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Individualization is dead, long live individualization! Reforms of reporting practices for fingerprint analysis in the United States

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Individualization, the claim to be able to reduce the potential donor pool of a forensic trace to a single source, has long been criticized. This criticism was echoed by a 2009 U.S. National Research Council report, which called such claims unsupportable for any discipline save nuclear DNA profiling. This statement demanded a response from those disciplines, such as fingerprint analysis, that have historically designated 'individualization' one of their approved testimonial conclusions. This article analyses three serial responses to this challenge by the U.S fingerprint profession. These responses posited new terms for testimonial reports or modified the definition of individualization. The article argues that these reforms have yet to 'fix' individualization and that all three reforms suffered semantic and conceptual difficulties. The article concludes by suggesting that these difficulties may be traced to the insistence on retaining, and somehow justifying, the term and concept 'individualization', instead of developing new terms and concepts from a defensible reasoning process.

Keywords: fingerprint; individualization; identification; reports; SWGFAST; decisions.

1. Introduction

Individualization has famously been conceived as the essence of forensic science (Kirk, 1963, p. 236). Individualization has been defined as 'a special case of identification, where the restricted class is populated by one object only' (Champod, 2009). It has become a standard testimonial claim for some forensic disciplines, notably fingerprint analysis[1] and firearms and toolmark analysis (Spiegelman and Tobin, 2013), and it is used on occasion in other disciplines, such as footwear, earmarks, questioned documents, DNA profiling and microtraces, as well (Champod, 2000). For decades now, however, forensic scholars have cast doubt on the concept of individualization, calling it 'not possible' (Stoney, 1991, p. 198) or 'not logically attainable' (Champod and Evett, 2001, p. 113) (also see, e.g. Kwan, 1977; Robertson, 1990; Risinger and Saks, 1996; Starrs, 1999; Inman and Rudin, 2001; Thornton and Peterson, 2002; Cole, 2004; Broeders, 2006; Meuwly, 2006; Biedermann *et al.*, 2008; Champod, 2008; Mnookin, 2008; Saks and Koehler, 2008; Cole, 2009; Haber and Haber 2009, p. 24; Koehler and Saks, 2010; Margot, 2011, p. 95; Page *et al.*, 2011; Amorim, 2012; Kaye, 2013;

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[1] This article uses the colloquial term 'fingerprint analysis', rather than the more precise term 'latent print analysis ' to refer to the analysis of all traces from fingers, palms and soles. Where feasible, this article follows the convention of using the term 'mark' for an impression found at a crime scene (sometimes called a 'latent print') and using the term 'print' for an impression of friction ridge skin taken deliberately from an individual. It is still sometimes necessary to use the term 'latent', as, e.g. in referring to the occupational category 'latent print examiner'.

Biedermann *et al*., 2013; Houck, 2013). In the last several years, these doubts have quickened, with one group of scholars wondering aloud whether individualization is 'an endeavor worth the effort' (Biedermann *et al*., 2008, p. 130), another declaring flatly 'There is no scientific basis for the individualization claims in forensic sciences' (Saks and Koehler, 2008, p. 202), and another author noting 'that the unsatisfactory nature of the classical theory' of individualization 'is becoming more widely appreciated' (Kaye, 2013). At least one scholar distilled these concerns into a call for abandoning the concept and term altogether (Cole, 2009). All these scholars noted that forensic analysis could still be useful without individualization.

Although scholars' concerns about individualization historically appear to have had little impact on forensic practice, this urgency of the issue was heightened in 2009 when a report by the U.S. National Research Council (NRC), concluded that claims of 'individualization' were not supported for any forensic discipline save one, nuclear DNA analysis (NRC, 2009, p. 142).

The fingerprint discipline, the discipline in which the claim of 'individualization' is most firmly ensconced and most steadfastly defended as the conclusion examiners must make when reporting an inclusion, has served as a principal site for the debate over 'individualization'. A second report, specifically on fingerprints, was jointly sponsored by the U.S. National Institute of Standards and Technology (NIST) and National Institute of Justice (NIJ). The Expert Working Group that wrote the NIST report was both larger and more inclusive of practicing forensic analysts than the NRC committee. Nonetheless, it likewise recommended that fingerprint examiners not make claims of individualization as traditionally defined (NIST, 2012, p. 72). A third report, the 800-page Fingerprint Inquiry Report, a comprehensive report commissioned by the Scottish government in response to a scandal over two alleged fingerprint misidentifications, also concluded that 'The ability of any examiner to "individualise" without the potential for any error at the claimed level of one person in the whole of human history is not scientifically validated' (Campbell, 2011, p. 683).

The fingerprint discipline, however, had standards that mandated the reporting of conclusions of 'individualization' (SWGFAST, 2003b). This seemed to set up a discrepancy between the profession and the bodies that issued these reports. This discrepancy seemed to portend a dilemma for courts, which might have to choose between the profession's continued confidence in conclusions of individualization and the clear statements by external scientific or legal inquiries that such conclusions were unsupported.

To those scholars who found claims of individualization to have 'no scientific basis' (e.g. Saks and Koehler, 2008, p. 202) or to be 'an article of faith rather than scientifically supported conclusion' (e.g. Kaye, 2013), it might have seemed like individualization was dead or in its death throes. Given the statements by neutral but authoritative bodies like the NRC and the Fingerprint Inquiry, and even bodies with practitioner representation like the NIST/NIJ Expert Working Group, surely individualization was on its way to the dust bin of history.

Individualization, however, was far from dead. An official Sourcebook, published by the NIJ, for the most part continued to espouse the notion of individualization (Moenssens and Meagher, 2011; Vanderkolk, 2011), with the exception of one chapter (Langenburg, 2011). Unabashed defences of the notion of individualization appeared (Swofford, 2012; Jayaprakash, 2013). Other individuals and institutions within the fingerprint discipline did respond to the critiques of individualization. But far from consigning 'individualization' to the dust bin, these responses ended up resurrecting either the term or the concept or both, giving it a new lease on life. If individualization was dead, it was dead only in the sense of death implied by the French legal notion *le mort saisit le vif,* in which the death of a hereditary monarch results in the instantaneous transfer of sovereignty to a new monarch. In the

familiar phrase: 'the king is dead, long live the king'.[2] The monarch changes, but the regime continues uninterrupted.

This article discusses the responses of the U.S. fingerprint profession to the critique of the concept of individualization launched by scholars and, more recently, external scientific inquiries. It details three distinct efforts to respond to the critique, each of which purported to remedy the logical and empirical flaws in individualization claims noted by these external observers. The article argues that these professional responses have not sufficiently remedied these flaws. While the new testimonial formulations improve upon the old ones, individualization has still not been 'fixed'.

While much of this discussion will be highly abstract and theoretical, it will be complemented by trial transcript data from actual expert testimony by latent print examiners in the USA. This data serves an important function in illustrating how high-level academic debates and institutional policy statements are implemented in actual expert testimony. All the expert testimony discussed in this article was given by latent print examiners who by any measure would be considered in the upper echelon of practicing latent print examiners in the USA in terms of their formal scientific background and education. Far from cherry picking poorly articulated testimony, the transcripts presented here are, if anything, skewed toward examiners with strong understanding of scientific concepts.

This article shows that all three responses encountered two common difficulties. The first difficulty was semantic. All three responses had difficulty disentangling 'new' meanings of 'individualization' from its historically acquired meaning. The second difficulty was logical. All three responses offered new definitions of 'individualization' whose logical distinctiveness from the 'old' meaning is at least questionable.

This article is aimed at two audiences. First, it is aimed at jurists. It is hoped that it will enable jurists to distinguish cosmetic fixes that do not address underlying problems in reasoning from true changes that place testimonial claims on a logically defensible foundation. Second, it is aimed at scholars. Probabilistic and decision theoretic approaches have become increasingly influential among forensic scholars as the 'proper' way to reason about forensic evidence. The reform of 'individualization' by the fingerprint profession in the USA offers a case study of an effort to implement those ideas in practice. This article elucidates the difficulties of applying those approaches to an actual working forensic practice 'in action' as well as explicating some of the ongoing conceptual problems with such applications. As such, its observations should be applicable beyond fingerprint identification to other forensic disciplines and legal problems as well. Finally, it is hoped that by showing how difficult it has been to 'fix' individualization, the article extends earlier work by further convincing both audiences that forensic science can, and should, do without both the concept and the term.

2. Defining 'Individualization'

One difficulty in discussing individualization is that forensic science has not been entirely clear and consistent about what the term means. Kirk (1963, p. 236) is generally credited with claiming the term for forensic science (Inman and Rudin, 2001; Champod, 2009). Kirk defined 'individualization' by distinguishing it from 'identification', which meant assigning an object to a taxonomic class of objects. For example, 'the criminalist would identify the object as a paint chip, but not relate it to the painted surface from which the chip derived'. 'Individualization', on the other hand, meant determining that

[2] For another use of this aphorism in socio-legal studies, see Bilz (2008).

TABLE 1 *Schematic explanation of conclusions of forensic association based on Kirk (1963)*

Term	Definition	Example	Potential donor pool	Alternate meanings
Identification	Determination that an object or trace is of a certain type.	An object is a paint chip (not some other hard, flaky object).	All objects of that type (all paint chips in universe)	In some disciplines, a colloquial synonym for *individualization*
Individualization	Determination of the only possible source of an object.	An object is a paint chip from a specific wall in a specific house.	1	

the source of that paint chip was a particular object, such as a particular wall (Table 1).[3] It was in this context that Kirk went on to famously assert '*Criminalistics is the science of individualization*' (entire sentence emphasized in original).

