ENFSI GUIDELINE FOR EVALUATIVE REPORTING IN FORENSIC SCIENCE

Strengthening the Evaluation of Forensic Results across Europe (STEOFRAE)

European Network of
Forensic Science Institutes

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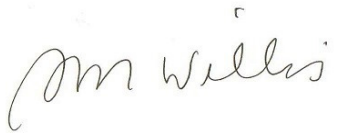
Foreword

The aim of this project is to standardise and improve evaluative reporting in ENFSI laboratories. ENFSI has always focused on improving the quality of scientific work underpinning forensic reports. However little has been done to meet the challenge of ensuring that the reports capture both the value and the limitations of the findings expressed in a manner understandable to a wide range of users including the police, lawyers and juries. In addition, Forensic Science as a recognised discipline, will not progress without a common language. Without a shared understanding of what the findings mean, forensic science will not progress and will be unable to assist judicial processes or law enforcement in addressing cross border crime. It is easy to imagine a situation where this framework will define forensic science in future. The recommendations are based on the published document of the Association of Forensic Science Providers, which itself was based on a significant body of scholarship and the formulation of principles of forensic science evaluation.

This project was undertaken by a core group of scientists from member institutes. It aimed to address the diversity of evaluative reporting across ENFSI laboratories by suggesting a standardised approach and providing support for its implementation including significant training. It is recognised that the aim of implementing a standardised approach in a wide range of evidence types in different countries is challenging and unlikely to occur overnight. The attached document contains the guideline produced; a roadmap for implementation, an auditing template and a number of worked case examples showing what aspects of the guideline are being illustrated. Most of the consultation and interaction during the three years of the project took place between the core group and ENFSI community particularly QCC and the ENFSI working groups. The core group is grateful to the ENFSI working groups for their active engagement.



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ENFSI guideline for evaluative reporting in forensic science

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1. SCOPE

1.1 This document[1] provides all reporting forensic practitioners with a recommended framework for formulating evaluative reports and related requirements for the case file.[2] An evaluative report is any forensic report containing an evaluative reporting section. It provides, ultimately, an assessment of the strength to be attached to the findings in the context of alleged circumstances. Although this guideline does not cover the requirements for intelligence, investigative or technical reporting, an evaluative report often also contains elements of technical reporting.

1.2 Forensic practitioners working with various types of known items and questioned or recovered items (e.g., traces), and different legal systems ultimately have a duty to assist the judicial system. This can be achieved by the production of intelligence, investigative, technical or evaluative reports.

1.3 Forensic practitioners will not report on matters outside their own area of expertise. Forensic practitioners will not usually give conclusions on issues that do not require specialist knowledge. However, if asked, they may do so provided it is made clear that this is not part of an expert evaluation. They should conform to the ENFSI code of conduct (BRD-GEN-003).

1.4 This document gives recommendations on the formulation of evaluative reports within a hierarchy of propositions and defines the conditions within which to operate within that hierarchy. In cases where the case information is unclear or incomplete (timing, nature of the alleged contact, recovery, etc.), it needs to be decided whether there are sufficient grounds to undertake work leading to an evaluative report or if only investigative reporting can be provided. As stated in 1.1, the requirements for such investigative reporting are not covered by the present document.

1 The elaboration of this document is based on previous works published by the Association of Forensic Science Providers (AFSP, 2009).

2 All terms underlined in the document have a definition in the glossary at the end of the document.

2. EVALUATIVE REPORTING

2.1 Evaluative reports for use in court should be produced when two conditions are met:

1. The forensic practitioner has been asked by a mandating authority or party to examine and/or compare material (typically recovered trace material with reference material from known potential sources)
2. The forensic practitioner seeks to evaluate findings with respect to particular competing propositions set by the specific case circumstances or as indicated by the mandating authority.

2.2 The evaluation section of the report shall be identified as such by the agency in order not to be confused with the other types of reporting (intelligence, investigative or technical).

2.3 Evaluation of forensic science findings in court uses probability as a measure of uncertainty. This is based upon the findings, associated data and expert knowledge, case specific propositions and conditioning information.

2.4 Evaluation will follow the principles outlined in Guidance note 1 (refer to paragraph 4.0). It is based on the assignment of a likelihood ratio. Reporting practice should conform to these logical principles. This framework for evaluative reporting applies to all forensic science disciplines. The likelihood ratio measures the strength of support the findings provide to discriminate between propositions of interest. It is scientifically accepted , providing a logically defensible way to deal with inferential reasoning. Other methods (e.g., chemometrical methods) have a place in forensic science, to help answer other questions at different points of the forensic process (e.g., validation of analytical methods, classification/discrimination of substances for investigative or technical reporting). Equally, other methods (e.g., Student's t-test) may contribute to evaluative reports, but they should be used only to characterize the findings and not to assess their strength. Forensic findings as such need to be distinguished from their evaluation in the context of the case. For the latter evaluative part only a likelihood ratio based approach is considered.

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3.0 STANDARD FRAMEWORK

3.1 The key issue(s) in the case will be established by:

- Considering all available, relevant information and, where necessary, requesting additional information
- Agreeing by discussing - when possible or necessary - with the relevant mandating authority or party (e.g., magistrate, prosecution or defence team)

3.2 On the basis of the case circumstances and the agreed key issue(s), competing propositions at a given level in the hierarchy are set [**guidance note 2**]. Propositions set should ideally not be changed at any stage unless:

- key issues in the case change and/or
- the conditioning information changes and/or
- forensic findings lead to new investigative avenues.

3.3 Pre-assessment helps achieve balance and ensures that forensic practitioners consider potential findings explicitly before the examination. It also helps the identification of the most appropriate examination strategy.

Case pre-assessment may not always be necessary for source level propositions, but should be conducted in cases when activity level propositions are set. Given the chosen propositions, and the circumstances of the case, pre-assessment aims to:

- specify main potential findings from scientific examinations of the items submitted;
- assign probabilities (at least within an order of magnitude) for potential findings regarding each proposition. This leads to likelihood ratios for potential findings at this stage.

When results are already known (e.g., results of a DNA-database search), and initial pre-assessment was not conducted, every effort should be made to avoid being led by the findings. This may involve having another practitioner carry out the assessment without the results.

3.4 If, as a result of the pre-assessment, scientific examinations are unlikely to assist in differentiating between the propositions, the mandating authority or party will be advised accordingly. It is recommended that such advice and the result of it is documented in the case file.

3.5 If a mandating authority or party dictates an examination strategy that, in the opinion of the forensic practitioner, is inappropriate then this authority or party shall be advised accordingly and the advice and conversations shall be made explicit on the case file. Any resulting limitations on the interpretation[s] shall be described in the report.

3.6 If access to relevant items is denied or unavailable then the mandating authority or party will be advised as to the limits of any resulting interpretation. This advice shall be made clear through the report.

3.7 Examination is carried out on the assumption that such items have been recovered, packaged, preserved and transported in accordance with accepted protocols or best practice unless there is good reason to believe otherwise - e.g. from the submission form, the container or packaging. In such cases further enquiries will be made and if necessary discussions will take place with the mandating authority or party to agree a way forward. This may result in the items not being examined or, if they are, any limitation that affects the results and conclusions shall be stated in the report. Also it may be decided to favour investigative reporting instead of evaluative reporting.

3.8 Pre-assessment, examinations, observations, analyses and evaluation carried out and their documentation should be valid and in accordance with an established and controlled methodology.

3.9 Pre-assessment, examinations, observations, analyses and evaluation should be made by competent and trained personnel.

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3.10 Based on the findings of the examination and their probabilities assigned during pre-assessment, a likelihood ratio is assigned. The assigned probabilities (at the pre-assessment stage) may be refined in the light of the findings e.g., a rare glass or fibre type. Justification for changes will be documented. According to their uncertainty, forensic practitioners should consider exploring the sensitivity of the likelihood ratio to different probabilities by examining the effect of assigning different probabilities (Biedermann & Taroni 2006).

3.11 The case file should include (not exhaustive list):

- Case information (verbatim, or as otherwise received)
- Mandate and questions asked, if available
- Materials and items received
- The key issue(s) and propositions of interest
- All discussions with mandating authorities and parties in the case
- Examination strategy
- Methods used
- Potential outcomes and assigned probabilities at the time when pre-assessment was carried out
- Relevant data used in probability assignments [**guidance note 3**]
- Observations made and analytical results
- Discussion and evaluation of the strength of support that the findings provide to help to resolve the issues (and related propositions) dictated by the purpose and the circumstances of the case
- Conclusions and report given to the mandating authority or party.

3.12 Reports should include (not exhaustive list):

- Conditioning information used
- Mandate and questions asked, if required
- The propositions of interest
- Relevant items collected/received
- Items examined
- Significant findings
- Discussion and evaluation
- Conclusion(s)
- A caveat that any change in conditioning information may require assessments, conclusions and/or propositions to be reviewed.

3.13 The conclusion(s) in the report shall be related to the propositions under consideration and the assigned likelihood ratio [**guidance note 4**].

3.14 The conclusion shall be expressed either by a value of the likelihood ratio and/or using a verbal scale related to the value of the likelihood ratio. The verbal equivalents shall express a degree of support for one of the propositions relative to the alternative. The choice of the reported verbal equivalent is based on the likelihood ratio and not the reverse. The report shall contain an indication of the order of magnitude of the likelihood ratio [**guidance note 4**].

4.0 GUIDANCE NOTES

Guidance Note 1: Reporting requirements

The reporting of the value of scientific findings shall conform to four requirements: Balance, Logic, Robustness and Transparency. These requirements are met by following the principles of forensic evaluation. The framework set out in this document describes the mechanism by which these requirements are met in formulating evaluative reports.

Balance - The findings should be evaluated given at least one pair of propositions: usually one based upon one party's account of the events and one based upon an alternative (opposing party's) account of the events. If no alternative can be formulated, the value of the findings cannot be assessed. In that case, forensic practitioners should state clearly that they are not reporting upon the value of the findings.

Logic – Evaluative reports should address the probability of the findings given the propositions and relevant background information and not the probability of the propositions given the findings and background information. The report should not contain statements that are transposing the conditional.

Robustness - The reporting should be capable of sustaining scrutiny and cross-examination. It should be based upon sound knowledge and experience

of the trace type(s) and the use of data (as defined in the glossary). The forensic practitioner will be satisfied that the results of the observations and analyses upon which inferences and conclusions are drawn are robust. When there are insufficient data, the likelihood ratio approach provides the practitioner with a framework for structured and logical reasoning based on his experience, as long as he can explain the grounds for his opinion together with his degree of understanding of the particular trace type.

Transparency - The reported conclusions should be derived from a demonstrable process in both the case file and the report (see also 3.11 and 3.12). The report should be written in such a way that it is suitable for a wide audience of readers (i.e., participants in the justice system). It may include supplements explaining the technical background.

Guidance Note 2: Propositions

Forensic practitioners have a duty to help the court by explaining the significance of their findings within the context of the case. When possible, the practitioner does this by considering the findings in relation to at least two competing propositions. Often the propositions are established from the prosecution and defence positions, but if this is unclear then the practitioner may propose the most reasonable propositions based on the case circumstances.

Level in the hierarchy

An evaluative statement will generally relate to propositions either at (sub-) source or activity level (e.g., Aitken et al. 2011, Cook et al. 1998a).

Activity level propositions should be used when expert knowledge is required to consider factors such as transfer mechanisms, persistence and background levels of the material which could have an impact on the understanding of scientific findings relative to the alleged activities. This is particularly important for trace materials such as microtraces (fibres, glass, gunshot residues, other particles) and small quantities of DNA, drugs or explosives.

For example, it could be misleading to factually report the presence of two rare fibres on the victim that cannot be distinguished from the suspect's jacket when the circumstances of the case and the characteristics of the fabric sug-

gest that a large number of fibres should have been found if the alleged activity has occurred.

Source level propositions are adequate in cases where there is no risk that the court will misinterpret them in the context of the alleged activities in the case. The following example illustrates this.

Example: A large fresh bloodstain is recovered at the point of entry at a burglary scene and delivered to the laboratory for DNA analysis. Combination of a presumptive test and appearance allows the scientist to safely assume that the stain is blood. A suspect says that he has never been in the premises. The set of propositions can be (1) the bloodstain came from the defendant and (2) the bloodstain came from another unknown individual.

Reporting analytical results at source level is adequate here because particular expert knowledge is not necessary for the court to interpret the findings at activity level. Because transfer and persistence are not an issue, there is no risk of the report being misleading: the source level information amounts to the activity.

This also applies to many other types of physical traces (e.g., footwear marks, toolmarks, fingermarks) – typically, marks and materials left at crime scenes. In addition, it applies to trace types such as hairs/fibres and paint when the forensic practitioner can reasonably assume that the material is the result of the alleged activity (e.g., tuft of fibres at point of entry).

In areas such as bullet and cartridge case comparisons, handwriting, speaker recognition, and physical fits, there is, in general, no distinction between source level and activity level propositions. This is because there is no risk of misinterpretation if it is assumed that the issue of source (e.g., the bullet originated from that gun or the signature is that of Mr Doe) is directly related to an activity (e.g., the bullet was fired from that gun or the signature was written by Mr Doe).

Absence of an alternative proposition

In cases where the alternative proposition is absent (e.g., one party makes "No comment"), the forensic practitioner can choose one of three options:

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- Adopt alternative propositions that most likely and reasonably reflect the party's position and prepare an evaluative report.[3] Only this option can lead to the production of an evaluative report. The report should specify that any change to the propositions (for example any new propositions proposed by the parties or mandating authority) may impact on the assessment of the strength of the forensic findings, and so will necessitate further evaluation and possibly the provision of a new report.
- Explore a range of explanations for the findings and prepare, if needed, an investigative report. Provision of such a range of explanations is not an evaluation of the probative force of the findings.
- State the findings, if needed, in a technical report . The report should stress that in the absence of an alternative proposition, it is impossible to evaluate the findings.

Absence of specified propositions

When no proposition can be specified, the forensic practitioner should provide an intelligence, an investigative or a technical report as deemed appropriate in the context of the case, making sure that they are not misleading to the reader.

Changing propositions

Propositions are not altered during examination/evaluation unless the key issues in the case and/or the conditioning information have changed. For example, when the issues at hand are at activity level, the absence of data or expert knowledge on transfer, persistence or background level of the trace type under consideration is not a justification to change the set of activity level propositions to a set of source level propositions. In fact, the choice between (sub-) source and activity should not be influenced by the availability of data or expert knowledge but solely from the consideration of factors such as transfer, persistence and background levels that could crucially affect the strength of the findings within the context of the case circumstances.

Example: In a case in which a considerable quantity of DNA was recovered from the hands of a suspect, and it is alleged that the suspect digitally penetrated a

3 Propositions should be chosen to be most relevant to the issues in the case and not chosen to maximize the likelihood ratio. For example, readers should be aware that using the proposition "he has nothing to do with it" might maximize the likelihood ratio.

victim, it is relevant to consider factors such as background and persistence of such trace material; this is particularly so if it is alleged by the suspect that recovered DNA on his fingers is the consequence of a legitimate social contact. If, in such a case, the examiner lacked the data or expert knowledge to assign probabilities given activity level propositions, it would be inappropriate to retreat to source level propositions (stating the victim versus an unrelated person as the source of the recovered DNA). The reason for this is that, firstly, it is not contested that the victim is the source of the recovered DNA (hence the propositions are irrelevant). Secondly, and more importantly, the potentially large likelihood ratio for source level propositions could be misinterpreted as extremely strong support for the alleged activity (digital penetration).

