challenges

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- Scientific Paradigm for Digital/Multimedia Forensics
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  • **Terminology** – Discipline-specific vs. Global
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  • Foundations – Questions asked and Answered

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QUESTIONS/DISCUSSION?

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