2.1 *Semantic issues*

Kirk's definitions of 'individualization' and 'identification' raised a semantic problem. Since 'fingerprint identification', as it was and is colloquially known, is more concerned with determining the sources of 'marks' than with determining whether marks are fingerprints, Kirk observed that fingerprint identification should have been called 'fingerprint individualization' and 'fingerprint identification bureaus' should have been called 'fingerprint individualization bureaus'. However, through an 'unfortunate failure of nomenclature' and 'bowing to the general scientific usage' fingerprint bureaus adopted the more familiar term 'identification'.

Kirk's discussion was confusing because he argued for a clearer nomenclature but, at the same time, acknowledged the desirability of conforming to common usage. In this way, he was confronting an age-old dilemma familiar to lexicographers: whether 'proper' language is language as it should be or language as it is used (for a witty popularized discussion of this issue, see Wallace, 2001). This leading figure in forensic science did not advise the profession on how to resolve the dilemma.

Many in forensic science echoed Kirk's account of the dilemma: they saw a conceptual distinction between 'identification' and 'individualization' and lamented the fact that vernacular usage compromised efforts to draw the distinction (e.g. DeForest *et al*., 1983, pp. 6–7; Tuthill, 1994, pp. 9–10; Wertheim, 2000; Olsen and Lee, 2001, p. 45). Even many forensic scientists who endorsed the distinction slipped into using the terms interchangeably compare (Champod, 2000 with Champod, 2009; see also Ashbaugh, 1999; Champod and Evett, 2001, p. 102; Olsen and Lee, 2001, p. 44). Some disciplines, like drug analysis, used the term 'identification' in Kirk's sense. But other disciplines, like fingerprints and firearms and toolmarks used the term interchangeably in official documents (AFTE 1998; SWGFAST, 2003a, 2012b).

[3] It is not entirely clear whether Kirk meant that the donor pool actually could be narrowed to a single source or whether he treated that as an aspiration that could be approached but never achieved. Kirk's statement, 'The real aim of all forensic science is to *establish* individuality, or to approach it as closely as the present state of the science allows' (236, emphasis added), would seem more consistent with the former interpretation.

TABLE 2 *Schematic explanation of conclusions of forensic association based on Inman and Rudin (2001). Note that the size of the potential donor pool diminishes, and probative value increases, as you descend through the table*

Term	Definition	Example	Potential donor pool	Alternate meanings
Identification	Determination that an object or trace is of a certain type.	An object is a paint chip (not some other hard, flaky object).	All objects of that type (all paint chips in universe).	In some disciplines, a colloquial synonym for 'individualization'. In some disciplines, 'classification'.
Classification	Reduction of the potential pool of sources of an object or traces to a group of potential sources.	An object is a paint chip from a specific brand, colour and lot.	All the paint chips of that brand, colour and lot.	
Individualization	Determination of the only possible source of an object.	An object is a paint chip from a specific brand, color, and lot AND a specific wall in a specific house.	1	

Inman and Rudin (2001, pp. 74–78, 113–151) brought some clarity by adding a third category to Kirk's two: they argued that, whereas 'identification' should denote the determination that an object is of a certain type (e.g. an item is a paint chip), the term 'classification' should denote the reduction of the potential donor pool of a trace to a group of objects (e.g. an item is a paint chip of a specific, brand, colour and lot). 'Individualization' should be reserved for the reduction of the donor pool to a single possible source (e.g. an item is a paint chip from a specific wall in specific house; Table 2). This terminology draws from the forensic notion of there being two kinds of 'characteristics': 'class' and 'individual'.[4] Colloquially, they suggest the distinction between 'classification' and 'individualization' may be understood as 'one-to-many' versus 'one-to-one'.

However, though Inman and Rudin's proposed framework has been endorsed by some forensic science textbooks (e.g. Houck and Siegel, 2006, pp. 59–63), it has certainly not been universally adopted in the forensic science community, and confusion surrounding the use of these terms across forensic science remains. Gaensslen *et al*. (2008), e.g. distinguish between 'identification' and 'individualization', but they use 'identification' to mean what Inman and Rudin mean by 'classification'.

2.2 *Individualization as testimonial conclusion*

The first guidelines drawn up by the U.S. Federal Bureau of Investigation-sponsored Technical Working Group on Friction Ridge Science, Analysis and Technology (TWGFAST) in 1998 codified

[4] I would question the sharpness of this distinction, but that is a matter for another day.

'identification' as one of three reports that latent print examiners were permitted to give (the other two were 'exclusion' and 'inconclusive'). Identification was defined as:

> the determination that two corresponding areas of friction skin impressions originated from the same person to the exclusion of all others (Simons, 1998, p. 156).

This definition characterized the reduction of the donor pool to a single source as having been 'determined'. The definition also incorporated the notorious 'six words', 'to the exclusion of all others', which would become the subject of much attention in ensuing years. The origin of the six words appears to have been the toolmark discipline (Cook, 1975; Berg, 1978). In the context of that discipline, the NRC (2008, pp. 83–85) would later comment that the six words 'cloak an inherently subjective assessment of a match with an extreme probability statement that has no firm grounding and unrealistically implies an error rate of zero', and it would recommend that such statements not be made. However, it is not clear precisely what the six words are supposed to mean and whether it is appropriate to characterize them as a 'probability statement' at all. The six words might be interpreted as a probability statement, as a characterization of the technique's accuracy, or as an expression of the analyst's confidence. The most natural interpretation is perhaps as a statement about population: a claim that the potential donor pool has been reduced to precisely one member. However, since the definition of 'identification' already makes that claim, the six words might also be interpreted as adding nothing to the definition of 'identification'—as merely being an emphatic repetition of the claim that two marks share a single common donor.

The earliest uses of the six words to characterize latent print identification that I have been able to locate were the draft TWGFAST guidelines (TWGFAST, 1997) and a statement by Adams comparing DNA to fingerprints (DNA Fingerprinting Comes of Age, 1997). Shortly thereafter, Ashbaugh (1999, p. 103) defined individualization, quite similarly, as 'the elimination of every other possible donor in the world except the one to whom the crime scene print is being compared in the opinion of the forensic identification specialist'. By 2002, SWGFAST (2002, s. 3.3.1), the successor organization to TWGFAST, had changed the term for its approved conclusion from 'identification' to 'individualization', which it defined as follows:

> INDIVIDUALIZATION. The determination that corresponding areas of friction ridge impressions originated from the same source to the exclusion of all others (identification) (SWGFAST, 2003a).

As noted above, however, the notion of individualization had already been critiqued over the years by a variety of scholars (e.g. Kwan, 1977; Robertson, 1990; Stoney, 1991; Risinger and Saks, 1996; Starrs, 1999; Champod and Evett, 2001; Inman and Rudin, 2001) and would be critiqued more in subsequent years (e.g. Thornton and Peterson, 2002; Cole, 2004; Broeders, 2006; Meuwly, 2006; Biedermann *et al.*, 2008; Champod, 2008; Mnookin, 2008; Saks and Koehler, 2008; Cole, 2009; Haber and Haber 2009, p. 24; Koehler and Saks, 2010; Page *et al.*, 2011; Amorim, 2012; Kaye, 2013; Houck, 2013). While the nature of these critiques varied, in broad terms these critiques expressed scepticism about the claim to have reduced the potential donor pool to one possible source. Such a claim had been characterized as 'not possible' (Stoney, 1991, p. 198) or 'not logically attainable' (Champod and Evett, 2001, p. 113), and a forensic report or testimony that claimed that it had been attained was, therefore, problematic.

3. First reform: the identification$_2$ solution

Even prior to the publication of the NRC Report, at least some latent print practitioners seemed to have become persuaded by the scholarly critiques of individualization (Langenburg, 2009, p. 252). But if individualization was to be disavowed, what conclusion would these practitioners report? It turned out they chose the term 'identification'. This approach was adopted, perhaps for the first time, by three examiner/scientists, Bergeron, Langenburg and Neumann, in the 2008 case *State* v. *Hull*. Because the distinctions being made are often quite subtle and to allow the witnesses the greatest chance to clarify their position, I will quote from the transcript of their testimony at length.

Bergeron testified first as follows:[5]

> Q: Okay. – And by comparing the unknown prints to the known prints, you hope to either declare an individualization or an exclusion between the unknown and the known, correct?
>
> A: Well when you say individualization and it's kind of a – when I come to my result, I'm actually referring to that as an identification. Individualization, the scientific community, kind of the international, it's, ah, more along the lines of excluding it to the possibility of all others on the face of the earth. But when we say an identification, um, being a scientist and being aware of the fact that the only way to really say an individualization could occur, is to actually do comparisons to all prints of everyone that has ever lived. With that being essentially physically impossible, um, and that can't occur, basically what I am doing when I'm making the result of an identification, I am telling you that I am confident that that latent print was made by this particular person.
>
> Q: And that is, meaning that particular individual?
>
> A: Yes.
>
> Q: So that would be an individualization; you'd be saying that this individual left that print?
>
> A: – Ah, no, the fact that when you used the term individualization, it does conjure up the idea that it is specific to that specific, or to that person. And when I say identification, it is my opinion and that I am confident in my result that this latent print and the known prints that I am comparing to were made by the same source.
>
> Q: Meaning that individual?
>
> A: No.
>
> Q: Well, what, so no? So you're saying that somebody else could have left the fingerprint besides Jeremy Hull?
>
> A: I'm simply saying that identification if you use the term individualization, I can't agree to it simply because of the, the, ah, when you look at latent prints and when I'm dealing with latent prints in general, an actual comparison of them, the – when we're doing a latent print examination the possibility exists that some person out there in the world, someplace, may potentially contain a similar number of minutiae that have been left by chance that would be enough minutiae in agreement that could potentially fool an examiner. But now in order for that to occur, we have to have several things actually come into place; 1) that

[5] The questioner was Andrew Northrup.

other individual had to have been at the scene and also left by chance that exact same area of ridge detail that we were comparing to and our known prints that we were given; and then on top of that, we also had to have a situation occur where that print was of poor enough quality that it would be able to fool the examiner; and in this case I didn't feel any of those were true. And in all of the proficiencies and tests that I've done where I've used the same methodology and the same idea behind making that identification, my results have been correct where that known truth has been set. And so when I say an identification, I am saying that I am aware and fully, you know, accounting for the fact that there is that minuscule if it so would be, it's a theoretical possibility that someone else out there on the planet may possess some ridge detail that may be in agreement enough to fool an examiner.