Nevertheless, if the examiner chooses in this case to report the findings at source level (arguing, for example, that the suspect is not saying anything about any alternative activity), the examiner shall explicitly state that the rarity of the profile does not address the question of the relevance of the findings in relation to the alleged activity.

Alternatively, the forensic practitioner could explain the possible activities (e.g., social contact) that may have led to the findings.

The next example illustrates the fact that propositions should not be adapted in the light of the forensic results obtained but should remain anchored on the framework of circumstances.

Example: Consider a case where it is alleged that an offender broke a double glazed window (made of two distinguishable sheets of glass denoted A and B, respectively). From the alleged circumstances, the following propositions were set to pre-assess the case at activity level: (1) the individual broke the low level double-glazed window by kicking it, versus (2) the individual has nothing to do with the breaking, nor was he near the scene. For illustration, assume that during pre-assessment the examiner expected under proposition (1) to recover from the garment worn by the offender a large amount of glass fragments from both windows. However, the examination led to the recovery of only two glass fragments of one group indistinguishable from sheet A. In such a case, the forensic findings still require to be assessed in the context of the above propositions (including the consideration of the small number of fragments associated with sheet A and the

absence of any glass fragments associated with sheet B). It would be misleading to adapt the propositions at activity level to a new pair of propositions at source level, i.e., (1) the two recovered fragments came from sheet A, vs. (2) the two recovered fragments came from an unknown source of glass.

It is recognized that there are cases where propositions are set following forensic examinations. Typical examples occur in the early stages of investigations.

Example: A body is found on the side of the road. It is not known if the person has died as a result of a traffic accident or an assault. The forensic practitioner examines the deceased's clothes and finds smears of red paint. This is communicated via an investigative report. When the police submit paint from a suspect red car, the forensic practitioner is now in a position to help formulate propositions and consider his expectations (pre-case assessment) prior to comparing the recovered and control paint.

Guidance Note 3: Data and expert knowledge used to assess the strength of the findings and assignment of likelihood ratio

Likelihood ratios are based on the assignment of the probability of the findings given each of the competing propositions. The basis for these assignments shall be documented on the case file. Relevant and appropriate published data will be used wherever possible. If appropriate published data are not available then data from unpublished sources may be used. Regardless of the existence of sources (published or not) of numerical data, personal data such as experience in similar cases and peer consultations may be used, provided that the forensic practitioner can justify the use of such data. For example, if the assessment is based on experience, the forensic practitioner will be able to demonstrate the relevant and documented previous professional activity.

In cases where the material or trace type is rarely encountered then the probabilities will be informed by either specialist knowledge and / or case tailored simulations or surveys.

Note that if a likelihood ratio cannot be assigned by the forensic practitioner (due to a lack of knowledge for example), then no appropriate evaluative assessment of the findings can be made.

Forensic practitioners often experience difficulty in assigning and justifying probabilities when the assignments are based on expert knowledge. However, likelihood ratios can be informed by subjective probabilities using expert knowledge. These probability assignments shall still be expressed by a number between 0 and 1 rather than by an undefined qualifier (such as frequent, rare, etc.). Such personal probability assignment is not arbitrary or speculative, but is based on a body of knowledge that should be available for auditing and disclosure. The forensic practitioner should not mislead the recipient of expert information as to the basis of the personal assignment, and the extent to which the assignment is supported by scientific research. Forensic practitioners should consider exploring the sensitivity of the likelihood ratio to different probabilities by examining the effect of assigning different probabilities according to their personal uncertainties.

Guidance Note 4: Meaning of the likelihood ratio in an evaluative report

The conclusion should express the degree of support provided by the forensic findings for one proposition versus the specified alternative(s) depending upon the magnitude of the likelihood ratio (LR).

For a LR assigned as one the conclusion should be to the effect that the findings provide no assistance in addressing the issue covered by the propositions. For values of LR greater than one the conclusion should be that the findings are more probable if the first proposition (in the numerator) is true rather than the alternative (in the denominator). For values of LR less than one then the conclusion should be that the findings are more probable if the alternative is true, than if the first proposition is true. This, in effect, is indicating a degree of support of the forensic findings for one proposition relative to the other.

The degree of support will relate to the magnitude of the likelihood ratio. A likelihood ratio may be expressed by a verbal equivalent according to a scale of conclusions (see also Nordgaard et al. 2012). An example is provided below for illustration purposes only:

Values* of likelihood ratio	Verbal equivalent (two options of phrasing are suggested)
1	The forensic findings do not support one proposition over the other. The forensic findings provide no assistance in addressing the issue.
2 - 10	The forensic findings provide weak support** for the first proposition relative to the alternative. The forensic findings are slightly more probable given one proposition relative to the other.
10 - 100	...provide moderate support for the first proposition rather than the alternative …are more probable given…proposition...than proposition...
100 - 1000	...provide moderately strong suppor tfor the first proposition rather than the alternative …are appreciably more probable given… proposition...than proposition...
1000 - 10,000	...provide strong support for the first proposition rather than the alternative …are much more probable given… proposition...than proposition...
10,000 - 1,000,000	...provide very strong support for the first proposition rather than the alternative …are far more probable given… proposition...than proposition...
1,000,000 and above	...provide extremely strong support for the first proposition rather than the alternative …are exceedingly more probable given… proposition...than proposition...

* Likelihood ratios corresponding to the inverse (1/X) of these values (X) will express the degree of support for the specified alternative compared to the first proposition.

** Forensic practitioners or their reports should avoid conveying the impression that a statement of the kind: "the forensic findings provide weak support for the first proposition compared to the alternative" is meaning that the findings provide (strong) support for the stated alternative. It just means that the findings are up to 10 times more probable if the first proposition is true than if the stated alternative is true. This is also the reason why the alternative should be explicitly stated. In cases where the reader could be mislead as described above, forensic practitioners shall add additional comments.

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Note that the ranges of likelihood ratio in the table above are indicative and should be seen as a continuum of expression of strength of support. It is obviously understood that a likelihood ratio of 999 is only trivially different in its overall impact from one of 1001.

Although the choice of terms, number of steps and intervals may vary between laboratories, the scale and its principles will apply across all forensic disciplines covered within a laboratory (or group of laboratories). The purpose is to assist the court in relation to the strength of the findings. Therefore, it is incorrect to use different scales for different types of evidence (e.g., DNA and glass).

When source level propositions are considered, and when the likelihood ratio amounts to the reciprocal of a conditional match probability (CMP)[4] – typically in a DNA case involving a large unmixed stain – the forensic practitioner may choose to report the conditional match probability instead of the likelihood ratio.

The categorical conclusions of identification expressed by examiners in areas such as the comparative examination of fingerprints, handwriting, signatures, tool marks, firearms, footwear marks, go beyond the sole assessment of the forensic findings. These types of conclusions sit outside the scope of the document. However, even in these cases, the strict evaluation of the strength of forensic findings associated with the comparison remains a balance between (1) the degree of correspondence between features shared by the two specimens and (2) the probability that those features would be observed in another source, which amounts to an assignment of a likelihood ratio following the principles exposed in Guidance Note 1. The examiner should also be prepared to justify this assignment following the requirements given in **guidance note 3.**

4 The term conditional match probability (CMP) expresses the probability of an adventitious correspondence conditional on a case-tailored alternative proposition. This term is more general than the more widely known but restrictive term 'random match probability (RMP)'. Note that the reporting of a CMP does not take into account the possibility of a laboratory error that would falsely associate a trace with a person of interest (Thompson et al. 2003).

5.0 Glossary

Preliminary note: Many of the distinctions between the terms described in this section are not rigid and exclusive. The reader should allow for a flexible view and accept that, in some situations, one term may appear more suitable in one situation than in another.

Case file
All laboratory notes, analytical results, calculations and correspondence associated with the case that may, under certain circumstances, be disclosed.

Classification
The assignment of a person or object to a particular category is called classification (see also examples given in the paragraph on technical reporting).

Conclusion
In evaluative reports, the conclusion is a statement that answers particular questions and is reached on the basis of a reasoning process that conforms to the principles of forensic evaluation. It is formulated as a likelihood ratio.

Data (associated with the evaluation of a given trace type)
Throughout this document, the term 'data' is not used to describe results of examinations associated with the items in the case at hand. These results are findings. The term 'data' refers to the technical and empirical knowledge associated with a given trace type. It is used to refer to general (empirical) observations, such as the occurrence of DNA profiles among members of a relevant population or the expected number of glass fragments transferred on garments as a result of breaking glass. Such data can take, for example, the structured form of scientific publications, databases or internal reports or, in addition to or in the absence of the above, be part of the expert knowledge built upon experiments conducted under controlled conditions (including case-specific experiments), training and experience.

Evidence
The term 'evidence' is generic. From a strict scientific point of view, evidence refers to outcomes of forensic examinations (findings) that, at a later point, may be used by legal decision-makers in a court of law to reach a reasoned belief about a proposition. Evidence should be a term kept for lawyers.

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Examinations (tests and analyses)
In their general meaning, examinations, tests and analyses refer to all technical operations conducted - in controlled conditions and/or according to a predefined protocol - by forensic practitioners for the purpose of making observations (that will constitute the findings) deemed to be relevant to help address the key issue(s) in a case.

Explanation
In the context of a forensic science evaluation, an explanation has been recognised as an intermediate consideration for use when exploring less formal alternatives. A key characteristic of explanations is that they are generated after the forensic findings have been obtained. While an explanation has the potential to account for particular observations, it does not qualify as a formal proposition because - often - it may be a statement of the obvious, speculative or fanciful. Moreover, an explanation can be offered provided that parties have presented no exclusive alternatives. See also Evett et al. (2000a). A few examples are given by Jackson et al. (2014, p.21):

- The mark could have been made by the defendant's shoe
- The bloodstaining on the wall could have been caused by multiple blows to the deceased's head
- The injuries are consistent with having been caused by the end of a claw hammer
- The defendant cannot be excluded as a source of the partial DNA profile seen in the mixture of DNA on the swabs

Findings
Findings are the result of observations, measurements and classification that are made on items of interest. They can be qualitative (nominal or ordinal) or quantitative (discrete or continuous). No result is also a finding. Examples for qualitative results (typically, descriptors for categories) are fibre types and blood groups. These are nominal because they have no natural ordering. Qualitative results are said to be ordinal if they have an underlying order even though it is generally not quantifiable (e.g., the damage of car involved in an accident, described as none, slight, moderate, severe, very severe). Examples for discrete quantitative results are counts of glass fragments or gunshot residues (in terms of integer values). Examples for continuous results are measurements of physical quantities such as length, weight or refractive index (in terms of any value on a continuous interval).
Generally, all results (i.e., material differentiated from the specimen and material that was not differentiated) should be included in the evaluation, as it is not balanced to assess only findings that correspond to a potential source. Observations are made in a case, not as part of a series of experiments where an outlier can be eliminated.

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Information (conditioning)
Conditioning information is the relevant case information that helps the forensic practitioner recognise the pertinent issues, select the appropriate propositions and carry out the case pre-assessment. It shall always be regarded as provisional and the examiner shall be ready to re-evaluate findings if the conditioning information changes. Examples of relevant information that could change include the nature of the alleged activities, time interval between incident and the collection of traces (and reference items) and the suspect's/victim's account of their activities.

More formally, conditioning information is an essential ingredient of the assignment of probabilities, since all probabilities are conditional. In forensic evaluation, it is important not to focus on all possible information, but only on the information that is relevant to an allegation of interest. Forensic reporting requires forensic practitioners to make clear their perception of the conditioning information at the time they conduct their examination (see also principles of forensic evaluation). Conditioning information is sometimes known as the framework of circumstances (or background information). Much of the non-scientific information will not have a bearing on the scientific findings, but it is essential to recognise those aspects that do. Further examples of relevant information include the ethnic origin of the perpetrator (not that of the suspect) and the nature of garments and surfaces. More generally, conditioning information could also be seen to include the data and knowledge that the expert uses to assign probabilities to the findings.

Key Issue(s)
The key issue(s) represent those aspects of a case on which a Court, under the law of the case, seeks to reach a judgement (Jackson et al. 2014). The key issue(s) provide the general framework within which requests to forensic practitioners and propositions (for evaluative reporting) are formally defined.

Likelihood ratio
A likelihood ratio is a measure of the relative strength of support that particular findings give to one proposition against a stated alternative (Aitken et al. 2011; Aitken & Taroni, 2004). It is defined in terms of the ratio of two conditional probabilities: (i) the probability of the findings given that one proposition is true and given the conditioning information; and (ii) the probability of the findings given that the other proposition is true and given the conditioning information. The two conditional probabilities forming the likelihood ratio shall be assigned on the basis of published data (see data as defined in this glossary) or a body of data that can be made available for peer review. Additionally, and in the absence of such data, experience or knowledge may be used. All bases used should be disclosed. The use of a likelihood ratio does not generally imply that one of the two propositions considered must be true. Though the considered propositions are those deemed most relevant, they do not need to be exhaustive, so both propositions could be false. The likelihood ratio says nothing about propositions other than the two that were considered.

Mandating authority or submitting parties
Mandating authorities or submitting parties are the persons or institutions that submit items to forensic practitioners (i.e., to the institutions to which the practitioners are affiliated).

Pre-assessment
Case pre-assessment seeks to specify potential findings prior to performing any analyses or prior to knowing the results, in order to assess the potential value associated with each of these findings, as well as the probability with which these results may be obtained under each of the competing propositions. The purpose is to (i) avoid bias in the evaluations of the findings, and (ii) devise an examination strategy on which a mandating authority or party can – in terms of expected results and associated evidential value – agree (Cook et al. 1998a). To ensure a balanced approach, forensic practitioners should – prior to any examinations – formulate potential outcomes (along with probabilities for these outcomes) given, in turn, that each of the competing propositions is true. Otherwise an evaluation may be biased. For example, a statement of the kind: 'These observations correspond well to my expectations[5] if the prosecution's proposition is true' is more trustworthy if the scientist can demonstrate that

5 Notice that this use of the term 'expectation' is a generic one and should be distinguished from its more restricted meaning and use in statistical literature.

the respective expectations (including assignments for factors such as transfer and persistence) have been formulated prior to conducting any examinations.

Principles of forensic science evaluation
The choice of probability as a measure for uncertainty suggests three precepts for evaluation in forensic science (here adapted from Evett et al. 2000b, p. 235):

1. Interpretation of scientific findings is carried out within a framework of circumstances. The interpretation depends on the structure and content of the framework.
2. Interpretation is only meaningful when two or more competing propositions are addressed.
3. The role of the forensic practitioner is to consider the probability of the findings given the propositions that are addressed, and not the probability of the propositions.

Probability, conditional
Probability is a concept by which one can express uncertainties (about an event or, more generally, an unknown state of affairs). The laws of probability define the values that probability can take and how probabilities combine (Aitken & Taroni 2004). Among forensic practitioners and other members of the judicial area at large, it is useful to view probabilities as conditioned on the information available to the individual who makes a probability assignment (i.e., all probabilities are conditional). Probabilities may be estimated from numerical data (where available and known as an objective probability) or stated as a personal degree of belief (known as a subjective probability) (Taroni et al., 2001).