Q: Ah, you wrote a report on this case, correct – or two reports?

A: Yes . . . .

Q: Now do you recognize the language down there under – I want you to read the line that starts 112-LP1.

A: Yup. 112-1LP1-112-LP1 is referring to a specific latent print. And then it says, dash has been identified to the left ring fingerprint of Jeremy Jason Hull.

Q: Thank you. Now, so that fingerprint has been identified to Mr. Hull?

A: Yes.

Q: It does not say there is a miniscule possibility of somebody else matching that?

A: No, it does not.

Q: So it says, so your conclusion is that Mr. Hull left those fingerprints?

A: Yes, my conclusion is that yes, Mr. Hull left those fingerprints (*State* v. *Hull*, 2008, pp. 48–51).

Notice that Bergeron here has disavowed 'individualization' and chosen to testify instead to what he calls an 'identification' which appears to admit that the potential donor pool may contain more than single source. This rendered the testimony problematic vis-à-vis the fingerprint discipline for two reasons. First, SWGFAST allowed only inclusionary testimony of 'individualization', and the International Association for Identification (IAI, 1979) banned probabilistic testimony at that time. Second, Bergeron insisted that 'individualization' and 'identification' have distinct meanings, whereas, as noted above, several SWGFAST documents (SWGFAST, 2002, 2003a,b) clearly stated that they are synonymous.

These problems were exposed later in the hearing on the cross-examination of Langenburg, a SWGFAST member:

Q: Okay. Now, now you heard Mr. Bergeron's testimony earlier?

A: I did.

Q: Is that in compliance with the SWGFAST Guidelines?

A: Um, he did not declare individualization, he declared an identification. And we can clarify what those specifically mean if you prefer.

Q: Well, I mean, I guess what I'm, what I see is I see individualization with parenthesis with identification, right? [see the quoted SWGFAST language at section 2.2 of this article]

A: Um-hum, yup.

Q: And under that it has two paragraphs dealing with, um, defining individualization?

A: Um-hum, yes.

Q: But there's no paragraph dealing with identification?

A: True.

Q: And so are you saying that identification is, ah, parenthetical word that is not defined by this guideline?

A: Well in the guideline I don't believe it is defined. I don't and I'm not sure that all examiners will agree on exactly the distinction between individualization and identification. I don't know that.

Q: So you're saying there's a difference there?

A: I – yes, there is a clear difference to me.

Q: There's –

Q: To me there is a clear difference, as well as Mr. Bergeron.

Q: Well sure, and so, but SWGFAST has not chosen to clarify the difference in its guidelines?

Q: Ah, not in that particular guideline I don't believe they have.

Q: Is it clarified in any guideline?

A: I don't believe so. I don't know if it's open for discussion right now since we are reviewing continuously documents. It may be an open document, but I don't know if it is published – as it is. I don't think it is. I suspect it's not.

Q: Okay, so there's no published guideline that defines identification as to state [distinct?] from individualization?

A: No.

Langenburg goes on the define 'identification' as follows:

> [Bergeron] has examined a latent print; he has found these features; they're corresponding to another individual; and he's made a decision given the relevant population that the chance that someone else could have left that is so remotely small, he's willing to dismiss it and say yes, I believe that this latent print in my opinion was produced by that individual. He did not say that he's excluded everyone else on the planet and he left a theoretical possibility that there might be someone else on the planet that could have produced a similar looking latent print. And he has no way of calculating what that probab[i]l[it]y is at this time.

Upon being asked whether he disagrees with the SWGFAST documentation, Langenburg replies that he does, in that he does not believe that individualization is possible, except in situations with a

defined and limited set of possible suspects (*State* v. *Hull*, 2008, pp. 146–151). Later in the hearing, Neumann also endorsed this notion of 'identification' distinct from 'individualization' (*State* v. *Hull*, 2008, p. 174).

How should we understand this new conclusion of 'identification'? It is certainly not what Kirk meant by 'identification'—the determination that a trace is a fingerprint. Indeed, we are going to have to label it 'identification$_2$' in order to distinguish it from Kirk's 'identification$_1$'. The three witnesses explicitly stated that it was not 'individualization'. Nor is it Inman and Rudin's 'classification' because it does not explicitly acknowledge 'multiple potential common sources for an evidence item' (Inman and Rudin, 2001, p. 115). The testimony does not speak of multiple sources; it asserts a single possible source. Any ambiguity on the matter (deriving perhaps from the difficulty of deriving meaning from oral testimony) may be cleared up by reference to Bergeron's (2008) written explication of his testimony where he clarifies that 'identification$_2$' means 'beyond a reasonable doubt (the "doubt" being this unknown theoretical possibility) we have reached a conclusion (opinion) that a particular latent was made by *a certain source and no one else*' (emphasis added).

It appears, then, that 'identification$_2$' purports to be some sort of intervening conclusion situated somewhere between 'classification' and 'individualization' on the continuum of probative value, though much closer to 'individualization'. The potential donor pool for conclusions of 'identification$_2$' appears to be the same as the potential donor pool for conclusions of 'individualization', one individual. The only difference seems to be, as Bergeron (2008) explicates, that 'individualization' conveys a potential donor pool of 1 with '*zero*' (original emphasis) probability of being false whereas 'identification$_2$' conveys a potential donor pool of 1 with a 'theoretical possibility' of being false. Table 3 illustrates how this new testimonial conclusion would fit into the scheme of conclusions described by Table 2.

Identification$_2$ raises several important issues. The first issue is semantic. While the appeal of 'identification' as an alternative to 'individualization' is understandable, one also has to ask whether, in seeking a term to denote a new way of reporting latent print conclusions, it was wise to chose a term that is officially defined by the profession as a synonym of the term the examiners were seeking to displace. Furthermore, other disciplines within forensic science use that same term to mean something different.

Second, it is not entirely clear that identification$_2$ is logically distinct from individualization. One must ask whether there is a logical difference between the statements:

> [A]. Individualization: The defendant is the source.
>
> and
>
> [B]. Identification: The defendant is the source, and there is a theoretical possibility that this statement is false.

The critique of individualization was always that a categorical statement by a forensic analyst that 'the defendant is the source' was 'not possible' (Stoney, 1991, p. 198) or 'not logically attainable' (Champod and Evett, 2001, p. 113). Some value must be assigned to the probability that the defendant is not the source (Lindley, 2006, p. 91). Claim [A], to the extent that it did not admit the possibility of error, was never a defensible claim in the first place. The concession of the possibility of error in claim [B], therefore, was less a concession than a belated admission of something that must always have been true about claim [A].

TABLE 3 *Schematic explanation of conclusions of forensic association based on Inman and Rudin (2001) with identification$_2$ added and distinguished from identification$_1$*

Term	Definition	Example	Potential donor pool	Alternate meanings
Identification$_1$	Determination that an object or trace is of a certain type.	An object is a paint chip (not another hard, flaky object).	All objects of that type (all paint chips in universe).	In some disciplines, a colloquial synonym for 'individualization'. In some disciplines, 'classification'. See identification$_2$.
Classification	Reduction of the potential pool of sources of an object or traces to a group of potential sources.	An object is a paint chip from a specific brand, colour, and lot.	Multiple (all the paint chips of that brand, colour, and lot).	
Identification$_2$	Determination of the only possible source of an object with a theoretical possibility of being false.	An object is a paint chip from a specific brand, colour, and lot AND a specific wall in a specific house.	1 with a theoretical possibility of more.	
Individualization	Determination of the only possible source of an object.	An object is a paint chip from a specific brand, colour, and lot AND a specific wall in a specific house.	1	

'Individualization' was dead, but long live 'identification$_2$'. This first reform enacted *le mort saisit le vif* by killing individualization only to instantaneously transfer sovereignty to a concept with a slightly different—or perhaps synonymous—name but whose logical distinction from the 'dead' concept of 'individualization' was at best questionable.

However, whatever the problems with the above resolution to the individualization dilemma, it represented a road not taken. Although Langenburg himself has continued to draw the distinction (*State* v. *Dixon*, 2011, pp. 117–130), no significant body within the fingerprint profession has endorsed the semantic move of replacing testimonial claims of 'individualization' with 'identification$_2$'. Individualization was not dead yet.

4. The NRC report

In 2009, the landmark NRC Report was published. With regard to 'individualization', it noted:

> Often in criminal prosecutions and civil litigation, forensic evidence is offered to support conclusions about 'individualization' (sometimes referred to as 'matching' a specimen to

> a particular individual or other source) or about classification of the source of the specimen into one of several categories.

Notice that the NRC Report adopts Inman and Rudin's terms 'classification' and 'individualization'. However, it goes on to note:

> With the exception of nuclear DNA analysis, however, no forensic method has been rigorously shown to have the capacity to consistently, and with a high degree of certainty, demonstrate a connection between evidence and a specific individual or source (NRC, 2009, p. 7).

This statement clearly included fingerprint identification. With regard to fingerprinting, quoting Mnookin (2008), the Report added:

> fingerprint identification experts should exhibit a greater degree of epistemological humility. Claims of 'absolute' and 'positive' identification should be replaced by more modest claims about the meaning and significance of a 'match' (NRC, 2009, p. 142).