Probability, subjective
Your subjective probability is the measure for your belief in the occurrence of an event. A number between 0 and 1 represents this measure. The laws of probability apply to these probabilities just as they apply to calculated probabilities.

A measure of belief might be obtained by doing thought experiments, and possibly further informed by ad hoc small-scale physical experiments. Expert knowledge elicitation is a more technical approach to obtain subjective proba-

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bilities (O'Hagan et al. 2006, Lindley 2014). Further reference about subjective probability is given in Taroni et al. (2001).

Propositions
Propositions are statements that are either true or false, and that can be affirmed or denied (Anderson et al. 2005). Propositions should be formulated in pairs (e.g., views put forward by the parties to the cases) and against a background of information and assumptions. Moreover, they should be amenable to a reasoned assignment of credibility by a judicial body and be useable for rational inference. Propositions should be distinguished from explanations that do not have the aforementioned properties. See also Evett et al. (2000a).

Proposition, alternative
An alternative proposition is mutually exclusive with respect to another competing proposition with which it forms a pair. Typically, the proposition put forward by the opposing party is referred to as an alternative proposition. Evaluative reporting requires the consideration of at least one pair of mutually exclusive propositions. It may involve the consideration of multiple pairs of propositions.

Propositions, hierarchy of
In the context of criminal proceedings, propositions can be classified into broad categories (or, hierarchical levels), such as 'crime level' (propositions that refer to the commission of a criminal offence), 'activity level' (propositions about a human activity or a happening), 'source level' (propositions about the source of physical matter). See also Cook et al. (1998b). 'Sub-source' represents a further propositional level which may be appropriate when it is not possible to attribute analytical findings to specific source material. In DNA profiling, for example, it may be that a profile cannot be attributed to a particular crime stain, item of tissue or other particularised source material. See also Evett et al. (2002).

Reporting, evaluative
Evaluative reporting evaluates the forensic findings in the light of at least one pair of propositions. It is based on a likelihood ratio and conforms to the principles of evaluation. Most of the time, evaluative reporting will follow from comparative examinations between material of unknown source and reference

material from one or more potential source(s) and/or associated activities. An evaluative report is any forensic expert report containing an evaluative reporting section.

Reporting, intelligence
In intelligence proceedings, forensic practitioners provide indicators (based on physical remnants of events) to link cases, events, and situations in the form of strategic intelligence (e.g., threat evaluation, measurement of impact of on-going crime phenomena) in order to help design strategies. This may lead to operational and investigative measures by determining trends and helping to design coordinated action. Operational measures may be crime disruption, prevention, etc. whereas investigative strategies lead to operational crime/case analysis.
Intelligence reporting addresses questions relating to phenomena and may be in the form of analytical products (such as crime pattern) or intelligence products (such as specific crime series to inform decisions on the prioritization of problems and targets).

Reporting, investigative
Investigative reporting provides explanations for technical/factual findings. The investigative approach is used when it is not possible to formulate a pair of competing propositions. This happens when there is insufficient background (conditioning) information or when the investigators requested explanations for findings at a scene and there is no obvious alternative. The absence of an alternative proposition when for example one party makes "no comment" may also lead to investigative reporting (see **guidance note 2**).

Examples of opinion in investigative reporting are:
(a) "The findings in relation to the blood on the hammer could be explained by the following:

- the hammer was used in the assault of Mr X
- the hammer was not used in the assault of Mr X, but came into contact with blood at the scene

This is not an exhaustive list of possible explanations"

(b) "In my opinion, the blood pattern is best explained by Mr X's bloodstained hair being in contact with the wall." When that type of opinion is offered, other

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potential explanations considered, and the reasons why these were considered less probable than the one explanation given, should be made explicit.

(c) "Particles characteristic of primer residues (GSR - gunshot residue) were found on the samples taken from the suspect. Possible explanations for the presence of primer residues on the samples from the hands of the suspect include that the suspect discharged a firearm, or was in the vicinity of a firearm when it was discharged or had handled a firearm or objects contaminated with gunshot residue."

Investigative reporting can also provide investigative leads following the examination of traces. Examples are:

- "The observations made on the mark suggest that it has been left by a Nike shoe, multi court III, size 47.5 (US13)."
- "The observations made on the cartridge case suggest that it has been fired by an ASTRA 9mm pistol."

Reporting, technical (factual)

In most cases, technical reporting precedes intelligence, investigative or evaluative reporting.

In a strict sense, purely technical or factual reporting amounts to a descriptive account of findings. In certain situations, the descriptive statement of observations may lead to particular conclusions, such as a statement about the nature of particular physical matter, or - more formally - the assignment of an object to a class (i.e., classification). Technical reporting is often restricted to the results associated with the observations of items. It can involve the reporting of quantitative measure(s) of an attribute (such as weight or concentration) associated with the item. These measure(s) are generally reported together with some indications of their associated uncertainties (precision, accuracy of the technique). Examination methods and analytical sensitivities will often be major constituents of technical reports. Even though such reports may contain elements of statistical evaluation, they remain descriptive and do not constitute evaluative reports as defined in this document. A technical report does not involve a formal evaluation, under a pair of competing propositions, expressed in terms of a likelihood ratio.

Below are a few examples of technical reporting:

- This electropherogram shows at that locus two peaks, one at position *a* and one at position *b*. Given the criteria for allelic designation, we can conclude that the genotype of the donor of the stain is *ab* for that locus.
- These transparent fragments have the following properties: size inferior to 2mm, anisotropic optical properties, etc. They are glass fragments.
- This powder of unknown composition has been analysed using GC-MS and FTIR. The results fulfil all the criteria to consider this substance to be cocaine. When quantified, the results showed a concentration X% (plus or minus Y%).
- The application of ESDA to the questioned document allowed the detection of the following indented numbers written on the document: 1, 10, 34, 22, 4.
- The submitted document has been produced by a xerographic device such as a laser printer.

Request(s)

The request(s) is (are) the question(s) that mandating authorities or submitting parties submit to forensic practitioners.

Strength of support of the findings

This is the expression of the extent to which the observations (i.e., findings) support one of the two competing propositions. The extent of the support is expressed to the mandating authority or party in terms of the magnitude of the likelihood ratio. It can also be expressed using a verbal scale related to the magnitude of the likelihood ratio.

Transposing the conditional

In legal contexts, a fallacious transposed conditional statement is one that equates (or, confuses) the probability of particular findings given a proposition with the probability of that proposition given these findings.

Example: Assume a large fresh bloodstain recovered from a crime scene that led to a DNA profile that corresponds to that of a suspect. If the probability of finding this DNA profile in an unknown person is, for example, 1 in 500 million, it would be fallacious to conclude that there is a probability of only 1 in 500 million that the suspect is not the donor of the stain. It is particularly important to remember this in cases in which the potential source has been found as a result of searching a – possibly large – DNA database.

References

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Nordgaard A., Ansell R., Drotz W., Jaeger L., Scale of conclusions for the value of evidence, Law, Probability and Risk, 2012, 11, 1-24.

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Thompson W.C., Taroni F, Aitken C., How the probability of a false positive affects the value of DNA evidence, Journal of Forensic Sciences, 2003, 48, 47-54.

To help putting the guideline into context, a series of worked examples have been prepared. They are all inspired from real cases as they were reported by the laboratory. They have been anonymised and slightly modified to focus only on the elements in relation to the application of the guideline. Formal/legal aspects have not been retained (e.g. reference numbers, status of the expert, use of assistants, approved procedures, etc.). The examples are provided here for illustrative purposes only. The aim is to show how evaluative statements may be prepared and to provide explanations (on the right hand side) to link with the guideline. They have not been modified or idealised. They represent the actual practice. Overall, they meet the requirements of the guideline as defined in the Audit template provided at the end of this booklet.

[DNA CASE]

Evaluative Statement

Background Information

The following is my understanding of the pertinent circumstances of this case.
During a pursuit of a car, the police observe one of the occupants throwing an object from the window.
A few minutes later, the suspect car stopped and the two policemen arrested the three occupants and drove them to the police station. One of the policemen, Officer P, went back to retrieve the object that had been thrown from the car. He found a bag containing brown powder. Officer P put on gloves before handling the bag at the scene.
The powder in the bag was analysed and found to be heroin.
All three suspects deny handling the bag. If any matching DNA is found on the recovered item, they allege that it is as a result of the contact between them and Officer P who retrieved the bag.
None of the suspects wore gloves at the time of the arrest and no gloves were found in the car.

On the left column, the reader will find the statement as it was written. On the right column, reference to the relevant section of the guideline are provided with additionnal explanations and data coming from the case file.

Evaluative reporting should be identified as such (section 2.2).

Relevant case information as understood by the forensic scientist is disclosed as part as the requirement of transparency (section 3.14 and guidance note 1). This also allows to show that the case assessment takes place in a framework of circumstances (section 2.3).

Issue

The issue in this case is whether one or more of the occupants of the car handled the bag or if some unknown person(s) did. The defence also raised the possibility that the plastic bag might have been contaminated.

Items Received

- Plastic bag containing heroin
- Reference DNA samples from Mr J, Mr H and Mr D, the occupants of the car.
- Reference DNA sample from Officer P.

Findings

A mixed DNA profile was generated from the minitape taken from the plastic bag. This profile consisted of a major profile and minor DNA elements. The minor profile consisted of a very low level profile with indications of more than one source and was unsuitable for further interpretation.

Before comparing the mixture to the persons of interest, the prospect of recovering a major profile matching the persons of interest was assigned given both propositions. Two types of transfer mechanisms (primary transfer of the offender(s), tertiary transfer of the suspect(s) from the gloves of Officer P.) were considered. If someone handles the bag with bare hands, one would expect to find a major profile in about 3 cases out of 10. One would not expect to find a major profile as a result of an extraneous contamination by Officer P. Indeed, he put on new gloves just before collecting the bag. Moreover, the collection of the bag did not take place on the scene where the persons were arrested.

The comparison of the mixture to the profiles of the person of interest (Mr J, Mr H, Mr D and Officer P) showed that the major profile matched the profile of Mr J.

Mr H, Mr D and Officer P were excluded as the sources of the major profile on the bag.

(section 3.14 and guidance note 1)
The issues are here at activity level because the interpretation of the biological evidence required the assessment of transfer, persistence and recovery (guidance note 2).

Indication of the items received as part as the requirement of transparency (section 3.14 and guidance note 1).

Description of the analysis conducted and associated results. Significant findings are presented (section 3.14).

Here, in order to avoid post hoc rationalisation, once the trace has been observed (before one does not know if the trace will be single, a mixture of two or more), transfer probabilities are assigned before considering the obtained DNA profiles.

Interpretation

In order to evaluate my findings, I have considered the following propositions:

- Mr J handled the bag of heroin
- An unknown unrelated person handled the bag of heroin, Mr J had nothing to do with the bag
  (except that he was arrested by the officer who had then collected it)

If Mr J handled the bag of heroin, I have some expectation of finding DNA matching him on the bag as was the finding in this case.
If someone else handled the bag, I have a low expectation of finding DNA that matched Mr J as a result of transfer via Officer P. A number of factors need to be in place for the DNA to transfer via Officer P. Examples of these factors are: Mr J's DNA had to transfer to Officer P's hand at some point during the arrest. When Officer P put on gloves, some of Mr J's DNA had to transfer to the outside of at least one of them, and at the same time no detectable DNA from Officer P had to transfer. When Officer P handled the bag of heroin, Mr J's DNA transferred from the glove to the bag. The amount of DNA transferred was sufficient for DNA analysis and allowed to detect a major profile.
If somebody other than Mr J handled the bag, insufficient DNA was transferred for analysis.

Therefore, in my opinion, the finding is in the order of 400 times more likely if Mr J was the person who handled the bag rather than someone else handled the bag and Mr J's DNA transferred via Officer P.

Discussion and evaluation (section 3.14).

Explicit reference is made to the propositions at hand (section 2.1 and section 3.14)

Indications of the expectation of the scientist under the first proposition. Note that it would be expected that the case notes will document the nature of the data used to reach that position (guidance note 3).

Indications of the expectation of the scientist under the alternative proposition. Case notes would also provide evidence of that assessment (guidance note 3).

Expression of the likelihood ratio (section 2.4 and guidance note 4).

Case file notes

In the case file, the following information is available:

Probability of observing DNA matching Mr J if he handled the bag (primary transfer t)

There are a number of publications on transfer of DNA following handling including:

Daly, D.J., Murphy, C. & McDermott, S.D., The transfer of touch DNA from hands to glass, fabric and wood, Forensic Science International: Genetics

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2012, 6, 41-46.
Phipps, M. & Petricevic, S., The tendency of individuals to transfer DNA to handled items, Forensic Science International, 2007, 168, 162-168.

They show that approximately 30% of plastic tubes had reportable DNA profile following holding for 10 seconds.

Polley, D. et al., An Investigation of DNA Recovery from Firearms and Cartridge Cases, Canadian Society of Forensic Science Journal, 2006, 39, 217-228.

An association between the shooter and the DNA profile was observed on 30% of the samples recovered from guns fired in the trial.

Based on the above, a value of 0.3 was assigned for t (for the probability that transfer of DNA occurred).
A value of 0.7 was assigned for t0 (for the probability that no transfer of DNA occurred).

Probability of observing DNA matching Mr J if he did not handle the bag, somebody else did

Four events have been envisaged:

1) transfer of Mr J's DNA to the hand of Officer P during the arrest (primary transfer t') and
2) transfer of Mr J's DNA from Officer P's hand to the outside of the glove(s) when he put them on before he retrieved the bag (secondary transfer ts)
3) transfer of Mr J's DNA from the glove to the bag (tertiary transfer tt) and
4) no DNA transfer from the actual person who handled the bag (t0)

Assignment of probabilities t', ts, tt and t0

The probability of transfer of Mr J's DNA to the hand of Officer P during the arrest (primary transfer t'), we could assign the same value here as for a regular touch (as in the references above) but as there may have been more contact during the arrest than touch, a value of 0.5 was assigned to t'.

To assign the probability of Mr J's DNA being transferred to the outside of the

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glove(s) of Officer P (secondary transfer ts) given that there was transfer from Mr J to Officer P's hand, we have used unpublished work (publication expected in 2015). In that study, party A rubs hands and face of party B and then touches his underpants showed that a reportable profile matching Party B was observed for 20% of tests. A value of 0.2 was assigned for ts.

For the probability of detection of Mr J's DNA following transfer from the glove to the bag (tertiary transfer tt) given that there had been secondary and primary transfer, we refer to the publication by Goray et al (2010) and Lehmann et al (2013):

Goray, M., Eken, E., Mitchell, R.J. & van Oorschot, R.A.H., Secondary DNA transfer of biological substances under varying test conditions. Forensic Science International: Genetics, 2010, 4, 62-67.

Lehmann, V.J., Mitchell, R.J., Ballantyne, K.N. & van Oorschot, R.A.H. Following the transfer of DNA: How far can it go? Forensic Science International: Genetics Supplement Series, 2013, 4, e53-e54.

There is little published data on detection of DNA profiles after tertiary transfer of touch DNA. Lehmann et al's work showed that touch DNA profiles were not detected following secondary and tertiary transfer. Goray et al. (2010) showed a loss of DNA at each transfer. Therefore there is a low expectation of observing a profile matching Mr J's DNA following tertiary transfer from the glove. A value of 0.01 was assigned for tt

For the probability of the non-transfer of reportable DNA from the person who handled the bag (tt), the value of t0 (0.7) has been used.