A report issued by the most prestigious scientific institution in the USA had stated that the testimonial conclusion which latent print examiners were 'required' to use was not supported. The NRC Report had stated that latent print examiners could not say what SWGFAST and IAI told them to say (Eldridge, 2009). This set up a discrepancy between a clear mandate of the leading professional organizations of fingerprint examiners and a clear mandate of the leading scientific institution in the USA.

5. Second reform: the SWGFAST 2009 modification

How did professional organizations react to this discrepancy? On the one hand, SWGFAST defended individualization, stating that it 'respectfully disagrees' with the NRC Report's statement about individualization (SWGFAST, 2009a).[6] On the other hand, immediately after the publication of the NRC Report in 2009, the IAI advised its 'members . . . to avoid stating their conclusions in absolute terms when dealing with population issues' (Garrett, 2009), which would seem to constitute a concession that the potential donor pool cannot ever be reduced to 1.

Thus, the profession's position with regard to individualization was, at best, confusing. However, SWGFAST soon published a modification of its definition of 'individualization'. Presumably due to lag by SWGFAST, the 2009 Modification was a response not to the NRC Report, but to the *Hull* case (Triplett, 2012). The 2009 modification of the definition of 'individualization' was as follows[7]:

> *INDIVIDUALIZATION. The ~~determination~~ conclusion that corresponding areas of friction ridge impressions originated from the same source ~~to the exclusion of all others (identification)~~* ' (SWGFAST, 2009b).

[6] SWGFAST supported that statement with the following: 'History, practice, and research have shown that fingerprints can, with a very high degree of certainty, exclude incorrect sources and associate the correct individual to an unknown impression' (SWGFAST, 2009a). Since no citations or references are offered, it is unclear to what 'research', e.g. this statement refers. Moreover, the use of the word 'can' renders the statement trivial.

[7] For clarity in following the changes, I use here formatting conventions standard for the amendment of laws, in which deleted text is struck through and added text is underlined.

It will be apparent that two changes were made. The first was the slight downgrading in strength of the term 'determination' in favour of the term 'conclusion'. This represented a positive, if small, step in the right direction away from the legacy of overstating the strength of fingerprint evidence. The more confusing change was the deletion of what I have elsewhere called 'the six little words' (Cole, 2011), 'to the exclusion of all others'. That change raises several issues that require discussion.

5.1 *Semantic issues*

It will be apparent that SWGFAST adopted the *Hull* solution conceptually, but not terminologically (Triplett, 2012). Whereas the *Hull* witnesses adopted a new term—though, admittedly, one that already had many other uses and meanings in both forensic science generally and fingerprint analysis—to label this new testimonial conclusion purportedly distinct from 'individualization', SWGFAST kept the term the same and changed the definition. Instead of shifting to 'identification$_2$', SWGFAST redefined 'individualization' to mean what the *Hull* witnesses meant by identification$_2$. Thus, SWGFAST acceded to the *Hull* witnesses' repudiation of 'individualization', but, instead of discarding the term, redefined it. Semantically, this seems an odd way of proceeding. As the NIST Report, written by a committee that included a significant contingent of practicing latent print examiners (including two of the *Hull* witnesses), cogently observed:

> [G]iven that the word 'individualization' has been associated precisely with the 'to the exclusion of all others' claim of universal individualization based on a premise of general uniqueness, it is potentially problematic and confusing to attempt to redefine it by fiat. Using alternative terminology might be a superior solution to attempting to 'legislate' a new and slightly modified meaning to a much-criticized term and theory (NIST, 2012, p. 73, cross-reference omitted).[8]

Or, as Bunch and Wevers (2013, p. 228, original emphasis) put it, such redefinitions impose on expert witnesses a 'need to explain in trials or scientific validity hearings how the term *individualization* fails to mean certainty'.

5.2 *Conceptual issues*

Again the question arises whether this purported 'change' is in fact a change at all. Does the deletion of the six words mean anything at all? The answer would seem to hinge on the original function of the six words when they were included in the initial TWGFAST definition in 1997 (see Section 2.2). Were they merely a redundant clarifying gloss, an emphatic repetition of the proposition 'originated from the same source', or did they constitute an independent proposition?

A strong argument can be made that the deletion of the six words changes nothing. There does not appear to be any logical distinction between the statement

> [C]. *The mark and the print originated from the same source.*

and the statement

> [D]. *The mark and the print originated from the same source to the exclusion of all others.*

[8] Given that there is at least some overlap in the memberships of SWGFAST and the NIST Expert Working Group, this critique suggests that both groups' published documents do not enjoy the complete consensus of their memberships.

The same source is the same source. The statements are logically equivalent. Adding (or deleting) the words 'to the exclusion of all others' would not seem to change anything. Thus, even testimony without the six words would seem to run afoul of the NIST Report's recommendation that 'latent print examiners should not report or testify, directly *or by implication*, to a source attribution to the exclusion of all others in the world' (NIST, 2012, p. 72, emphasis added).

Although the elimination of the six words does not seem make any logical difference, it is possible that they signal a change in justification for what remains the same statement. Three possible changes in justification present themselves: the acknowledgement of a 'theoretical probability', what I will call 'actual elimination', and what Kaye *et al.* have called 'local individualization'.

5.2.1 *'Theoretical' probability.* One possible change in justification is suggested by Bergeron's (2008, original emphasis) defense of the *Hull* testimony in which he wrote: 'I am 100% certain (if you want to put a number on it) of my opinion that this person left this latent. However, since I believe there is a minute theoretical possibility as stated above, I can't truthfully testify to individualization *to the exclusion of all others*'. For Bergeron, the deletion of the six little words appears to represent the difference between attaching a value of zero to the probability that the impressions derive from different sources and attaching a value of 'minute theoretical possibility' to the probability that the impressions derive from different sources. If so, the deletion would represent a very minimal change, one that hinges on the mistaken belief that it was possible in the first place to attach a value of zero to the probability that the impressions derive from different sources (Lindley, 2006, p. 91).

5.2.2 *Actual elimination.* Another possible change in justification is suggested by Triplett (2012, who, it should be noted, is not an advocate of the *Hull* solution): the purpose of the deletion of the six words was 'to specify that the unknown impression was not compared to every possible source'. This is consistent with Langenburg's explanation in his *Hull* testimony that 'individualization' is only possible in problems involving suspect sets in which all members are available for examination (e.g. a murder on a lifeboat) (*State* v. *Hull*, 2008, p. 148).[9] It also seems consistent with the following *Hull*-like testimony by Eldridge[10]:

> Q. So let's be really clear. You believe that you—the science—you are—there's a—you are scientifically validated to testify that one person is the source of a fingerprint?
>
> A. Yes.

[9]The colloquial term 'closed set' is often used to describe problems like lifeboat murders. I decline to use that term here because the 'open' versus 'closed' set distinction is muddled. All suspect pools are in some sense 'closed' in that some members of the human population are not possible suspects. What makes lifeboat problems different is not the 'closedness' of the suspect pool, but the availability of the entire suspect pool for examination. I thank Michael Risinger, who suggests that the term 'examinable set' would be preferable, for making this point.

[10] The questioner was Rosalind Lee. At the time of this testimony, Eldridge was a Forensic Analyst for the Eugene, Oregon Police Department with 5 years experience in forensic science and 4 years experience in latent prints. She had completed 300 h of coursework in latent prints and received 2 years of internal training. She had 'received the best training available from the most respected authorities in the discipline' (Affidavit of Heidi Eldridge, *State* v. *Doe*, 2010). She held a master's degree in Biology from Duke University, one of the most prestigious research universities in the USA. This level of formal scientific training seems quite high relative to most practicing latent print analysts in the USA (Furton *et al*., 1999, p. 131). Far from being an anomalous example of poorly articulated testimony, I contend, based on my reading of a substantial volume of U.S. testimony by fingerprint examiners, that, in fact, the situation is just the opposite: Eldridge's testimony represents a relatively high level of scientific sophistication relative to the universe of latent print testimony in the USA at that time.

> Q. But you're not allowed to say to the exclusion of all others?
>
> A. Correct.
>
> Q. But when you say that one person is the source of the fingerprint, that's what you're saying.
>
> A. No.
>
> Q. What is the difference between one person being the source of the fingerprint and to the exclusion of all others?
>
> A. So basically what I'm saying is that I've looked at this print, this latent print. I've looked at the standard. And the amount of information I've seen in agreement and the lack of disagreement has led me to believe that they come from the same source. Now, because I have not compared this latent print to everyone else that ever lived, lived, will live, I cannot unequivocally state that there isn't a possibility, however remote, that somebody out there in the whole wide universe ever, might not have a fingerprint or a fingertip that could leave behind an impression that was similar enough to the latent print that I have that they could be easily confused. So I'm leaving open the door for that small theoretical possibility that somebody else could have a similar enough print to create confusion. . . . (Trial Transcript, *State* v. *Doe*, 2010, pp. 120–121).[11]

It seems, then, that some fingerprint examiners perceive the words 'to the exclusion of all others' to imply an 'actual elimination' approach—i.e. to imply that the examiner has *actually excluded* 'all others' as donors by examining their fingerprints. Since this is obviously not the case, except in problems involving suspect sets where all members are available for examination, fingerprint practitioners might see the deletion of the six words as a concession that 'individualization' is an inferential claim, rather than a claim to have actually eliminated 'all other[]' possible donors. If this is indeed the case, the deletion would be a very minimal change since it seems unlikely that anyone ever believed that individualization claims were based on the actual comparison and elimination of all possible donors through examination of their fingerprints. Indeed, as the above discussion makes clear, 'individualization' was always a claim that the probability the two impressions derive from different sources could be eliminated without examining every area of friction ridge skin the world, based on certain assumptions about the variability of friction ridge skin and examiners' ability to perceive and weigh the rarity of those variations (see Triplett, 2012).