The likelihood ratio on this case is obtained as follows

$LR = t / (t' \times ts \times tt \times t0) \approx 400$

Note that the above LR does not account explicitly for background levels of DNA because they will impact the findings equally under both propositons.

Conclusion

The above finding provides moderately strong support for the proposition that Mr J was the person who handled the bag rather than an unknown unrelated person handled the bag of heroin and Mr J had nothing to do with the bag except that he had been arrested by Officer P who then collected the bag away from the scene putting on a new pair of gloves.

This evaluation is based on my understanding of the relevant circumstances as described above. If this assumption or any of the information is incomplete or incorrect, I will have to re-evaluate my findings.

Expression of the likelihood ratio (section 3.13 and guidance note 4).

The meaning of the likelihood ratio is conveyed (section 3.14 and guidance note 4).

To stress upon the fact that changes in the background circumstances may impact the assessment (section 3.12).

[Glass case]

Outline of the report

Evaluative Statement

Information

I understand from information supplied by the Police that at approximately 19.20 hours on 7 July 2014, an alarm was activated at a House, 123 Road, Anywhere. The Police attended and found Mr Suspect standing by a gate, in a perimeter fence, at the premises. It was noted that entry and exit to the property had been gained via a smashed window. The window (approximate size: 40 by 60 cm) appeared to have been entirely broken with a tool.

I also understand that Mr Suspect denies breaking the window, being close to the scene, or gaining entry to the premises and states he was looking for a dog. His clothing was seized at the police station 40 minutes after the alarm went off. He does not recall breaking glass in the last few days.

Links between the example statement and the guideline (numbers refer to the relevant section in the guideline)

Evaluative reporting should be identified as such (section 2.2).

Relevant case information as understood by the forensic scientist is disclosed as part as the requirement of transparency (section 3.12 and guidance note 1, Note 2).

To help decide whether one should consider an evaluation given source (sub-source) or activity level propositions, we referred to the guideline note 2: as 'transfer mechanisms, persistence and background levels of the material could have an impact on the understanding of scientific findings relative to the alleged activities', the results were assessed given activity level propositions.

*Note: The decisions to provide an evaluation given **activity level propositions** and the pair of propositions formulated were made at the pre-assessment stage of this case.*
The prosecution proposition is based upon the information about what happened at the scene and what actions the offender did. In this case there seems to be only one offender and that a window was broken to gain entry at the property. So a reasonable prosecution proposition considered was: *Mr Suspect broke the window and gained entry via the hole created.*

It is important to record what the suspect is saying about the incident as this forms the alternative or competing proposition. In this case Mr Suspect denies breaking the window, being close to the scene or gaining entry to the premises. Therefore, a reasonable alternative proposition would be: *Mr Suspect has nothing to do with the incident.*

Examples

Items Received

On 20 July three items were received at the Forensics Laboratory, from the Police:

From Mr Suspect seized at 20.09 hours on 7 July:

SM/5 Dark grey overcoat, considered as highly retentive. Given the garment, the method of breaking and the time lapse, one would expect in 8 times out of ten to find a large group of glass (more than 3 fragments) if Mr Suspect had broken the window. The prospect of finding glass matching the window was therefore considered to be different given both propositions (as one would not expect to find matching glass on a person who had nothing to do with breaking glass).

From 123 Road, taken 8 July:

SE/8 Glass sample window POE. This sample was considered as representative from the window. The items were well packaged.

Request

I have been asked to examine items taken from Mr Suspect for the presence of glass fragments and to compare any found with the broken window at the scene. This examination was done in order to help the Court assess whether the person of interest broke the window and gained entry via the hole created or if he has nothing to do with the breaking incident.

We would not take the negation and suggest as an alternative 'He did not break the window nor gained entry via the hole'. Indeed, by saying that he has nothing to do with the incident, we do not consider the possibility that he was present when someone else broke the window or that he broke it but did not gain entry or any other scenario. It is also believed that 'has nothing to do with the incident' reflects more closely the general position of the defence.

Indication of the items received as part as the requirement of transparency (section 3.12 and guidance note 1).

Here, we give our transfer probabilities in order to ensure that there is no post hoc rationalisation. We also explicit the process of broad pre-assessment.

It is important to ensure that the samples from the window are representative of the pane as a whole.

(section 3.12 and guidance note 1) – The issues are here at activity level because the interpretation of glass evidence requires the assessment of transfer, persistence and recovery (guidance note 2).
The purpose of request should reflect what you have been asked to do by the police. In addition, a summary of the propositions is also useful for the reader to gain an idea as to what the scientist is aiming to evaluate. One needs to express both propositions in order to be balanced.

Nature of Examination

When a window is broken, the majority of the glass is pushed forwards in the direction of the blow to the pane. However, a considerable number of small fragments of glass will be scattered in the direction from which the blow came. These fragments can become lodged in the clothing, hair and footwear of a person breaking glass. Glass found on clothing and shoes can be compared with control glass from the broken pane.

This can be done primarily by measuring the refractive index - a property that measures how much light is bent when it passes through the glass, and by analysing the glass to determine its chemical composition. Using these techniques, it is possible to distinguish between different types of glass (i.e., the discriminative power of the techniques is high). However, it is not possible to determine conclusively that the fragments originated from a particular source.

If the person has not broken the window and has nothing to do with the incident, then any glass found will be considered to be present as background (i.e., for some unknown reason). Data have been acquired on the presence of glass recovered on persons suspected of breaking windows (Coulson, S.A., Buckleton, J.S., Gummer, A.B. & Triggs, C.M., Glass on clothing and shoes of members of the general population and people suspected of breaking crimes. Science and Justice, 2001, 41, 39-48). I have also used a laboratory database comprising control glass items to assist in my evaluation of the findings. Indeed, elemental analysis generally enables to classify recovered glass according to its provenance (e.g., container, window). If the recovered glass is not differentiated from the window, then if the glass does not come from the broken window, then it is assumed to come from some unknown window. Whilst a cautious approach should be taken in assessing the occurrence of any particular glass, the database does provide some indication of the rarity or commonness of glass seen by forensic scientists.

Examination and Results

From 123 Road, Anywhere

Item SE/8 contained one piece of plain, flat glass, manufactured by the float process (used to make distortion free window glass) as indicated by the optical examinations. The refractive index and chemical composition of respectively 10

General explanations of the reasons why these examination may help address the issues in relation to the alleged activities. Not mandatory according to the guideline but felt helpful in this context. section 3.12 is not an exhaustive list.

This will vary from forensic laboratory and country. In this case it gives the reader a brief introduction to glass evidence evaluated given activity level propositions and what could be expected (possibly a large number of matching fragments) if the suspect broke the window.

Nature of the examination conducted in such cases. Again this will vary from forensic laboratory and country. In this case it gives the reader a brief introduction as to how glass evidence may be examined at the laboratory.

We look at glass given both views. And, explain the source of the data.

The data that helped to inform judgments are disclosed (guidance note 3).

The scientist is highlighting the potential limitations of a database being used during his/her evaluation process.

Pertinent findings are presented (section 3.12). It shows that element of technical reporting will be found and used in an evaluative report (section 1.1).

Factual findings and factual results are summarised in this section with regards

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and one samples from the window pane were determined.

From Mr Suspect
Item SM/5 comprised a grey three-quarter length coat. Over twenty fragments of glass with a freshly broken appearance were recovered from the surface of the coat. No fragments with a freshly broken appearance were found in the pockets. The coat had good retentive properties with respect to glass particles.

Eight fragments from the surface of the coat were examined. Of these, six fragments were found to form a group, indistinguishable from the control glass in refractive index. Two of these fragments were examined further and found to be indistinguishable in elemental composition from this item of control glass.

The two remaining fragments were different in refractive index from the control glass. These both had refractive indices that were indistinguishable from one another.
The matching glass had properties that had been infrequently encountered (on 19 occasions in 2326 samples) in a database of control glass items held at the laboratory.

Note: I have used the following statistical methods to assist in my determining whether or not any of the recovered glass fragments match the control glass samples(s): a dot plot, Grubbs test (for outliers) and the Welch test for the comparison of refractive indices (as temperature) and plus/minus three standard deviation of glass references/standards for elemental composition.

Evaluation

I have used the following propositions to assist in my interpretation of the findings:

- Mr Suspect broke the window and gained entry via the hole created.
- Mr Suspect has nothing to do with the incident.

In summary, a large group of glass, indistinguishable from the control glass, was found on the coat attributed to Mr Suspect. This is a pertinent finding as surveys have shown that it is unusual to find large groups of glass on the

to control samples from the scene in this case.

Factual findings and factual results are summarised in this section, regarding what was found on the suspect's clothing.

The results of the comparison of the control sample and recovered fragments tested from the suspect's clothing have been summarised. In addition, the scientist has summarised an interpretation of the findings (via statistical tests as declared below) of recovered fragments that were tested and found to be indistinguishable from the control glass sample and those recovered fragments tested that found to be different.

The Student T-test, Welch test and Grubbs tests are well documented. A good reference specifically for glass is: Curran, J.M., Hicks, T.N. & Buckleton, J.S., Forensic Interpretation of Glass Evidence. Boca Raton, CRC Press LLC, 2000.
These tests form part of staged or stepwise process of assigning a Likelihood Ratio. The second part of the process is explained below. Note: some laboratories and scientists will use a continuous approach to the LR – this was not used in this case and will not be discussed further in this example.

Part of the requirement for transparency in relation the methodology (guidance note 1 and guidance note 3). Note that dedicated statistical methods may also be used here.

Explicit reference is made to the propositions at hand
(section 2.1 and section 3.12)

These are the propositions devised at pre-assessment stage and listed previously.

Discussion and evaluation (section 3.12).
Indications that data have been used to evaluate the significance of the

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surfaces of clothing of a person from the general population. Moreover, other surveys have shown that when glass is found it is not uncommon to find non-matching glass in the presence of matching glass.

I understand that Mr Suspect has denied breaking the window, being close to the scene, or entering the premises.

Therefore, considering this information and taking both matching and non-matching glass into account, in my opinion it is far more probable (in the order of 2000 times more probable) to observe the findings if the first proposition were true rather than the alternative.

Note: The final evaluation of the evidence in this case is based upon my experience and my assessment of the likelihood ratio, in relation to the two propositions listed, along with any pertinent background information provided by police. In addition, I have used a calculation to assist in my assignment of the likelihood ratio, and a record of this, all case-notes including the other statistical calculations listed and my evaluation are contained in the case file held at the laboratory and this is available for inspection if required.

Conclusion

In my opinion, the findings provide strong support for the proposition that Mr Suspect broke the window and/or gained entry via the hole created rather than neither of these activities (i.e., the glass was present for some unknown reason). By strong support I wish to indicate that the findings are in the order of 2000 times more probable given the proposition that Mr Suspect broke the window rather than the proposition that he had nothing to do with the breaking incident.

The strength of the evidence or likelihood ratio in relation to either proposition considered is assessed on a scale of: no support for either proposition, limited, moderate, moderately strong, strong, and very strong support. Each point on the scale represents a numerical range, which has logarithmic basis such that each increment provides ten times greater support than the previous one. For example, 'moderate' has a range from 10-100 and 'moderately strong' has a range from 100-1000 and so on. A likelihood ratio of less than one takes

findings (guidance note 3).

Explicit reference is made to the case information used in the evaluation.

Expression of the likelihood ratio (section 3.14 and guidance note 4). The LR in this case was assigned as in the order of 2000. That is, the findings are 2000 times (strong) in favour of the prosecution proposition as opposed to the alternative proposition. See below for further details.

To stress upon the fact that changes in the background circumstances may impact the assessment (section 3.12).

Expression of the likelihood ratio (section 3.14 and guidance note 4). The meaning of the likelihood ratio is conveyed (guidance note 4). A LR value (order of magnitude) is given.

With reference to the scale of evidence the evaluation of the evidence equates to strong support in favour of the prosecution proposition.

The findings could be expressed numerically as: the findings are in the order of 2000 times more probable given the prosecution proposition than given the alternative proposition. However, providing a numerical result suggests that an accurate evaluation was made, in every case, therefore, in the UK, the tendency is to use the verbal equivalent. But if asked about the LR calculated during oral testimony the scientist could state 'approximately 2000 in favour of the prosecution proposition and explain why the level of accuracy is not present here, as seen in some other areas of science for example.

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the reciprocal; the equivalent is then support for the alternative proposition considered. An evaluation of 'no support for either proposition' has a value of one and indicates that one proposition is not favoured more than the other.

My conclusions are based on the results of my laboratory examination and the information made available to me at this time. If any aspects of the case should change (in particular the propositions), then I am prepared to review my conclusion in the light of such changes.

To stress again upon the fact that changes in the background circumstances may impact the assessment (section 3.12)

Case file notes

The LR given above is presented in the case file, along with all information considered during the case, the findings, results and the evaluation – all of which is peer reviewed by another expert in the relevant evidence type. It would be expected that the case notes will document the nature of the surveys and the results from their consultation. For example some of the useful survey papers used in the UK are:

McQuillan, J. & Edgar, K., A Survey of the Distribution of Glass on Clothing. Journal of the Forensic Science Society, 1992, 32, 333-348.

Lambert, J.A., Satterthwaite, M.J. & Harrison, P.H., A Survey of Glass Fragments Recovered From Clothing of Persons Suspected of Involvement in Crime. Science & Justice, 1995, 35, 273-281.

Harrison, P., Lambert, J.A. & Zoro, J.A., A Survey of Glass Fragments Recovered from Clothing of Persons Suspected of Involvement in Crime. Forensic Science International 1985, 27, 171-187.

Curran, J.M., Hicks, T.N. & Bucklet,on, J.S., Forensic Interpretation of Glass Evidence. Boca Raton, CRC Press LLC, 2000.

Coulson, S.A., Buckleton, J.S., Gummer, A.B. & Triggs, C.M., Glass on clothing and shoes of members of the general population and people suspected of breaking crimes. Science and Justice, 2001, 41, 39-48.

To assess the value of the findings we use a model. For example, we can use the likelihood ratio formula in its generic simplified form (focusing on the main term). This simple model was presented in Curran, J.M., Hicks, T.N. & Buckleton, J.S., Forensic Interpretation of Glass Evidence. Boca Raton, CRC Press LLC, 2000 page 73, with definitions) given activity level propositions for glass evidence.

$$LR = \frac{(G-M)!P_{G-M}T_{S1}T_{S2}.....T_{SM}T_0^{N-M}}{G!P_GS_{S1}S_{S2}.....S_{SM}f_1f_2.....f_M} \equiv \frac{P(E\,|\,Hp,I)}{P(E\,|\,Hd,I)}$$

- *G* Number of groups of glass on clothing
- *M* Number of Matching Groups of Glass
- *P* Probability of presence of a particular number of groups
- *S* Probability of size of group
- *T* Probability of transfer, persistence and recovery of group of glass fragments
- *f* Probability to observe the matching analytical characteristics given that the fragments are present as background and that they do not come from the control. This probability can be assigned using the proportion of glass (from one source) that match in the RI the recovered (matching) glass
- *N* Number of controls received, but not transferred

In this particular case: Only one window was broken at the scene so M = 1.

There were two groups of glass found on the clothing after the relevant tests – one forensically large group (of six fragments) indistinguishable from the control sample and one group (of two fragments) that were different from the control sample, so G = 2. In the UK there is a tendency to use a database of control glass samples to estimate to occurrence of the glass- in this case 19 occasions in 2326 or about 0.0082, we found glass that would be indistinguishable from the recovered glass using the Welch test. This is the relative frequency in the database. Other statistical approaches (.e.g., Bayesian estimators) exist that allow one to arrive at values of comparable magnitude.

The transfer or T probabilities were assigned by the scientist, based upon the scientist's experience and what happened at the scene. That is, what is the probability of transfer of no glass, a small group of glass (1-3 fragments) or a large group of glass (>3 fragments) in each case if the prosecution proposition was true P(E|Hp,I). In this case a large number of fragments matching the control were found so T is large. This was assigned a probability of 0.8 – that is in 80% of occasions the scientist would expect a large group of glass to be transferred from the breaking window to the surfaces of the coat if the suspect smashed the window and entered via the hole created.

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The P and S probabilities were obtained from the reference by Coulson, S.A., Buckleton, J.S., Gummer, A.B. & Triggs, C.M., Glass on clothing and shoes of members of the general population and people suspected of breaking crimes. Science and Justice, 2001, 41, 39-48, Table 3 - summarised from the Lambert et al. survey listed previously.

The values P relate to the probability of finding no glass, one group, two groups etc. as found in the survey. In addition the S values relate to the size of each groups found during the survey – in essence the larger the group the smaller the S value. In this case the values have been combined as the scientist has considered small or large sized groups, in line with the T values. Extra from the Table 3 in the publication:

Number of groups	Probability
0	0.40
1	0.26
2	0.12
3	0.09
4	0.05
5	0.03
6	0.02
7	0.01
8	0.00
9	0.00
10	0.00

Size of group	Probability
Small (1-3)	0.95
Large (>3)	0.05

Therefore, there were a total of two groups identified on Mr Suspect's coat, then P_G is 2 = 0.12

The number of groups identified (i.e. 2) and the number of groups matching the control sample (i.e.1) then P_{G-M} is 1 = 0.26.

A large group of matching fragments was found so S_L = 0.05.

So putting the values into the equation:

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$$LR \approx \frac{(1-1)!x0.26x0.8}{2!x0.12x0.05x0.009} \approx 2000$$

The figure obtained can be regarded as an order of magnitude, because of the data used from the surveys, database and from the scientist's experience. However, it is a fair assessment of the findings because the LR expressed in this formula allows for the transfer/persistence of glass matching the control sample and also the presence of non-matching glass on the clothing. LRs obtained between scientists may vary, although the magnitude should not differ. In the absence of data the scientist must have notes or comments on the case file reflecting the scientist's experience or encountering such findings and the evaluation.

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[SPEAKER RECOGNITION CASE]

Outline of the report

Links between the example statement and the guideline (numbers refer to the relevant section in the guideline)

Evaluative Statement

Evaluative reporting should be identified as such (section 2.2).

Information

The following information has been provided by the investigative authorities:
A man made a phone call to a private call centre, in a terrorist organization's name, from a mobile phone. The man warned that a van with a bomb containing a large amount of explosives has been parked in front of the terminal of an international airport, detailing place, model, colour, and registration plate. The man indicated that the bomb would explode approximately one hour later.
The explosion of the bomb took place as announced.
The terrorist organization claimed the attack a few days later in the local press.
As part of the on-going investigative proceedings, the police arrested a man six days after the attack.

Relevant case information as understood by the reporting examiner is disclosed as part of the requirement of transparency (section 3.12 and guidance note 1).

Items Received

The following items have been received from the investigating magistrate:

- Cassette tape related to the judicial statement made by the person of interest.
- CD with the alert recording, related to the bomb attack at the airport terminal.
- CD with speech recordings from the person of interest (tapped conversations at the prison centre, authorized by the Judge).

A full description of the features of the received items is available in the technical appendix.

Indication of the items received as part of the requirement of transparency (section 3.12 and guidance note 1).

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Issue

We have been asked to compare the unquestioned recording of the voice of the person of interest with the recording related to the airport terminal bomb alert. This examination was carried out in order to help the Court assess whether the person of interest made the bomb alert or alternatively if the person of interest has nothing to do with the incident.

Nature of Examination

Details on the nature of the examinations, factors affecting intra-speaker variation, and features of the experimental procedure are specified in our standard operating procedure (XYZ) that is available upon request.
Our analytical system has been validated through participation in recognised collaborative exercises (i.e., the NIST Evaluations, Department of Commerce of the United States of America), held from 2001 to 2008.

Examination and results

First, a statistical speech model is made from the voice of the person of interest, using the unquestioned voice recording from the phone tapped in the prison. Some experiments are carried out to check the suitability of such a recording to be used for the voice comparison. They consist of checking the channel adjustment between the suspect model and the selected reference models, and between test files (coming from people different to the suspect and recorded on the same channel as the questioned voice) and the same selected reference models.

Next, the voice comparison is carried out using a procedure that is suitable for the following pair of propositions, defined according to the issues specified above:
The recorded questioned voice and the unquestioned voice from the tapped conversation come from the same person (i.e., the person of interest).
The recorded questioned voice is that of an unknown person.

The voice comparison resulted in a score for which a likelihood ratio of about 210 was assigned. Details of all tests carried out are confined to a technical appendix.

The issue are here is at source level because there is no risk that the recipient of the expert evidence will be misled if it is assumed that the issue of source (recorded speech in a call centre) is directly related to an activity (to speak by phone at the same time). See also guidance note 2.

Indications on the nature of examinations are not mandatory for evaluative reporting. However, it can be included in the description of the analyses carried out, and associated results (section 3.12).

Pertinent findings are presented (section 3.12).

The case file will provide all the results from the software (Batvox - http://www.agnitio-corp.com/products/government/voice-recognition-system) that led to the LR of 210 quoted in the report.

Note that, when the speaker in the questioned recording is not the suspect, the technology of the speaker recognition system used in this case minimizes misleading evidence consisting of likelihood ratios higher than 1.

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Evaluation and conclusion

The findings reported in the previous section represent moderately strong support for the proposition that the questioned voice is that of the person of interest, rather than that of an unknown person recorded in similar acoustic conditions.

By 'moderately strong' we consider any result that it is in the order of 100 to 1000 times more probable if the first proposition is true rather than the alternative proposition. The qualifier 'moderately strong' is part of an assessment scale reproduced in full detail at the end of this report.

My conclusions are based on the results of my laboratory examination and the information made available to me at this time. If any aspects of the case should change, then I am prepared to review my conclusion in the light of such changes.

Full verbal scale

Supported proposition	Verbal scale	LR
First proposition is supported against the alternative proposition	Slight support /Limited support	$1 < LR \leq 10$
	Moderate support	$10 < LR \leq 100$
	Moderately strong support	$100 < LR \leq 1000$
	Strong support	$1000 < LR \leq 10000$
	Very strong support	$LR > 10000$
The alternative proposition is supported against the first proposition	Slight support /Limited support	$0.1 \leq LR < 1$
	Moderate support	$0.01 \leq LR < 0.1$
	Moderately strong support	$0.001 \leq LR < 0.01$
	Strong support	$0.0001 \leq LR < 0.001$
	Very strong support	$LR < 0.0001$

Technical appendix: [not reproduced here]

Explicit reference is made to the propositions at hand (section 2.1 and section 3.12). The conclusion is expressed in terms of the likelihood ratio (section 3.14 and guidance note 4).

The report emphasises that changes in the conditioning information may impact the assessment (section 3.10).

[FOOTWEAR MARK CASE 1]

Outline of the report

Evaluative Statement

Information

From information supplied by The Police, I understand that during 17 October to 22 October a series of burglaries took place at Scene 1, Scene 2 and Scene 3 during 19 October and Scene 4 on 21 October. It is believed that the same individual is responsible for the offences.

The Suspect was arrested in connection with the incidents and his footwear seized on 22 October. The suspect made no comment about the scenes during interview. In order to help with the issue of whether or not Mr Suspect is the person who burglarised the scenes 1,2,4 and 4, I was asked to compare the marks recovered on the scenes with Mr Suspect's shoes. In the absence of an alternative from the defence and in order to assess the findings in a balanced manner, I have assessed the value of the findings given the view that Mr Suspect's shoes made the marks on the four scenes and given the view that some unknown shoes made the marks. Should this alternative not reflect the defence's point of view then I will need to re-evaluate the evidence given this new proposition

Links between the example statement and the guideline (numbers refer to the relevant section in the guideline)

Evaluative reporting should be identified as such (section 2.2).

Relevant case information as understood by the forensic scientist is disclosed as part as the requirement of transparency (section 3.12 and guidance note 1). The information about what has happened during the incident will help identifying what is the issue and what propositions are useful. The level of hierarchy will depend on whether expert knowledge is required to consider factors such as transfer mechanisms, persistence and background levels of the material and whether they have an impact on the understanding of scientific findings relative to the alleged activities. For footwear marks, usually, source level propositions are sufficient.

Note: The decisions to provide an evaluation given source level propositions and the pair of propositions formulated were made at the pre-assessment stage of this case. The prosecution proposition is based upon the information that footwear marks were deposited at the scene. So a reasonable prosecution proposition considered was: *The marks at each scene were made by the submitted shoes from Mr Suspect*. It is important to record what the suspect is saying about the incident as this forms the alternative or competing proposition. However, in the case the suspect made no comment in interview about the scenes. In order to evaluate the findings (i.e., assign a LR) it is necessary that an alternative is considered. So here the alternative was given as: *An unknown pair of shoes are at the origin of the marks.*
If the scientist is uncomfortable in providing an alternative proposition then explanations should be considered and no LR expressed. Hence the resulting report will not be evaluative.

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Items Received

The following items were received at the Forensic Laboratory, from the Police:

Scene1

E/02 Partial footwear mark on paper
E/04 Partial footwear mark on booklet
E/05 Partial footwear mark on laminated sheet

Scene 2

D/02 Partial footwear mark on o/s front door

Scene 3

S/10 Gel lift of footwear mark on shelf

Scene 4

P/2 One piece of paper and one envelope

Suspect

RT/7 Black Reebok Trainer (left)
RT/8 Black Reebok Trainer (right)

Request

I have been asked to examine the marks on the items recovered from the scenes to determine whether or not these could have been made by the shoes submitted. The value of the results will be assessed given two propositions: Mr Suspect's shoes made the marks recovered on scene and some unknown shoes made the marks. Each scene was treated separately.

Nature of Examination

Training shoes and boots are manufactured with a wide range of sole patterns each of which is available in a range of different sizes. The dimension of the patterns will also vary between different sizes thus allowing for a degree of discrimination between different shoes and subsequent sizes.

As the footwear is worn, the whole sole pattern slowly wears away. Depending upon how a shoe is worn and how the individual walks, then some areas of the sole pattern will wear away more quickly than others. Varying degrees of

Indication of the items received as part as the requirement of transparency (section 3.12 and guidance note 1).

(section 3.12 and guidance note 1) – The issues are here at source level because the interpretation of marks does not involve special knowledge on transfer, persistence and recovery (guidance note 2).
The purpose of request should reflect what you have been asked to do by the police. In addition, a summary of the propositions is also useful for the reader to gain an idea as to what the scientist is aiming to evaluate. With multiple scenes, one can either have one pair of propositions and treat the case globally, or treat each scene separately.

General explanations of the reasons why these examination may help address the issues in relation to the alleged activities. Not mandatory according to the guideline but felt helpful in this context. section 3.12 is not an exhaustive list. This will vary from forensic laboratory and country. In this case it gives the reader a brief introduction to footwear mark evidence and what could be expected if the shoes made the marks at the scene and if they did not.

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wear across the soles can assist further in the discrimination between footwear. However, not all features of wear are distinctive as many people walk in similar ways. Research has shown that, in some cases, fine detail as a result of wear can be very valuable.

In addition to wear, minor damage can occur in the form of cuts and gouges. Such damage has been shown to be completely random and specific to a particular shoe. Thus damage of this type, which appears in both the mark at the scene and the suspect shoe, is highly significant, and in many cases will allow a very strong association to be established between the mark at the scene and the shoe in question.

The acquisition of damage detail (and wear detail) is a dynamic process. That is, every time a shoe is worn any damage initially present may change in shape or be worn away, whilst other additional damage may be acquired elsewhere on the sole. Therefore, a footwear mark left at a scene, for example, is a 'snap shot' of that sole pattern at that time. As the footwear is worn after this event the chances of acquiring additional damage are increased. Consequently, the additional damage would not be visible in the mark left at the scene. It is possible to acquire additional damage features without significantly altering the wear detail.

Marks can be recovered from a variety of different surfaces using a number of different methods. For example this may involve lifting with gelatine coated material or by chemically treating surfaces and photographing the marks.

Because marks found on crime scenes are often of limited quality compared to prints that are made on purpose at the laboratory, one has also to consider the possibility that the mark was left by some unknown shoe. In order to assess the probability of observing the mark given that possibility, one has to use a database. No database is ideal, but what is the most useful is to refer to marks that have been recovered on crime scenes as it was the case here or by persons that have been arrested for those types of crimes.
I therefore have used a laboratory database comprising shoe-marks from footwear that have been previously submitted to the laboratory, to assist in my evaluation of the findings. Whilst a cautious approach should be taken in assessing the occurrence of any particular pattern type as it is not possible to

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The data that helped to inform judgments are disclosed (guidance note 3). The scientist is highlighting the potential limitations of a database being used during his/her evaluation process.

determine how many shoes with a particular pattern or style may be present in the relevant population at any one time, the database does provide some indication of the rarity or commonness of footwear types seen by forensic scientists. Our database consists of 2600 marks.

Examination and Results

Scene 1

Items E/02 consisted of a piece of paper and items E/04 and 05 consisted of black gelatine lifts. The marks are partial (see photographs 1 and 2). Marks E4/E5 appear to have been made by a right shoe; mark E2 by a left shoe. The items all bore several partial overlapping footwear marks comprising a roundel and rows of small hexagons. The marks were photographed and observed under small magnification. In addition, the mark in item E/02 was lifted using black a gelatine lift. The observation of the photographs and the lifts showed that the marks had a similar level of wear. The quality of the marks did not allow comparing fine level of detail.

The observations of the marks given the case information, allows to infer that one pair of shoes has left the marks.

The sole pattern was one of the more commonly encountered types seen at the laboratory previously – seen 370 times in database of 2600 footwear marks.

Suspect

Items RT/7 and 8 were left and right 'Reebok' training shoes respectively, labelled as UK size 10. These had black uppers with Velcro fastenings. These also had a complex sole pattern, which comprised a roundel and rows of small hexagons. The soles showed signs of specific wear and damage. Test marks were made at the laboratory to aid in the comparison with the marks from the scenes.

Comparison of the marks and the 'Reebok' prints

A comparison of these marks with shoe-soles RT/7 and 8 showed marks in E/05 and 04 to be similar in pattern, pattern dimension and general wear to the right shoe RT/4. The mark in E/02 was similar in pattern, pattern dimension and general wear to the left shoe RT/3. There was some

Pertinent findings are presented (section 3.12). It shows that element of technical reporting will be found and used in an evaluative report (section 1.1).

Factual findings and factual results are summarised in this section, regarding what was found on the scene marks followed by what was observed during a comparison of each scene mark and the test-marks form the suspect's footwear. One will begin with the description of the material recovered on the crime scene in order to reflect that sequential unmasking has taken place (i.e., the marks have first been observed and then compared to the prints).