The 'actual elimination' argument is potentially misleading because it implies that the only problem with individualization was the problem of induction—the fact that it is not possible to examine every area of friction ridge skin (whether the population is construed as limited to the living or extended to the not-living). This suggests that the only trouble with individualization is its failure to live up to the impossible standard of examining every area of friction ridge skin in the universe. Such an argument neglects the facts that defensible probabilistic inferences can be made without examining every potential source object in the world and even access to all the prints in the world would not preclude the need for probabilistic inference (Cole, 2011, p. 479).

[11] At the defendant's request, the name is not revealed.

5.2.3 *Local individualization.* A third possible change in justification is that the removal of the six words represents an attempt to adopt the notion, posited by Kaye et al., of 'local individualization' (Kaye et al., 2004; Kaye, 2009, 2010; NIST, 2012, p. 18). Whereas 'universal individualization' implies the reduction of the potential donor pool to 1 within the maximum possible population pool, or the 'earth population paradigm' as Champod (2009) calls it, 'local individualization' implies the reduction of the potential donor pool to 1 within a limited population pool. Kaye agrees that universal individualization is not possible, but argues that local individualization is sometimes possible. Problems involving suspect sets in which all members are available for examination (e.g. a murder on a ship) constitute one example of cases in which 'local individualization' is possible, but Kaye contends that 'local individualization' can also be possible even if all those inhabitants' fingerprints are not available for examination.

The continuation of Eldridge's testimony quoted in the preceding section offers an example of an examiner claiming that the removal of the six words transforms individualization from 'universal' to 'local':

> . . . That being said, looking at the information before me, considering the relevant population—in other words, we're excluding that guy that died in China 600 years ago, I feel comfortable that there's enough information here to make that call.
>
> Q. Okay. And who is the relevant population?
>
> A. Anybody who may have had reasonable access. I'm – start off with people in the United States, if you like, or people alive right now. You know something smaller than all the prints –
>
> Q. So which – those are three very different things.
>
> A. Yes.
>
> Q. On the one hand, you're looking at the facts of the case and you're saying, well, anyone who had access.
>
> A. Mn-hmm.
>
> Q. Okay. What is the scientific justification for you to consider that as your pool?
>
> A. Well, the pool isn't really up to me. I mean that's – that's kind of information about the case that I'm not privy to. Really I'm just looking at the prints. The less I know about the case the happier I am . . . .
>
> Q. Right. But we're talking about the relevant population.
>
> A. Mm-hmm.
>
> Q. Who is the relevant population that you are excluding?
>
> A. It's going to vary. I mean, I don't think I can give you a sort of solid answer on that because it's going to depend on where the incident happened, who was around when it happened. A lot of things we don't know.
>
> Q. So you – so then how can you know – how can you make this conclusion without knowing who you're excluding?
>
> A. I guess what I'm saying is that I'm not specifically excluding anyone, because I haven't made a comparison against that person. What I'm doing is including someone. And I'm

> allowing for the possibility that there may theoretically be another possible conclusion out there (121-23) . . . .
>
> Q. Right. So you don't know who you're excluding, correct?
>
> A. Well, I can tell you I'm excluding everyone who hasn't been born yet. I'm excluding everybody who died 20 years ago. I mean some of these are no-brainers.
>
> Q. Okay. So – right. But, I mean, really. Let – I mean, we can talk about this, you know, reasonably, right? That you say I'm excluding the relevant population, but you can't identify the relevant population?
>
> A. I'm not saying I'm excluding the relevant population. I'm saying that I'm including the person who I've compared who bears that degree of similarity.
>
> Q. Okay. And how many people in this case are in the relevant population?
>
> A. I don't know.
>
> Q. What is the likelihood that somebody else in this relevant population could have a similar fingerprint?
>
> A. I would say it's very low, but I don't have a number.
>
> Q. How do you know that it's low? What is the scientific basis for that opinion?
>
> A. Well, that would be going back to the uniqueness (124-25).

While the testimony seems to draw on the notion of 'local individualization', it deviates from Kaye's articulation of the notion in important ways. First, Kaye envisioned an explicit statement of the relevant population pool, which the witness here steadfastly declined to provide.[12] Indeed, since Eldridge concedes only having limited the pool to the living human population by excluding the dead and unborn, it is unclear that the testimony really does constitute 'local', as opposed to 'universal' individualization. Second, Kaye (2009, p. 92) envisioned an articulated estimate of the random match probability, which the examiner has again declined to provide. As the NIST Report (2012, p. 131, edited and partially authored by Kaye, see p. x) notes:

> For single-source testimony to be admissible under the theory that the random-match probability is so small that the duplication probability in a particular region is negligible, the expert would need to have a reasonable estimate of the random-match probability, or at least an upper bound on this quantity.

5.3 *Ethical implications*

If it is correct that the deletion of the six words logically changes nothing, the ethical implications are disturbing because some courts have treated the preclusion of the six words as a remedy for the alleged

[12] Eldridge's stated reason for not articulating the suspect pool—a deliberate lack of knowledge about the case—illustrates a potential tension between the 'local individualization' concept and recent calls for 'sequential unmasking', measures to combat bias by 'protect[ing] examiners from exposure to extraneous (domain-irrelevant) information in a case' (NIST, 2012, p. 207). Because the more information the analyst has about the case, the more precisely she should be to estimate the size of the suspect pool, a local individualization approach would seem to argue in favour of providing the analyst with as much contextual information about the case as possible. A sequential unmasking approach, however, would argue in favour of providing the analyst with as little contextual information as possible.

overclaiming associated with latent print reporting. At least three courts have responded to defence challenges to fingerprint testimony by barring latent print examiners from using the words 'to the exclusion of all others' (*State* v. *Pope*, 2008; *State* v. *Doe*, 2010; *United States* v. *McCluskey*, 2013). In one of these cases, the examiner, again Eldridge, made clear that she intended to testify that the defendant was the source of the print:

> Q. So to make sure we're clear, you propose to testify that [the defendant] is the source of the fingerprints that you were provided?
>
> A. Yes.
>
> Q. You're willing to concede a theoretical possibility it could be someone else?
>
> A. Yes.
>
> Q. But you don't under — you don't — you are unable to articulate what that theoretical possibility is?
>
> A. Correct (Trial Transcript, *State* v. *Doe*, 2010, p. 135).

The court apparently would have allowed this testimony even though it had granted the defence motion to bar the use of the six words (which the witness indicated she had 'no intention' of using anyway; Affidavit, *State* v. *Doe*, 2010).

5.4 *Summary*

Rather than discarding the term and concept of 'individualization' as some scholars (Saks and Koehler, 2008; Cole, 2009; Koehler and Saks, 2010) and even the *Hull* witnesses had suggested, the 2009 Modification enacted *le mort saisit le vif* by killing off 'individualization' and instantaneously transferring sovereignty to the same term with a purportedly 'new' definition. Whether this 'new' definition was logically distinct from the old definition is at least unclear, if not downright doubtful. Far from signalling the end of individualization, the 2009 Modification either changed nothing or represented extremely minimal changes. Individualization was not dead yet. However, yet another Modification was in the offing that would at least appear far more dramatic.

6. Third reform: the SWGFAST 2011 modification

The 2009 Revision fell short of resolving the bind posed by individualization and the NRC Report, but further signs of concession to the critiques of individualization soon appeared. In 2010, the IAI passed a Resolution rescinding its 1979 Resolution banning 'probabilistic' testimony (IAI, 2010). This seemed to undermine a non-probabilistic understanding of 'individualization'. A very few courts began to show signs of discomfort with individualization as well. One federal court prohibited 'individualization' testimony (*United States* v. *Zajac*, 2010). Another court indicated that it might well have prohibited such testimony had it not deemed the error harmless (*Commonwealth* v. *Gambora*, 2010). However, many other courts allowed 'individualization' testimony (e.g. *United States* v. *Pool*, 2009; *Markham* v. *State*, 2009; *United States* v. *Aman*, 2010; *Bond* v. *State*, 2010; *United States* v. *Council*, 2011).

In 2012, SWGFAST issued a Position Statement that stated 'The ability of a latent print examiner to individualize a single latent impression, with the implication that they have definitively excluded all other humans in the world, is not supported by research' (SWGFAST, 2012b). At first glance, this

sounded like it might signal the death of individualization at last. A closer reading, however, reveals that it is, not a repudiation of individualization, but yet again, merely a repudiation of 'the six words', the notion of 'excluding all others'. Indeed, the Position Statement refers the reader to yet another modification issued the previous year—the second in three years—of the definition of 'individualization', which, it would appear, remained alive and well. The 2011 Modification reads:

> INDIVIDUALIZATION. Individualization is the decision by an examiner that there are sufficient features in agreement to conclude ~~The conclusion~~ that ~~corresponding~~ two areas of friction ridge impressions originated from the same source. Individualization of an impression to one source is the decision that the likelihood the impression was made by another (different) source is so remote that it is considered as a practical impossibility (SWGFAST, 2011a).

Unlike the 2009 Modification, the 2011 Modification appears to represent a wholesale revision, rather than the deletion and changing of a few words. Two things stand out in the 2011 Modification: the use of the term 'likelihood' and the use of the term 'decision'. These two innovations will be considered in turn.

6.1 *The probability of a practical impossibility*

Through its colloquial (though technically incorrect) use of the term 'likelihood' to mean 'probability',[13] the 2011 Modification is the first SWGFAST definition of 'individualization' to acknowledge the existence of probabilistic reasoning at all and to explicitly require the consideration of the probability that two impressions derive from different sources.[14] In so doing, the 2011 Modification seems to reflect a long overdue embrace of a probabilistic approach to forensic evidence, something that has long been advocated for the fingerprint discipline (Champod and Evett, 2001). Closer examination, however, casts doubt on the notion that the 2011 Modification represents a truly probabilistic approach to fingerprint analysis.