Part of the requirement for transparency in relation the methodology (guidance note 1 and guidance note 3). Note that dedicated statistical methods may also be used here (see Guideline line 65ss).

correlation in areas of moulding detail and specific wear between the soles and the marks. The quality of the marks, however, precluded a more detailed comparison with the footwear.

Scene 2

Item D/02 contained a black gelatine lift which was heavily contaminated with fragments of glass. This was photographed in order to facilitate a comparison with the footwear (see photographs 3 and 4). The marks visible however were poorly defined due to the presence of the glass.

Two pattern types were identified; one comprised a roundel and rows of small hexagon (Marks D/02a) and the other blocks (Marks D/02b). The observations of the marks given the case information allow the inference that two pairs of shoes have left the marks.

Comparison of the marks and the 'Reebok' prints

A comparison of the marks comprising a roundel with rows of small hexagons with the footwear, RT/7 and 8 showed at least one mark to be similar in pattern and very general pattern dimension to the left shoe RT/7. The quality of the mark precluded any further comparison. The other marks of this type were unsuitable for any meaningful comparison. The marks with the pattern with blocks cannot have been made by Mr Suspect's shoes. The marks were left by some unknown shoes.

Scene 3

Item S/10 a black gelatine lift bearing footwear marks developed in aluminium powder. This was photographed in order to facilitate a comparison with the footwear.

Item S/10 also bore an almost complete footwear mark comprising a roundel and rows of small hexagons. From the mark, we can infer that it was left by a left shoe.

Comparison of the marks and the 'Reebok' prints

A comparison of the mark with the footwear, RT/7 and 8 showed these to be similar in pattern, pattern dimension and general wear to the right shoe, RT/8. In addition, there was good correlation in areas of specific

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wear between the sole and the marks. The quality of the marks, however, precluded a more detailed comparison of damage detail.

Scene 4

Item P/2 contained a piece of paper and a small envelope which bore several partial and overlapping footwear marks comprising a roundel and rows of small hexagons made in dirt. The marks were photographed and lifted using black gelatine lifts. The quality of the marks was higher than for the other scenes. One mark (photograph 5) allowing the observation of the level of wear and moulding detail.

Comparison of the marks and the 'Reebok' prints

A comparison of the marks showed these to be similar in pattern to the shoes RT/7 and 8. The most clearly defined mark present on the paper was similar in pattern dimension, general wear and moulding detail to the left shoe RT/7. Moreover, there was some indication of corresponding damage detail.

The mark present on the envelope was similar in pattern dimension and general wear to the sole of the right shoe RT/4. The quality of the mark, however, precluded a more detailed comparison with the footwear.

Evaluation

In order to measure the value of the findings in a balanced and logical way, I have used the likelihood ratio approach as advised in the ENFSI 2015 guideline for evaluative reporting.

A likelihood ratio is a measure of the relative strength of support that particular findings give to one proposition against a stated alternative. It is defined in terms of the ratio of (i) the probability of the findings given that one proposition is true and given the conditioning information; and (ii) the probability of the findings given that the other proposition is true and given the conditioning information. The two probabilities forming the likelihood ratio have been assigned both on the basis of data (see below) and on my general knowledge.

I have used the following propositions to assist in my interpretation of the

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Here the ENFSI guideline is cited in order to explain what a LR is.

findings: for the scenes 1, 3 and 4 where one type of mark was found, I considered the results given that :

- The marks were made by the submitted shoes from Mr Suspect.
- The footwear marks were made by some unknown pair of shoes

For scene 2, two sets of marks were recovered. It was assumed that these marks were left by two persons. The results were therefore assessed given that :

- Mr Suspect's shoes and an unknown's person shoes are the source of the marks
- Two unknown person shoes are the source of the marks.

This enabled to assess all the results (i.e., the two sets of marks).

Scene 1

The observations made on the shoes, RT/3 and 4 and the marks in E/02, 04 and 05, recovered from Scene 1, are, in my view, in the order of 700 times more likely if the first proposition were true rather than the alternative. Therefore, the evidence provides moderately strong support for the proposition that the N marks were made by the submitted shoes from Mr Suspect rather than for the propositions they were made by some unknown pair of shoes.

Scene 2

The observations made on the left shoe, RT/3 and the marks in D/02, recovered from Scene 2 are, in my view, slightly more likely if the first proposition were true rather than the alternative. By slightly more likely I indicate that the results are in the order of 7 times more probable given the proposition that 'Mr Suspect's shoes and an unknown's person shoes are the source of the marks', than given the proposition that 'Two unknown persons shoes are the source of the marks'.

Scene 3

The observations made on the right shoe, item RT/4 and on the mark in S/10, recovered from Scene 3, are, in my view, far more likely if the first proposition were true rather than the alternative. By far more likely I indicate that the results are in the order of 2000 times more probable given the proposition that 'Mr Suspect's left shoe is the source of the mark', than

Explicit reference is made to the propositions at hand (section 2.1 and section 3.12)

These are the propositions devised at pre-assessment stage and listed previously.

Discussion and evaluation (section 3.12). Indications that data have been used to evaluate the significance of the findings (guidance note 3).
Explicit reference is made to the case information used in the evaluation.

It would be expected that the case notes will document the nature of the surveys and the results from their consultation.

In this case the laboratory database showed that the suspect's shoe sole pattern had been seen 370 times previously in a 2600 samples.

The reference Evett, I.W., Lambert, J.A. & Buckleton, J.S., A Bayesian Approach to Interpreting Footwear Marks in Forensic Casework, Science & Justice, 1998, 38, 241-247, was used for the LR detailed below. It is assumed that each is independent and thus can be multiplied together.

$$LR = lr_p.lr_s.lr_{gw}.lr_{spw}.lr_d \equiv \frac{P(E \mid Hp,I)}{P(E \mid Hd,I)}$$

lr_p Likelihood ratio of pattern type in the data set = 1/(370/2600) ≈ 7

lr_s Likelihood ratio of size/dimension/mould type of shoes responsible for marks – could be size 9, 10 , 11 (also half sizes where appropriate). Therefore need to consider occurrence of males shoe sizes in the range 9-11, as percentage of the male population in UK (can be obtained via sales in the UK as SATRA) = 1/0.44 ≈ 2, however, there is likely to be further discrimination with respect to spatial configuration of components, such that only a quarter of the shoes of this pattern in the 9-11range would be capable of making the marks. Therefore, lr_s =1/0.44 x 4 ≈ 9 (note this will varying upon what is seen during the comparison)

lr_{gw} Likelihood ratio of general wear seen in the data set. For example, in this case 35% of the 360 were seen to exhibit similar wear, then

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given the proposition that 'An unknown person's left shoe is the source of the mark'

Scene 4

The observations made on the shoes, RT/3 and 4 and the marks in P/2, recovered from Scene 4, are in my view, far more likely if the first proposition were true rather than the alternative. By far more likely I indicate that the results are in the order of 1500 times more probable given the proposition that 'Mr Suspect's shoes are the source of the mark', than given the proposition that 'An unknown person's shoes are the source of the mark.

lr_{gw} = 1/0.35 ≈ 3 (note this will varying upon what is seen during the comparison)

lr_{spw} Likelihood ratio of specific wear seen in the data set. For example 37 of the 360 were seen to exhibit similar wear, then lr_{spw} ≈ 1/0.1 = 10 (note this will varying upon what is seen during the comparison)

lr_{d} Likelihood ratio of corresponding damage features noted. For example if one damage feature is noted then the scientist may assess the chance of finding such a feature on another show of the type considered very low, say 1% of cases than lr_{d} = 1/0.01 = 100 (note this will varying upon what is seen during the comparison).

Scene 1 – using the details listed during the examination process and the data above:

lr_{p} ≈ 7
lr_{s} = 1/0.44 x 4 ≈ 9
lr_{gw} = 1/0.35 ≈ 3
lr_{spw} = 1/0.25 = 4 assigned due to specific wear.

Quality of mark prevented further comparison of damage.

$$LR = 7 \times 9 \times 3 \times 4 = 756$$

The LR for scene 1 was calculated as 756. That is, the findings are 756 times (moderately strong) in favour of the prosecution proposition as opposed to the alternative proposition.

Scene 2 – using the details listed during the examination process and the data above:

lr_{p} ≈ 7
lr_{s} = 1/0.44 ≈ 2

Quality of mark prevented further comparison of general wear, specific wear and damage. The final likelihood ratio will be divided by 2 to account fo the fact that two different types of marks were recovered from the scene and they both are equally relevant.

The scientist decided given the quality of the mark to evaluate as limited support for the prosecution proposition.

Scene 3 – using the details listed during the examination process and the data above:

$lr_p \approx 7$
$lr_s = 1/0.44 \times 4 \approx 9$
$lr_{gw} = 1/0.35 \approx 3$
$lr_{spw} = 1/0.1 = 10$ assigned due to specific wear
Quality of mark prevented further comparison of damage.

$$LR = 7 \times 9 \times 3 \times 10 = 1890$$

The LR for scene 3 was assigned as 1890. That is, the findings are in the order of 2000 times (strong) in favour of the prosecution proposition as opposed to the alternative proposition.

Scene 4 – using the details listed during the examination process and the data above:

$lr_p \approx 7$
$lr_s = 1/0.44 \times 4 \approx 9$
$lr_{gw} = 1/0.35 \approx 3$
$lr_d = 1/0.13 \approx 8$ assigned due to indications of damage detail

Quality of mark prevented further comparison.

The LR for scene 4 was calculated as 1512. That is, the findings are 1512 times (strong) in favour of the prosecution proposition as opposed to the alternative proposition.

The figures obtained for each scene can be regarded as an order of magnitude, because of the data used from the surveys, database and from the scientist's experience. However, it is a fair assessment of the findings because the LR expressed in this formula allows the scientist to take into account the rarity

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Note: The final evaluation of the evidence in this case is based upon my experience and my assessment of the likelihood ratio, in relation to the two propositions listed, along with any pertinent background information provided by police. In addition, I have used a calculation to assist in my determination of the likelihood ratio, and a record of this, all case-notes and my evaluation are contained in the case file held at the laboratory and this is available for inspection if required.

Conclusion

In my opinion, the findings provide **moderately strong** support for the proposition that the marks recovered from Scene 1, were made by the shoes RT/7 and 8 rather by some unknown shoes. By moderately strong, I indicate that the findings are in the order of 700 times more likely if the first proposition were true rather than the alternative.

In my opinion, the findings provide **limited** support for the proposition that 'Mr Suspect's shoes and an unknown's person shoes are the source of the marks', compared to the proposition that 'Two unknown persons' shoes are the source of the marks'. By limited support, I indicate that the findings are in the order of 7 times more likely if the first proposition were true rather than the alternative.

In my opinion, the findings provide **strong** support for the proposition that the mark in S/10, recovered from Scene 3, was made by the right shoe RT/8 rather than some other right shoe. By strong support, I indicate that the findings are in the order of 2000 times more likely if the first proposition were true rather than the alternative.

In my opinion, the findings provide **strong** support for the proposition that the marks in P/2 recovered from Scene 4, were made by the shoes RT/7 and 8 rather than by some other shoes. By strong support, I indicate that the findings

of the pattern, size and wear which can be obtained from the dataset and population data where available. With less common patterns, a judgment has to be made by the scientist. The LR obtained between scientists will vary, although the magnitude should not generally differ, it should not differ by more than one order of magnitude.
In the absence of data the scientist must have notes or comments on the case file reflecting the scientist's experience of encountering such findings and the evaluation.

To stress upon the fact that changes in the background circumstances may impact on the assessment (section 3.12).
The LR discussed above is contained in the case file, along with all information considered during the case, the findings, results and the evaluation – all of which is peer reviewed by another expert in the relevant evidence type.

Expression of the likelihood ratio (section 3.14 and guidance note 4).
The meaning of the likelihood ratio is conveyed (guidance note 4)
With reference to the scale of evidence the evaluation of the evidence equates to the relevant level for each scene, in favour of the prosecution proposition. The findings could be expressed numerically as detailed above. For example the findings are 756 times in favour of the prosecution proposition as opposed to the alternative proposition. However, providing a numerical result suggests that an accurate evaluation was made, in every case, therefore in the UK the tendency is to use the verbal equivalent. But if asked about the LR calculated during oral testimony the scientist could state 'approximately 700' in favour of the prosecution proposition and explain why the level of accuracy is not present here, as seen in some other areas of science for example.

are in the order of 1500 times more likely if the first proposition were true rather than the alternative.

The strength of the evidence is assessed on a scale of: inconclusive, limited, moderate, moderately strong, strong, very strong, and extremely strong.

The strength of the evidence or likelihood ratio in relation to either proposition considered is assessed on a scale of: no support for either proposition, limited, moderate, moderately strong, strong, very strong and extremely strong support. Each point on the scale represents a numerical range, which has logarithmic basis such that each increment provides ten times greater support than the previous one. For example, 'moderate' has a range from 10-100 and 'moderately strong' has a range from 100-1000 and so on. A likelihood ratio of less than one takes the reciprocal; the equivalent is then support for the alternative proposition considered. An evaluation of 'no support for either proposition' has a value of one and indicates that one proposition is not favoured more than the other.

My conclusions are based on the results of my laboratory examination and the information made available to me at this time. If any aspects of the case should change, then I am prepared to review my conclusion in the light of such changes.

To stress upon the fact that changes in the background circumstances may impact the assessment (section 3.12).

[FOOTWEAR MARK CASE 2]

Outline of the report

Evaluative Statement

Background information

My understanding of the case circumstances is as follows:
There was a burglary at Number 7, Main Street, on the 22nd of August 2014. A window was forced open and a footwear impression was recovered from the inside window sill. The owner of the house saw a man wearing a red jacket running from the scene.

John Brown is a suspect in this case. He was found hiding in the back garden of a nearby house, wearing a red jacket. He says he was never in this house and had nothing to do with the crime.

The shoes that John Brown was wearing were taken on the same day as the burglary.

If this information is incorrect I will need to reconsider my examination and conclusion.

Items Received

On the 25th of August 2014, I received the following items from Mr. C. W. of this laboratory:

- A gel lift of a footwear impression.
- A pair of Adidas training shoes taken from John Brown.

Links between the example statement and the guideline (numbers refer to the relevant section in the guideline)

Evaluative reporting should be identified as such (section 2.2).

Relevant case information as understood by the forensic scientist is disclosed as part as the requirement of transparency (section 3.12 and guidance note 1).

Indication of the items received as part as the requirement of transparency (section 3.12 and guidance note 1).
(Details of packaging and labelling would normally be included here).

Issue

I examined the items submitted to help address the issue of whether one of John Brown's shoes made the footwear impression at the scene, or whether it was made by some other, unknown, shoes and John Brown was not involved.

Expectations

If the impression was made by John Brown's shoe, I would have a very high expectation that the impression would match the sole of his shoe in pattern, size and degree of wear. Depending on the clarity of the impression, I would also expect that any accidental features present in John Brown's shoes would also be present in the scene impression.

If the impression was made by another, unknown shoe, I would have a low expectation that it would match John Brown's shoes in terms of pattern and size, a very low expectation that it would match in the degree of wear, and an extremely low expectation that any accidental features present in the impression would correspond to those in John Brown's shoes.

Nature of Examination

The impression from the scene consisted of a pattern of parallel bars, open circles and fine parallel lines.

John Brown's shoes were a pair of size 44 Adidas shoes with a sole pattern of parallel bars, open circles and fine parallel lines. The soles of the shoes were well-worn and there were a number of random acquired or accidental features visible on the soles. I made test impressions of the soles and found that these acquired features were reproduced in the test impressions.

Examination and Results

I compared the impression from the scene with the test impressions I had made with John Brown's shoes and found that impression at the scene matched the sole of his left shoe in terms of pattern, size and degree of wear. There were a number of features present (see demonstration attached) in the impression which corresponded to acquired features in the sole of the left shoe.

(section 3.14 and guidance note 1) – Although the words used suggest activity level ("John Brown's shoes made the impression at the scene"), the issues here are at source level because the interpretation of the footwear evidence requires no assessment of transfer, persistence and recovery (guidance note 2). Saying "John Brown's shoes made the impression" is not the same as saying "John Brown himself" made the impression. The choice of the propositions depends on the information used to select the shoes. Here, in this case, the shoes were taken on the basis that these were the shoes that Mr Brown usually wore. No information about the mark was used in order to choose the pair of shoes.

Indications on the nature of examinations are not mandatory for evaluative reporting. However, it can be regarded as part of the description of the analysis conducted, and associated results (section 3.12).

Pertinent findings are presented (section 3.12).

Evaluation

The findings were evaluated given the following two propositions:

- The footwear impression at the point of entry was made by one of John Brown's shoes, or
- The footwear impression was made by another, unknown shoe, and John Brown was not involved.

The quality of the mark is very good and allows the observation of distinctive features. The mark is also almost complete. The findings of matching pattern, size, wear and other features are expected if John Brown's shoe made the impression at the scene. Indeed, the time delay between the crime and the seizure of the shoes is small (i.e., same day), and the quality of the mark is good. I therefore would expect to find these matching features (if the shoe made the mark) in about 9 cases out of 10.

These findings are not expected if another shoe made the impression. Indeed, not only does the size and the pattern correspond, but also numerous accidental features (more than 10) have been observed both on the mark and on the shoe. The number of features in correspondence is therefore very high (see demonstration) and I would not expect another shoe to have the same accidental features. I assigned the probability of these observations if some unknown shoe had made the mark as in the order of less than one in a million.

Therefore, the results are in my opinion in the order of a million times more probable given the seized shoe made the mark than given an unknown shoe made the mark.

Explicit reference is made to the propositions at hand (section 2.1 and section 3.12)

Discussion and evaluation (section 3.12).
Indications of the expectation of the scientist under both propositions. The size and quality of the scene impression and the presence or absence of individualising features on the shoes will have a bearing on the evidential potential of the examination.

The case notes would document in detail the nature of the data used to reach that position (guidance note 3).

Reference to a laboratory footwear impression collection and to footwear seen in casework should help the examiner in assessing how common or rare the impression is in comparison to other impressions submitted in cases;

Frequency of occurrence of this type of shoe: Comparing the pattern with a database of footwear from casework will help assess whether the sole is a common or rare pattern. Databases may be generated within a laboratory or commercially available. In our footwear database which has >1000 impressions, even "common" patterns might only occur fewer than 5 times. In this case, only 2 occurrences of that type of general pattern have been found. The discrimination power of the general pattern has been confirmed by a few recent published studies:

Gross, S., Jeppesen, D. & Neumann, C. 2013 The Variability and Significance of Class Characteristics in Footwear Impressions. Journal of Forensic Identification 63, 332-351.

Benedict, I., Corke, E., Morgan-Smith, R., Maynard, P., Curran, J.M., Buckleton, J. & Roux, C. 2014 Geographical variation of shoeprint comparison class correspondences. Science & Justice 54, 335-337.

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A laboratory footwear database might record the size of shoes examined; in our collection, 20% of shoes are size 43, 20% are size 44 but only 5% are size 45. The size (similar to size) 44 as observed in this case is not particularly discriminative.

Degree of wear: Comparison of wear is one of the parameters considered by the scientist. Wear may also help to eliminate a shoe from the enquiry if it is more or less worn than the scene impression. In our case, the level of wear was consequent and share between the mark and the known impressions

Number and complexity of acquired features: The more accidental or acquired features there are, the greater the number of points of comparison between the shoes and the scene impression. Accidental features on the sole will have physical attributes like size, shape, direction, dimensions and complexity (from a simple cut to a complex multi-featured area of damage). The literature and experience tell us that features corresponding to cuts, deformations etc. are very unusual and are unlikely to be seen in the same place with the same size and shape in a shoe chosen at random. The shoes may have other individualising features like small stones wedged in the sole. As with wear, non-matching features may be a reason for eliminating a shoe.

The rating of accidental marks is case-specific and it is difficult to put numerical values on the characteristics, but broadly the rarer the pattern, and the more distinctive and more numerous the individualising features are, the higher the LR will be. If the pattern, size and wear match, then the greatest effect on the LR is the presence of distinctive accidental features, which will have a dramatic effect on the distinctiveness of the impression.

Even with only class characteristics (pattern, size) the LR could be >60 for a common pattern and >130 for a rare pattern (Hancock, S., Morgan-Smith, R. & Buckleton, J. 2012 The interpretation of shoeprint comparison class correspondences. Science & Justice 52, 243-248).

A further discussion of the relevance of position, shape and number of acquired features is the paper by Adair, T.W., Lemay, J., McDonald, A., Shaw, R. & Tewes, R. 2007 The Mount Bierstadt Study: an Experiment in Unique Damage

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Conclusion

The degree of correspondence between the sole of John Brown's left shoe and the impression at the scene in terms of pattern, size, wear and acquired features, provides extremely strong support for the proposition that the footwear impression at the scene was made by his shoe, rather than by a different, unknown shoe.

I have chosen the phrase "extremely strong support" from the following scale: weak support, moderate support, moderately strong support, strong support, very strong support, extremely strong support.

This evaluation is based on my understanding of the relevant circumstances as described above. If any of this information is incomplete or incorrect, I will have to re-evaluate my findings.

Formation in Footwear. *Journal of Forensic Identification* 57, 199-205. They compared marks made on 6 pairs of new boots during a 7 mile (11 km) hike and found that the accidental marks generated were sufficient to distinguish any boot from the others.

In the present case, the presence of 10 acquired features (with a high level of complexity) in correspondence between the mark and the print would be exceptional to observe on impressions made by two different soles.

Expression of the likelihood ratio (section 3.14 and guidance note 4).

The meaning of the likelihood ratio is conveyed (guidance note 4).

To stress the fact that changes in the background circumstances may impact on the assessment (section 3.10).

In this case the scientist considered that the distinctiveness and number of the acquired features in the scene impression and the degree of correspondence with the sole of the suspect's shoe were enough to justify a conclusion of "extremely strong support". With less distinctive features, or with a poorer-quality impression, the strength of the conclusion would be reduced. Even with a poor impression it may still be possible to exclude a shoe from having made an impression, based on pattern, size and wear); conversely, even with a small partial impression with a distinctive acquired feature, it may be possible to give a high level of support for the proposition of a common source.

[CCTV CASE]

Outline of the report

Evaluative Statement

General information about an evaluative statement from the laboratory

The findings reported in an evaluative statement are those resulting from the examination and analysis made. These findings are normally evaluated against two propositions: the first proposition (based on the issue, as formulated by the mandating authority) and an alternative proposition usually provided by the defendant.

During the evaluation, probabilities of the findings are assigned assuming in turn that each of the two propositions is true. The ratio of these two probabilities forms the value of evidence and is reported as a graded conclusion in the laboratory's scale of conclusions (*attached*).

If new information comes about, or if other propositions are requested to be used for the evaluation, this may affect the conclusion.

A graded conclusion shall be considered as a factor that either strengthens (positive scale level), weakens (negative scale level) or leaves unaltered (scale level 0) the prior opinions on the two propositions (prior to the forensic investigation). The laboratory makes no judgment about how probable any of these propositions are.

In a case where a certain exclusion can be made, phrases like "is", "is not" and "can be excluded" are used instead of a graded conclusion.

Links between the example statement and the guideline (numbers refer to the relevant section in the guideline)

Evaluative reporting should be identified as such (section 2.2).

This general information is provided in each evaluative statement (front page). The scale of conclusion used is attached (but was taken out from this example). This is not mandatory in the guideline (part from the third paragraph), but is related to the issue of transparency (guidance note 1).

section 3.12 and guidance note 2

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Information

A case of arson took place on the 17th December 2011.

There is normally very little amount of information provided about the case in the request. One person convicted, both at the district court and in the court of appeal, was granted a rehearing at the court of appeal.
This particular information is not found in the original statement but has been provided here to make the example clearer.

Items received

The following material was received at the laboratory:
1: CD-ROM with CCTV-recording
2. Passport photo of the suspect from 2013.
3. Paper copy of a photo of the suspect taken by the Police
4. Digital images of suspect taken by the Police

Besides listing each item, there is information about which method of analysis that was used, whether that method is part of the laboratory's accreditation, and how the material will be handled when the case is closed.

Indication of the items received as part of the requirement of transparency (section 3.12 and guidance note 1)

Purpose

The purpose is to examine the items received with a view to helping address the issue of whether or not the indicated person captured on the CCTV still (item 1) is the person on the photos/images of items 2-4.

The issue is formulated based on the request sent to the laboratory (sections 3.1 and 3.12).

Nature of examination

During the examination and the evaluation of the findings, issues of image quality, angles of imaging and lighting conditions are taken into consideration.

This section may sometimes contain mandatory parts from the guidelines. Here it is about significant findings (section 3.12).

Examination and Results

Upon comparison of the person captured on the CCTV still (item1) and the person on the photos and digital images (items 2-4) similarities were observed with respect to general appearance (constitution of the body) and posture, facial shapes and proportions, hairline, eyebrows, eyes, nose, ears, growth of beard and wrinkles at the corners of the mouth. No dissimilarities were observed besides those which were deemed to be due to issues of imaging

The findings are presented (section 3.12). This section is technical reporting (section 1.1).

Explicit reference is made to the propositions at hand (section 2.1 and section 3.12).

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(quality, angles and lighting).

Evaluation

The following propositions were considered when evaluating the findings:

- The person indicated on the CCTV (item1) is the same person as in the photos and images of items 2-4.
- Alternative proposition: The person indicated on the CCTV still (item 1) is another adult male.

With respect to the issues of imaging, the findings reported under the **Examination and Results section** are deemed to be expected if the person on the CCTV (item 1) is the person on the photos and images of items 2-4. These findings are deemed less probable if it is another person. With respect to the fairly low quality and weak light of the CCTV still, the observed features have merely been of general kind, apart from some specific details. The proportion of men in the general population that would look like this if they were imaged under similar conditions is deemed to be small. Based on my knowledge and experience in controlled conditions, I would not expect to see such a result in more than about 1 out of 100 cases.

Evaluation (section 3.12).

Indications that data have been used to evaluate the significance of the findings (guidance note 3)
The case notes shall on request be disclosed on any part of the case. Here, the details of the evaluation are found (section 3.11)

We begin by assuming that the first proposition is true, and, conditioning on the issues of imaging (quality, angles and lighting) in all items examined. We deem the probability of the findings from observations made of the person in the photos and images of items 2-4 (general appearance or constitution of the body) and posture, facial shapes and proportions, hairline, eyebrows, eyes, nose, ears, growth of beard and wrinkles at the corners of the mouth), and observing the corresponding features on the person captured on the CCTV still to be all very high, with their joint probability deemed to be about 0.999, i.e. we would not expect deviances in any of the characteristics observed in more than 1 out of 1000 cases.
We then assume that the alternative proposition is true. Conditioning on the issues of imaging of item 1, we deem the probabilities of the findings from observing corresponding features of the forehead and eyes to be high; the probabilities of the findings from observing corresponding features of the bodily constitution and posture, the ears, the eyebrows, the nose, the cheeks, the mouth, the jaw and chin, and the growth of beard to be moderately high; and the findings from observing the corresponding features in the hairline and wrinkles at the corners of the mouth to be moderately low. The joint probability of all these findings are deemed to be lower than 0.01.

The value of evidence is assigned a value larger than 100, rendering level +2 in our scale of conclusions. The verbal expression used for this level is “The

Conclusion

The findings from the examination support the view/ proposition that the person indicated on the CCTV still (item1) is the person on the photos and images of items 2-4 (*level* +2), rather than that the individual is another adult male.

This evaluation is based on my understanding of the relevant circumstances as described above. If any of this information is incomplete or incorrect (in particular if the alternative changes), I will have to re-evaluate my findings.

findings support the first proposition rather than the second"

section 3.14 and guidance note 4

The term "likelihood ratio" is not used at the laboratory that suggested this worked example due to the lack of wording in the language and the expected difficulties for a forensic expert to explain the meaning of the statistical term "likelihood".

Expression of the likelihood ratio (section 3.14 and guidance note 4)

Here, it is important to check that the propositions are the same as in the issue.

To stress the fact that changes in the background circumstances may impact on the assessment (section 3.10).

[GSR CASE 1]

Outline of the report

Evaluative Statement

Information

Case information has been received from: Conversation with the Police on 5 October 2011 and initial report/statement on 6 April 2011.

From the information given to me, I understand that during a struggle in a parking lot near a nightclub 3 shots were fired at around midnight. Mr S, suspected of being the shooter, denies any use or contact with a firearm. Neither firearm nor elements of ammunition have been recovered. The surfaces of the hands of Mr S have been swabbed, using stubs, approximately 2h30 after the incident. His jacket has also been seized.
Standard questions regarding activities that are important when searching GSR were asked to Mr S (SOP XYZ1). He answered by the negative to all questions.

Mr S was not exposed to a police environment (e.g., detained in an interrogation room, transported in a police car etc.) prior to sampling of the surfaces of his hands.

Items Received

On 19 September 2011, the following item was received at the laboratory, from the Police: GSR kit 05X3

Issue

I have been asked to examine items taken from Mr S for the presence of GSR particles. This examination was done in order to help the Court assess whether Mr S is the shooter or alternatively if he has nothing to do with the shooting incident (i.e., Mr S did not use or handle a firearm nor has he declared to been

Links between the example statement and the guideline (numbers refer to the relevant section in the guideline)

Evaluative reporting should be identified as such (section 2.2).

Relevant case information as understood by the forensic scientist is disclosed. This ensures transparency as required by section 3.12 and guidance note 1.

Items received are mentioned as part of the requirement of transparency (section 3.12 and guidance note 1).

In this case, the issues pertain to activity level propositions. Moreover, the evaluation of the kind trace material (i.e., particles) expected in a shooting case requires the assessment of factors such as transfer, persistence and recovery (guidance note 2).

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involved in activities that can lead to GSR like particles, either before or after the incident).

Nature of Examination

The discharge of a firearm results in the formation of residues that are principally composed of burnt and unburnt particles from the propulsive charge. They may also contain components from the primer, the bullet, the cartridge case and the firearm itself. Further information on the nature of these particles and analytical techniques and procedures for their analysis is given in the laboratory's operating procedure XYZ.

Note that, more generally, professional nail guns using powder can also produce characteristic particles whereas activities such as plumbing, works on cars, as well as fireworks can lead to particles that share some but not all of the features observed on gunshot residues.