The current forensic statistical approach would be to ask the forensic analyst to assign two probabilities: (1) the probability of the evidence if the impressions derive from the same source; (2) the probability of the evidence if the impressions derive from different sources. The 2011 Modification

[13] SWGFAST appears to be using the term 'likelihood' as a colloquial synonym for 'probability', but statisticians reserve the term 'likelihood' to refer to the conditional probability of certain evidence given a hypothesized value of a parameter (Hacking, 2001, p. 174; Dawid, 2005, p. 49; Taroni *et al*., 2006, pp. 9–10). As Hacking (2001, p. 174) notes, 'This is very confusing because in ordinary English, "probability" and "likelihood" in many contexts are synonyms'. The homology between this situation and that described in Section 3 of this article, in which an attempt is made to create a technical distinction between the colloquial synonyms 'individualization' and 'identification', should not be lost on the reader. In both cases, a group of technical experts have chosen to create a technical semantic distinction between two words that are synonyms in colloquial language. Since both expert groups count communicating with the public among their assigned duties, these choices create difficulties. And, in both cases, the expert groups now consider themselves locked into these confusing terminologies because they have 'become absolutely fixed' (Hacking, 2001, p. 175). A similar situation relevant to scientific evidence also obtains with regard to the words 'reliability' and 'validity' (Giannelli, 1980, p. 1201).

It is possible—though I think unlikely—that SWGFAST was using the term 'likelihood' in the technically correct sense, and its use of the term was meant to signal that. If so, one might have expected SWGFAST to use more explicit language to clarify its intention and distinguish it from the colloquial meaning of the word 'likelihood', especially given that much of the readership of SWGFAST documents is probably unfamiliar with statisticians' technical distinction in nomenclature.

[14] I am aware the most forensic statisticians argue that forensic analysts should report the probability of the evidence given the proposition, rather than the probability of the proposition itself. However, the most natural reading of the SWGFAST text is that it refers to the proposition. Even though this commits the dreaded fallacy of the transposed conditional (Lindley, 2006, p. 79), it is not appropriate for me to assume that SWGFAST intended to avoid transposing the conditional.

seems to suggest that the forensic analyst should report an 'individualization' when the probability that the impressions derive from different sources is 'practical impossibility' or less. If the probability that the impressions derive from different sources is greater than 'practical impossibility', the analyst should report 'inconclusive' (unless, of course, the probability that the impressions derive from different sources is so strong that the analyst should report 'exclusion').

A probability may be conceived as having a value between 0 and 1 (Lindley, 2006, p. 91), but it is acceptable to express it with either numbers or words. The 2011 Modification espouses a verbal, rather than a numerical, way of characterizing the probability of interest. This alone is not fatal to the exercise, but we are still entitled to inquire to what sort of numerical value is 'practical impossibility' equivalent (Lindley, 2006, p. 44)? In other words, what is the probability of 'a practical impossibility'?

'Practical impossibility' is hardly a statistical term of art. The term appears very rarely in the statistical literature, and Spiegelman and Tobin (2013) have stated that its complement, ' "practical certainty" cannot be operationally defined and has no scientific meaning'. The most extensive use of the term is found in the literature on teleological arguments for the existence of God, where some have claimed that a probability of 10^{-50} is equivalent to a 'practical impossibility' (Ratzsch, 2013). The basis for this claim has been attributed to Borel in some 'creationist' texts.[15] Although Borel did not use the term 'practical impossibility', 'Borel's law' states that 'Phenomena with very low probabilities do not occur' (Borel, 1962, p. 1), and Borel (1962, p. 28) specified 10^{-50} as the threshold for non-occurrence for events on 'the cosmic scale'. 10^{-50} seems not much less preposterous a value for the probability that two impressions derive from different sources than 10^{-97}, the 'entirely insupportable' (Champod and Evett, 2001, p. 112) figure that was bandied about a decade ago to such severe criticism (see also Wayman, 2000; Stoney, 2001; Pankanti *et al*., 2002; Kaye, 2003a). This would seem to suggest that assigning a probability of 'practical impossibility' to an event means that the analyst believes that it does not (and will not) occur.

Since 'practical impossibility' is not a statistical term of art, where did SWGFAST derive the term? Although it is possible to find claims that the probability of fingerprint error is 'practical impossibility' in the literature as early as 1980 (Duke, 1980, p. 11), the term does not seem to have appeared in official documents until the 2011 Modification. However, the Association of Firearm and Toolmark Examiners (AFTE) Theory of Identification has used almost exactly the language found in the 2011 Modification since 1992 (AFTE Criteria for Identification Committee, 1992; AFTE, 1998; Committee for the Advancement of the Science of Firearm & Toolmark Identification, 2011). Several texts (e.g. Biasotti and Murdock, 2002), however, trace the origin of 'practical impossibility' to Biasotti's (1959, p. 44) classic study in which he claimed that the probability of the chance occurrence of more than four consecutive matching striations could be reduced to 'for all practical purposes impossible' based on the probability estimates generated by his study of consecutive matching striations. Once again, therefore, the latent print discipline appears to be adopting language from the toolmark discipline.

Later toolmark writings made clear that 'practical impossibility' was meant to convey a probability greater than zero, although there is some residual inconsistency on that point (Biasotti *et al*., 2012: compare 688 with 694). Likewise, some toolmark examiners emphasize the distinction between 'absolute identity' and 'practical identity' (Nichols, 2007b, p. 590), 'absolute certainty' and 'practical certainty' (*United States* v. *McCluskey*, 2012, p. 24 [Aug. 22]), and 'absolute impossibility' and

[15] 'Creationism', which may be less well known outside the USA, is a religiously inspired alternative to Darwinian evolutionary theory.

'practical impossibility' (*United States* v. *McCluskey*, 2012, p. 109 [Aug. 21]). The discipline's efforts to turn practical impossibility into a reasonable non-zero probability by distinguishing it from the (possibly redundant) notion of 'absolute impossibility' rests upon the same 'actual elimination' argument we saw earlier (see Section 5.2.2): the claim that 'absolute impossibility' would be impossibility achieved through examination and elimination of all candidate sources, whereas 'practical impossibility' would be impossibility achieved through statistical inference (*United States* v. *McCluskey*, 2012, p. 24 [Aug. 22]).

The AFTE Theory of Identification offers no more information about the purported meaning of the term, or the basis upon which such probabilities rest, than does the SWGFAST 2011 Modification. Nor does the toolmark literature.[16] The NRC noted that 'no specific empirical definition is given for', among other terms, 'likelihood . . . so remote [as to be considered a practical impossibility]' (NRC, 2008, p. 60). As one U.S. court has summarized the situation, 'At the current time, there is no statistical model or study that can quantify the meaning of the term "practical impossibility" ' (*United States* v. *McCluskey*, 2013, p. 30).

Moreover, the claim that Biasotti's study and its follow-up studies provide a basis for probabilistic claims of 'practical impossibility' for toolmark analysis (let alone fingerprints) seems shaky. Biasotti counted the greatest number of consecutive matching striations from different tools in his sample (4), and he inferred that a finding of consecutive matching striations greater than that reduced the probability of different source origin to 'practical impossibility'. This has been characterized as a 'probability model' that has been improperly represented as an 'identification model' (Bunch, 2000, p. 961). The soundness of making a probabilistic inference of 'practical impossibility' from this counting approach has been questioned from within the toolmark discipline (Bunch, 2000, p. 961; Champod *et al*., 2003, pp. 313–314) leading Howitt *et al.* to observe as recently as 2008: 'The statistical likelihood that a particular correspondence of the striae will occur by chance has . . . never been properly assessed' and Petraco *et al.* (2012, p. 901) to observe 'there are no standard methods for the application of probability and statistics to the analysis of tool mark evidence'. Indeed, Murdock has made clear that the Biasotti 'practical impossibility' claim is 'not based on mathematical estimates of probability, they are based on longstanding series of empirical testing and validation testing' (*United States* v. *McCluskey*, 2012, p. 36 [Aug. 22]).

But setting aside whatever criticisms may be made of the Biasotti line of studies, one can still ask whether the verbal characterization 'practical impossibility' is the optimal way to convey the probability estimates for toolmark analysis. For example, what Murdock characterized as 'mathematical estimates of probability' for toolmark associations have now been published. However, the probability of 'practical impossibility' is conspicuously absent from these works. Instead, they report numerical probabilities (Howitt *et al.*, 2008). These numerical probabilities can be converted into verbal

[16] Biasotti and Murdock (1984, p. 16) discussed what was presumably a probability comparably small as 'practical impossibility': a 'chance[] . . . so small that for practical purposes it can be disregarded'. They then asked the same question posed by the present article: 'What is the rational [*sic*], either theoretical or empirical, which allows us to make identifications of this nature?' Remarkably, having posed this question, Biasotti and Murdock never do go on to provide a rationale for assigning this very small value to the probability that two toolmarks derive from different sources. Instead, they merely provide a description of the process of toolmark analysis. Elsewhere Biasotti and Murdock (2012, p. 694) have defined 'practical impossibility' as 'a probabilistic inference of practical certainty'. Nichols, despite promising a 'more precise definition' (591) of 'practical impossibility', never offers one. The article instead segues into a discussion of whether firearms and toolmark analysis is subject to statistical analysis at all concluding only that 'The potential role for statistics in the firearms and tool mark discipline has been and continues to be studied' (592). Indeed, Nichols's text has been read as suggesting that the firearms and toolmark discipline does not require a statistical conceptualization (Biedermann *et al*., 2008, p. 128; see also Nichols, 2007a). If so, this would make this article a rather unpromising place to look for a coherent articulation of the probability of 'a practical impossibility'.

formulations, but the underlying numerical probability still remains. Moreover, even when a table of verbal formulations has been provided, 'practical impossibility' was conspicuously absent. 'Extremely strong support for a conclusion that two marks were made by the same tool surfaces' is the strongest conclusion provided (Buckleton *et al*., 2005, pp. 356–357). Of course, probabilities do not necessarily have to be formulated numerically. Champod *et al.* (2003) describe a Bayesian approach to toolmark evidence that would generate subjective, non-numeric probabilities. For example, Champod *et al*.'s (2003, p. 310) verbal characterization of 'a very high likelihood ratio' is 'the probability of obtaining this evidence if they were fired in different firearms is very low'. Given that the verbal characterization of the probability as 'very low' would be less exotic, it is difficult to understand either the preferability or the empirical or logical basis for the rather mysterious probability of 'practical impossibility'.