Examination and Results

Analyses were carried out from 11 to 13 of October 2011.
The following quantities of particles were detected on the submitted GSR kit 05X3:

- 30 "characteristic" particles, that is particles that contain the elements lead, barium and antimony in combination;
- 37 "indicative" particles, that is particles that contain combinations of lead and barium, lead and antimony or barium and antimony, possibly combined with others elements.

The findings are summarised in the following table:

Indications on the nature of the examination to be carried out are not mandatory for evaluative reporting. It is possible to refer to other laboratory procedures (e.g., SOP). However, such information may be conveyed as part of the description of the analyses and the associated results (section 3.12).

Key findings are presented (section 3.12).

Number of particles found on the GSR kit 05X3				
Area where stub was applied	**Number of "characteristic" particles** lead/barium antimony	**Number of "indicative" particles** lead/ barium	lead/ antimony	barium/ antimony
Right thumb and index finger	2	2	3	6
Right palm	14	6	4	10
Left thumb and index finger	3	0	4	2
Left palm	11	0	0	0
Total	**30***	**8†**	**11†**	**18**

Legend: * within these particles, two contain silver
† within these particles, one contains also tin
† within these particles, four contain also tin

Evaluation

The following propositions have been used to assist the interpretation of the findings:

- M. S. discharged a firearm during the alleged incident.
- M. S. has nothing to do with the incident.

If the proposition that Mr S discharged a firearm during the incident is true, it is reasonable to expect that considerable quantities of GSR will be present immediately after the shooting on Mr S, especially on his hands. However, due to subsequent activities of Mr S and the limitations of the particle collection method, a substantial loss is expected with respect to the initially transferred quantity of particles. Based on literature, and according previous cases (previously processed in our laboratory) relating to individuals involved in shootings or firearm incidents, we consider that it is reasonable to find about 30 characteristic particles, along with indicative particles. We assign the probability of 0.1 to such an event.

If the alternative proposition is true, the detected particles do not come from the discharge of a firearm, but are present for some other reason. Generally, this may include contamination in the environment of the police, but also exposure to particular working environments (e.g., mechanics, construction workers) and sources such as fireworks. None of these circumstances are specified in the relevant information of this case. Based on specialised literature

The competing propositions of interest are mentioned explicitly (section 2.1 and section 3.12)
This part contains the discussion and the evaluation (section 3.12). At this juncture, the report specifies and explains the extent to which the findings would be expected given the first proposition and the conditioning information. Note that the case notes will document the nature of the data used in the assessment (guidance note 3). Also, it would be required that this expectation was formulated as part of the pre-assessment (section 3.3), that is before searching and analysing any trace material.

The findings are also considered assuming the specified alternative proposition to be true. The case notes would document evidence of that assessment (guidance note 3).

and our data on individuals not involved in shooting incidents, we thus consider the finding of about 30 characteristic particles, along with indicative particles, as a particularly rare event. We would not expect to see such a result in more than about 3 out of 10'000 cases characterised by such circumstances.

In summary, we thus consider that the findings are about 300 times more probable if the first proposition is true rather than if the specified alternative proposition is true.

Note: The evaluation in this case is based upon my experience and my assessment of the likelihood ratio, in relation to the two propositions specified above, along with any pertinent background information provided by the submitting party. I have used my knowledge, as well as both data from published literature and from internal records of our laboratory to assist in my assignment of the likelihood ratio. A record of this and all case-notes are contained in the case file held at the laboratory and this is available for inspection if required.

Conclusion

The analysis of the stubs from the submitted GSR kit shows the presence of a considerable quantity of particles that, given their composition and morphology, qualify as gunshot residues.

In my opinion, these findings provide **strong** support for the proposition that Mr S discharged a firearm during the incident rather than that he has nothing to do with this activity.

Generally, by 'strong' we consider any result that is in the order of 100 to 500 times more probable if first proposition is true rather than the alternative proposition. The qualifier 'strong' is part of an assessment scale that contains the following steps: no support for either proposition, limited, moderate, moderately strong, strong, and very strong support.

My conclusions are based on the results of my laboratory examination and the information made available to me as specified at the beginning of this report. If any aspects of the case should change, then I am prepared to review my conclusion in the light of such changes.

The conclusion is expressed in terms of a likelihood ratio (section 3.14 and guidance note 4).

The meaning of the likelihood ratio is explained (guidance note 4).

The report emphasises that changes in the conditioning information may impact the assessment (section 3.10).

[GSR CASE 2]

Outline of the report

Evaluative Statement

Background Information

On 14/1/2014 at approximately 10.30pm, one shot was fired at the door of 9 Barrack Street. A witness observed a man leaving the scene on a bicycle. Police were alerted and his escription circulated. A short time later, police on patrol in a nearby street stopped a suspect X on a bicycle who fitted the description. He was wearing black knitted gloves. Th gloves were taken from X within 30 minutes of the incident and submitted for GSR examination. A discharged shotgun cartridge case was recovered at the scene of the shooting. A sawn-off shotgun was subsequently located near where the suspect was arrested. X made no comment when interviewed.

If any of the above is incorrect, please advise me as re-evaluation of my approach may be required.

Items Received

On 15/1/2014, the following items were received at the laboratory:

AB1 A sealed tamper evident plastic bag serial number XXXxxxx containing a pair of black knitted gloves. I understand that these were taken from the suspect on his arrest.

AB2 A sealed tamper evident plastic bag serial number YYYyyyy containing a discharged shotgun cartridge. I understand that this was recovered at the scene of the shooting.

Links between the example statement and the guideline (numbers refer to the relevant section in the guideline)

Evaluative reporting should be identified as such (section 2.2).

Relevant case information as understood by the forensic scientist is disclosed. This ensures transparency as required by section 3.12 and guidance note 1.

Items received are mentioned as part of the requirement of transparency (section 3.12 and guidance note 1

EXAMPLES

Purpose

The purpose of my examination was to determine whether or not there was evidence to support the suggestion that X was the person who discharged the shot at the door of 9 Barrack Street, rather than he had nothing to do with the incident and someone else discharged the shot.

Gunshot Residue (GSR)

When a firearm is discharged, a shower of tiny particles, invisible to the naked eye, is produced. These particles may be deposited on the weapon itself and on whatever is closest to it; usually the hands, face and clothing of the person discharging the weapon. These particles may be lost over time through normal movement, contact with air currents, washing etc. A small proportion of the particles are characteristic of firearm discharge (3-component particles containing lead, barium and antimony with specific sheroidal shape). Other consistent particles are also produced following firearm discharge. By the term "consistent particles", we mean 2-component particles such as Sb/Ba, Pb/Sb, Pb/Ba, Ba/Al. However, many of the consistent particles produced are also found in relation to occasions other than firearm discharge. A collection of such particles, containing both characteristic and consistent particles, is referred to as Gunshot Residue. If a person is wearing gloves and/or a face mask when a firearm is discharged, the particles will be deposited not on their hands or face but on the gloves and/or face mask. Gunshot Residue can persist on hands for a number of hours and for longer on clothing.

Expectations

If X was the person who discharged the shot while wearing the gloves, I have a high expectation (about 90% probability) of finding gunshot residue on the gloves.
If X did not discharge the shot and had nothing to do with the incident, I have a low expectation (about 2% probability) of finding gunshot residue on the gloves.

Two mutually exclusive propositions are identified:
X was the person who discharged the shot in this case (Hp);
Someone else discharged the shot and X had nothing to do with the incident (Hd).
In this case, given the "no comment" interview, it has been assumed that the individual will deny the shooting (guidance note 2). The statement will stress on that aspect in the conclusion.

Indications on the nature of the examination to be carried out are not mandatory for evaluative reporting. It is possible to refer to other laboratory procedures (e.g. SOP). However, such information may be conveyed as part of the description of the analyses and the associated results (section 3.12).

A probability tree setting out a range of potential findings under each scenario and the probabilities assigned to them is included in the case file (see image below). The probabilities assigned under H_p (prosecution hypothesis) are based on literature reports and casework experience. The probabilities assigned under H_d (defence hypothesis) are based on the results of a survey of clothing carried out in this laboratory.

EXAMPLES

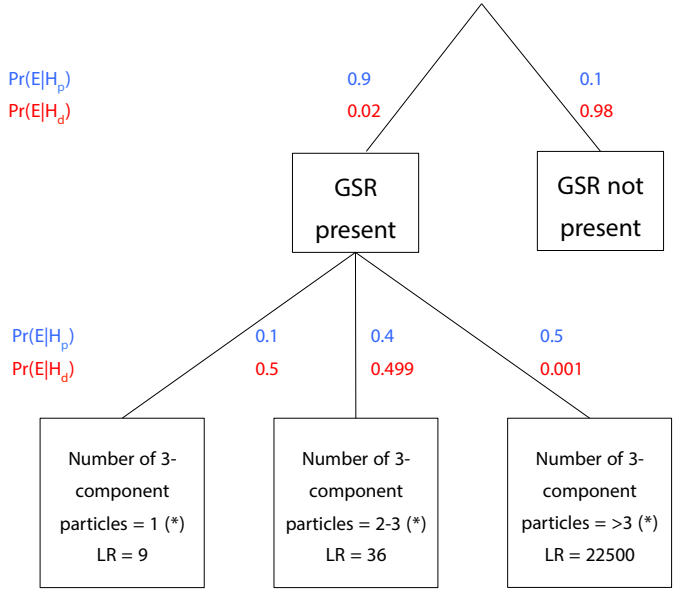
Results

Gunshot residue (~~thirteen 3-component particles~~) was found on the gloves taken from X.

The gunshot residue recovered from the gloves was compared with gunshot residue recovered from the discharged shotgun cartridge found at the scene and was found to be similar in terms of the range of elements present. However, the same type of residue could be produced by other combinations of firearm and ammunition.

Evaluation

The finding of firearm residue on the gloves is much more probable to be obtained if X was the person who discharged the shot at 9 Barrack Street, rather he had nothing to do with the shooting and another person did it.



(*) particle(s) considered within a population of other consistent particles.
By the term "consistent particles", we mean 2-component particles such as Sb/Ba, Pb/Sb, Pb/Ba, Ba/Al.

Using the probability tree, the finding of thirteen 3-component particles on the gloves is approximately 22,500 times more likely to be obtained if X was the shooter, rather than if he had nothing to do with the incident. If however, the suspect were to offer another explanation e.g. that he was not the shooter but was present and/or the gunman handed him the weapon afterwards, we would have to re-evaluate. Our expectations under either scenario would be much the same, LR ~ 1, and GSR analysis could not assist in determining the issue.

EXAMPLES

Conclusion

These findings provide very strong support for the suggestion that X discharged the shot at 9 Barrack Street, rather he had nothing to do with the shooting and another person did it.

By "very strong" we consider any result that is in the order of 10000 to a million times more likely if X discharged the short at 9 Barrack Street, rather than he had nothing to do with the shooting and another person did it.

I have chosen the above phrase from the following scale : Weak support; Moderate support; Moderately strong support; Strong support; Very strong support; Extremely strong support.

Note that if different activities are suggested in relation to the shooting and especially with regards to X, this may impact on the assessment of the strength of the forensic findings, and so will necessitate further evaluation and possibly the provision of a new report.

Expression of the likelihood ratio (Section 3.14 and Guidance Note 4). The meaning of the likelihood ratio is conveyed (Guidance Note 4). A LR value (order of magnitude) is given.

[Audit Template]

The purpose of this audit template is to offer a mechanism for auditors to assess whether or not evaluative reports meet the requirements of the guideline. A global overview of the compliance to the guideline can be obtained by assessing each section of the following table. Three levels can be used for the assessment column: in accordance with the guideline: Yes (Y), No (N) or debatable (D)

Assessment criterion	*Section in guideline*	*Assessment*
Does the report meet the requirements of evaluative reporting? • Is there a request from mandating authority to examine and/or compare material? • Are findings evaluated with respect to competing propositions relevant to the case circumstances?	2.1	
Case file (complementary information in addition to the report): • Are the examination strategy, methods, observations made and analytical results recorded? • Pre-assessment: was it necessary? Were probabilities assigned to reasonable potential findings? Was the basis for this assignment documented? Is the examination strategy aligned with the pre-assessment? • Does the case file contain the assigned probabilities and the relevant data?	3.3, 3.11	
Mandate, key issue(s) and conditioning information: • Are the key issue(s) disclosed in the report? • Is sufficient relevant conditioning information available or has been requested if needed and disclosed in the report? • Does the report state any assumptions made in order to carry out a full evaluation? • Does the report mention that any change in conditioning information may require assessments, conclusions and/or propositions to be reviewed?	3.12	
Items received, examined and the associated significant findings: • Are they disclosed in the report?	3.12	
Is the evaluation section of the report identified as such?	2.2	
Propositions: • Does the report specify at least one pair of propositions? • Do they derive from relevant case information? • Are they in the appropriate level in the hierarchy of propositions? • Have the propositions been provided by the parties and do they reflect the case information? • If not, does the alternative proposition chosen most likely and reasonably reflect the party's position? • Does the report specify that any change to either of the propositions means the findings shall be re-assessed?	guidance note 2	
Discussion and evaluation: • Is the evaluation based on the likelihood ratio? • Are the findings evaluated in the light of the propositions (and not the reverse)? • Does the report and the case file make explicit the reasoning that led from the findings to the conclusions?		
Conclusions: • Is the conclusion expressed in terms of the likelihood ratio either by its value or a verbal equivalent? • Does the report contain a numerical expression of the likelihood ratio (or the order of magnitude)? • Do the conclusions contain a transposed conditional? • Do the conclusions address the key issues? • Are the propositions still the same as those defined at the outset?	3.14, guidance note 1 and guidance note 2	

[ROADMAP]

It is recognized that the implementation of the *Guideline for evaluative reporting* is a challenge in itself and below is proposed the key elements of a roadmap that should help laboratories in this task.

Step 1
Managing the change

- Identifying **key personnel responsible** for the implementation
- Deciding on a **strategy** to approach each forensic discipline covered by the laboratory (focus groups, leaders in each discipline, etc.)
- Adopting a **project plan** with defined objectives and timeline

Step 2
Training

- Providing **training** and **workshops** on the guideline (i.e. framework of circumstance, propositions, likelihood ratio, workshops per discipline)
- Identifying what is covered by **evaluative reports** (compared to factual or investigative reports)
- Training should include **competency testing**.
- Providing **information** and **training** to the stakeholders (e.g. police officers, judiciary, mandating authority) in relation to the changes associated with the guideline in particular the exchange of information at the outset of the case and the reporting practice

Step 3
Identifying the issues

- Implementing the mechanisms to establish the **key issues** in the submitted cases by adapting the exchange of information between the forensic laboratory and the mandating authority
- Setting an appropriate **framework of propositions** (including dealing with "no comment" interviews)
- **Identifying the levels of propositions** (source or activity level) that best help address the key issues
- If appropriate, carrying out a **pre-assessment** of cases and communicating with the mandating authority
- Identifying the ***data* requirements** (*data* as defined in the guideline) to help address the issues. If needed, undertake structured data acquisition
- **Optional**: Developing a uniform **verbal scale** to support consistent reporting within the laboratory

Step 4
Reporting according to the guideline

- Reporting on the **probability of the findings given the propositions** and relevant background information which leads to a **likelihood ratio**
- A**voiding in reports statements that are transposing the conditional** (i.e. not reporting on the probability of the propositions given the observations)
- **Auditing** the casework using the audit template associated with the guideline

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