For these reasons, neither the Theory of Identification nor the toolmark literature provides a defensible justification for claims that toolmark analyses can reduce the probability that two impressions derive from different sources to 'practical impossibility'.[17] Needless to say, adopting this language does not provide such a justification for fingerprint analyses. Curiously, the Chair of SWGFAST recently testified that she herself prefers not to use the term 'practical impossibility', although she claimed that testifying that she 'would not expect to see the same amount of information repeated in a different source . . . meant essentially the same thing' (*United States* v. *McCluskey*, 2013, p. 30).[18] How SWGFAST expects 'To establish and disseminate guidelines and standards' (SWGFAST, 2011b) across the discipline (or at least the discipline in the USA) when its own Chair opts out of using its guideline for reporting fingerprint conclusions is not clear.

While the precise value of 'practical impossibility' remains obscure, it seems clear that it is meant to convey a very small value that is very close to zero. This seems an aggressively low value for at least two reasons. First, the 2011 Modification offers scant explanation of the criteria for forming such a probability other than 'sufficient features in agreement'. No formal studies or data are cited in support of the claim that the probability that two impressions with 'sufficient features in agreement' derive from different sources is a 'practical impossibility'. Instead, this claim is supported by reference to 'international practices, general awareness of longstanding, as well as current literature and trends in ongoing research' (s. 5.3.1.3).[19] But it is not stated what practices, general awareness, literature or trends are being referred to or how these referents support a 'likelihood' of 'practical impossibility'.

Of course, it might be argued that 'practical impossibility' is understood to be a subjective probability. That is, it is not derived from data, but rather subjectively formed based on the analyst's experience. This is less desirable than forming a probability with 'explicit reference data' (Nordgaard and Rasmusson, 2012), but not alone fatal to the exercise. However, the 2011 Modification never states that analysts should be generating subjective probabilities, never justifies the use of subjective probabilities, and never instructs examiners on how to assign them. Even if 'practical impossibility' is meant to be understood as a subjective probability, it is neither clear how this probability is arrived at, nor how a proper probabilistic reasoning process should lead to such an obscure and seemingly nonsensical value for a probability as 'a practical impossibility'.

[17] This is yet another flaw in the 'vacuous' (Schwartz, 2008, p. 15) Theory of Identification, not explicitly discussed in the thorough critiques of other flaws in that document (e.g. Tobin & Blau, 2013, pp. 126ff.).

[18] This language—'the expectation is that they would not occur in an impression from another source'—appears in the most recent draft of SWGFAST (2013b, s. 10.12.11).

[19] I am assuming that 'longstanding' is intended to refer to 'awareness', rather than to 'literature' although the punctuation of this passage does not make that entirely clear. The addition of a comma would clarify the intended meaning of this passage.

The second reason 'practical impossibility' seems aggressive concerns the historical context of the claim. We have noted that the fingerprint discipline routinely reported (implicitly or explicitly) that the probability that impressions derived from different sources was zero. Since at least 1979, the IAI and SWGFAST and its predecessor TWGFAST advised fingerprint examiners to report that the probability that the impressions derived from different sources was zero. Scholars who criticized this practice were described by at least one those bodies as ill-informed and 'self-serving' (IAI, 2007). SWGFAST (2012b) now concedes that such a claim 'is not supported by research', and, to its credit, has endeavoured to revise that advice. The 2011 Modification seeks to put a name to a subjective probability intuited by an examiner. One might have expected SWGFAST, perhaps somewhat chastened by the century of understating the value of the probability that the impressions derived from different sources, to advise the examiner to err on the side of caution and select a semantic term that, if anything, overstated the value of the probability that the impressions derived from different sources. Instead, SWGFAST chose a semantic term that, to the extent it means anything at all, is scarcely distinguishable from zero.

Indeed, the word 'impossibility' would seem a poor choice for reporting a probability to a lay audience. It would seem to pose a risk that it might be interpreted as meaning actual impossibility. As Biedermann *et al*. (2013) comment:

> a recurrent issue in forensic reporting is the use of definite conclusions referred also to as 'practical certainties' (i.e., probabilities close to 1) that, by means of the so-called 'leap of faith' argument, are suggested to be equal to logical certainties. A major ambiguity in this conceptualisation stems from the fact that it blurs the sharp definitional distinction between practical certainty and logical certainty. This is problematic because the rules of logic loose [*sic*] their validity when equating the former with the latter. In order to clarify this, it suffices to notice that the logical combination of several practically impossible events may become something very probable — which is not the case for logically impossible events. Thus, strictly speaking, claims of practical certainty ought to be properly considered as cases that pertain to the domain of probability (citations and cross-references omitted).

The technical term *epsilon*—'an arbitrarily small positive quantity' (*Merriam-Webster Dictionary*, 2013)—e.g. while still vague as to its precise value and perhaps not empirically or logically justified, would be less exotic and bear less risk of being confused with 'actual' impossibility (Lindley, 2006, p. 91). Indeed, reference to the technical definition of this term might help clarify for fact-finders what it is the expert is trying to express.

Some American courts that have considered the toolmark discipline's use of the phrase 'a practical impossibility' have expressed precisely this worry that consumers of forensic reports will understand a probability of 'practical impossibility' to mean a probability of zero. For example, the Supreme Judicial Court of Massachusetts recognized no distinction between 'practical impossibility' and 'absolute certainty' (*Commonwealth* v. *Heang*, 2011, p. *12). Despite toolmark examiners' insistence that 'practical impossibility' is a conclusion distinct from 'absolute impossibility', a Magistrate Judge of the U.S. District Court of Maryland termed firearm and toolmark examiners' claims of practical impossibility 'astonishing[]' and found 'that there is no meaningful distinction between a firearms examiner saying that "the likelihood of another firearm having fired these cartridges is so remote as to be considered a practical impossibility" and saying that his identification is "an absolute certainty" ' (*United States* v. *Willock*, 2010, pp. 572–573).

Rather than explicitly or implicitly claiming that individualization is achieved when the probability that the impressions derive from different sources reaches zero, which has been described as absurd, the 2011 Modification claims it is achieved when that probability reaches a value of 'practical impossibility'. This seems less like an embrace of probabilistic reasoning than like an effort to find a semantic phrase that is not vulnerable to the criticism of being logically unsupportable but still conveys the same sense of certainty to a lay audience. There is a real danger that this semantic workaround may be perceived by legal audiences to constitute genuine change or a genuine adoption of a probabilistic approach. For example, one U.S. court recently prohibited a latent print examiner from testifying 'that any individual is the source of a particular print "to the exclusion of all others," or that she is "100% certain" about an identification, or any variant thereof', but permitted the examiner to use the language of the 2011 modification (*United States* v. *McCluskey*, 2013). The 2011 Modification seems to be enacting *le mort saisit le vif* yet again, in that the new version of 'individualization' seems scarcely distinguishable, or even indistinguishable, from the old. Indeed, Champod (2008, p. 113) has asserted that courts had already understood fingerprint examiners to be testifying to 'practical impossibility' under the 'old' definitions of individualization.

6.2 *The decision*

Some readers, accustomed to outputs of fingerprint analyses cast as 'facts', 'determinations' or 'conclusions', may be taken aback to see the output of fingerprint analysis described as a 'decision'. On the one hand, since the term 'decision' sounds epistemically less strong than these other terms, the 2011 Modification has the appearance of the adoption of 'greater epistemological humility' that the NRC called for. On the other hand, the term raises questions. What is the theoretical framework that supports SWGFAST's notion of 'decisions' and 'decision-making'? What does SWGFAST mean by a 'decision' and how does it enable an examiner to 'reach a conclusion of individualization'? If a fingerprint report is a 'decision', why should that decision be made by the forensic analyst as opposed to some other party? These questions are not satisfactorily answered by the Modification.

Careful readers will recall that the term 'decision' already appeared in Langenburg's defence of identification$_2$ (see Section 3). The characterization of 'individualization' as a 'decision' seems most likely to have originated from European thinking about fingerprint analysis.[20] For example, the Interpol European Expert Group on Fingerprint Identification (IEEGFI, 2004, pp. 21–29) described a decision 'to identify or not . . . The decision whether the total volume is sufficient for individualization'. This was a reference to what would be known to some examiners as the 'E' stage of the 'ACE-V' process,[21] where the examiner must 'decide' whether the aggregate consistent detail is so rare that the donor pool in the relevant population has been reduced to 1. If yes, the examiner reports 'individualization'; if no, the examiner reports 'inconclusive'. Thus, IEEGFI used the term to mean something like a 'decision threshold'. SWGFAST's recently issued, aptly-titled draft supporting document titled 'Guideline for the Articulation of the Decision-Making Process for the Individualization in Friction Ridge Examination' (SWGFAST, 2012a, s. 9.2.2) suggests a similar understanding of the term when it refers to 'the decision threshold beyond which individualization can be concluded'.

[20] I do not regard Olsen's (1991, p. 46) discussion, which describes a series of 'decisions' that lead to a 'conclusion', as an intellectual source of the reconceptualization of fingerprint conclusions as 'decisions'.

[21] 'ACE-V' is an acronym used by some fingerprint examiners to describe the process of fingerprint analysis. For further detail, see SWGFAST (2010; NIST, 2012).

The criticisms of such a dichotomous framework are well known (see, e.g. Kwan, 1977; Robertson, 1990; Stoney, 1991; Risinger and Saks, 1996; Starrs, 1999; Champod and Evett, 2001; Inman and Rudin, 2001; Thornton and Peterson, 2002; Cole, 2004; Broeders, 2006; Meuwly, 2006; Biedermann *et al*., 2008; Champod, 2008; Mnookin, 2008; Saks and Koehler, 2008; Cole, 2009; Koehler and Saks, 2010; Page *et al*., 2011; Kaye, 2013). This dichotomous approach to reporting the probative value of the evidence compels examiners to report nothing (inconclusive) unless they feel extremely confident, in which case they report something they cannot support (individualization). The system thus undervalues some 'inconclusive' evidence, overvalues all 'individualization' evidence and amounts to 'a transition from a state of an absence of knowledge to a state of certainty' (Champod *et al*., 2004, p. 35).

There is, moreover, the question of whether examiners could really be expected to make rarity estimates at so fine a level of precision. IEEGFI noted that the examiner must 'decide' (without external reference data) whether the frequency of the observed features is 1 in a population of around 60 billion fingers. But what basis do we have for believing that examiners' experience will allow them to distinguish rarities of 1 in 60 billion, from 10 in 60 billion, from 100 in 60 billion and so on (Kaplan, 1968, p. 1067; Zabell, 2005, pp. 155–156; Thompson and Cole, 2007, pp. 50–51)? IEEGFI itself candidly noted the danger that examiners, rather than making these fine rarity estimates would instead decide the 'irrelevant' question of whether or not she 'think[s]' the suspect is the source of the mark (IEEGFI, 2004, pp. 21–29). An examiner who did that, even though their decision might accord with ground truth, would be misleading the fact-finder if they testified to 'individualization', not to mention assuming prior odds, testifying outside the scope of their expertise and usurping the fact finder's role.

6.2.1 *Decision theory.* Interestingly, there is a field, called 'decision theory' that could provide a intellectually coherent basis for conceptualizing fingerprint analysis in terms of decision-making (e.g. Kaplan, 1968; Kaye, 1999). And, Biedermann *et al.* (2008) have painstakingly articulated a framework that would apply decision theory precisely to 'the problem of individualization in forensic science'. SWGFAST's draft 'Guideline for the Articulation of the Decision-Making Process' (*s.* 10.3.2), a document whose title suggests it may shed light on how SWGFAST conceptualizes the notion of 'decision', does cite the Biedermann *et al.* paper in support of the notion of 'decision-making in forensic identification'. This would seem to suggest that the 2011 Modification meant to invoke decision theory as a defensible foundation for a reformulated reporting framework for fingerprint analysis.

However, because of SWGFAST's admirably transparent practice of posting its guidelines in draft for public comment and responding (privately) to those comments, we can determine that, in fact, SWGFAST does not claim to rest the notion of 'decision' posited in the 2011 Modification on decision theory. In response to a comment submitted by the author, SWGFAST clarified, first that the draft 'Guideline for the Articulation of the Decision-Making Process' is 'not' intended to be a supporting document for the 2011 Modification, and second, that its use of the word 'decision' in the Guideline is not meant to refer to decision theory. It is worth quoting SWGFAST's response in full:

> We do not intend the word 'decision' as used in this document to refer in a formal way to 'decision theory'. This document is a guideline for articulating the decisions, as made by a competent expert, leading to individualization conclusions and is not intended to justify the underlying basis on which those decisions are made. This underlying basis is the subject of other SWGFAST documents. The supporting references are provided as

> material of which competent examiners should be aware. They are meant to be representative, not all-inclusive, and are not provided as authorities to justify the articulation (SWGFAST, 2013a).

This response demonstrates not only that SWGFAST is not relying on decision theory, but also that is not offering any clear justification for its notion of decision-making. SWGFAST's claimed 'underlying basis' remains unarticulated, with its vague reference to 'other SWGFAST documents'.

I must confess to some surprise that SWGFAST is not using decision theory, given its citation of the Biedermann *et al.* paper and the institutional overlap between the authors of that paper and several members of SWGFAST.[22] But, in any case, even if it were intended as such, the 2011 Modification could not be considered an application of decision theory. The most important way in which the 2011 Modification is inconsistent with decision theory is that what Biedermann *et al.* (2008, p. 131) call the 'utility function' is nowhere to be found anywhere in the 2011 Modification or its supporting document. According to Biedermann *et al.*, the decision-maker should posit possible decisions that could be made from a probabilistic assessment of fingerprint evidence (e.g. reporting 'the prints are from the same source', reporting 'the prints are from different sources' or reporting 'I can't tell whether the prints are from the same or different source') and then consider the 'consequences, preferences and utilities' (123). In a criminal law context, these 'consequences' and 'utilities' may be thought of, e.g. as the costs of erroneous individualization, the costs of false exclusion, the benefits of correct individualization, and the benefits of correct exclusion. Decision theory posits that the decision-maker must consider not merely the probability she adopts for each hypothesis, but also the benefits and costs she assigns to the states of being right and wrong: the 'decision process involves not only a probability of the respective state of nature but also a consideration of the desirability of the outcome' (122). This reasoning process is nowhere to be found in the 2011 Modification. Instead, the 2011 Modification purports to justify the reaching of individualization conclusions by fingerprint examiners without considering the utility function and reporting about the decision-maker's preferences–without as Biedermann *et al.* (2008, p. 128) put it, fulfilling 'their responsibility to explicate their probabilistic beliefs along with their preferential matrix [a reference to the utility function]'. Since the utility function is an essential component of decision theory, its omission alone renders the 2011 Modification incomplete as an adoption of the decision theory. Interested parties, jurists especially, tempted to conclude that individualizations are now firmly grounded in decision theory should be aware of the discrepancies between the 2011 Modification and decision theory.

6.2.2 *Whose dsecision?.* Another question that immediately arises if 'individualization' is conceptualized as a 'decision' is: why should the forensic analyst make the decision, as opposed to some other actor in the criminal justice system? Decision theory does not specify who the decision-maker should be. Biedermann *et al.*, *e.g.* describe 'some not further specified individual—referred here to as the decision maker' (121). They 'intentionally . . . avoided' specifying the identity of the decision-maker because it 'is irrelevant for the argument's logical underpinnings' (128). They make clear, however, that the decision-maker 'need not necessarily be the scientist' (122). Because their decision

[22] The Biedermann *et al.* paper was written by three scholars, two of whom are associated with the forensic science program at the University of Lausanne. As noted in Section 3 of this article, the term 'decision' was used in 2008 to describe fingerprint conclusions by three expert witnesses, two of whom (Langenburg and Neumann) were students in this program. Those same two individuals, plus one more (Champod), were members of SWGFAST around the time the 2011 Modification must have been written.

theoretic approach to individualization is a two-step process, the scientist could perform the probabilistic assessment, report its results to some other party (such as the fact-finder), and that other party could engage in the decision process, which, recall, requires weighing the decision-maker's 'consequences, preferences and utilities' (123). But at the end of the paper Biedermann *et al.* acknowledge that 'Whose Decision?'—which actor in the legal system should serve as the decision-maker—is an important question (128).

The 2011 Modification arrogates the role of decision-maker to the fingerprint examiner. As noted above, it is possible, within the decision theory, to assign the role of decision-maker to the scientist. But what makes the 2011 Modification inconsistent with decision theory is that it does not inform the consumer of the forensic report that it has assigned the role of decision-maker to fingerprint examiners, even though other assignments (such as to the fact-finder) were possible, and explain why it has done so. It makes no mention of the fact that it taking a difficult legal and ethical issue and resolving it. The 2011 Modification represents an incomplete adoption of decision theory, not because of the answer it gives, but because it neither justifies its answer nor makes it explicit. Instead, the 2011 Modification obscures that fact that a policy choice to assign the role of decision-maker to fingerprint examiners has been assumed.

It may further be argued that, while not a technical violation of decision theory, the answer the 2011 Modification gives is the wrong answer. Most forensic scholars seem to agree that fact-finders, rather than experts, should make what Biedermann *et al.* call 'decisions'. In a classic discussion, Cook *et al*. (1998, p. 235) noted that, with regard to what Biedermann *et al.* call the 'probabilistic assessment' of the evidence, the expert is 'well placed to address this question'. However, for what Biedermann *et al.* call the 'decision', 'The scientist cannot be of direct help' (Cook *et al*., 1998, p. 237).[23] Robertson and Vignaux similarly argued (1995, p. 196) that expert witnesses 'should provide evidence as near as possible to "raw data" '. Biedermann *et al.* themselves, despite professing agnosticism on the issue, seem to lean toward the fact-finder as decision-maker. Delegating the decision to the expert, they note, would mean using the *expert's* personal values, rather than the fact-finder's, to weigh the relative benefits and costs of the available decisions (129). Indeed, one of the authors of the Biedermann *et al.* (2008) paper has elsewhere stated that 'the query about "identification" must be regarded as one for the judge(s) or Court and not for the expert' (Taroni and Margot, 2000; see also Champod *et al*., 2003).[24]

Because the expert has no special competence greater than that of any other person at the decision stage of the process—as opposed to at the probabilistic assessment stage—the choice of decision-maker is essentially a policy choice, rather than a scientific mandate. There may be an efficiency argument for assigning the decision to fingerprint examiners: the entire process could be completed at 'one stop', and there would be no need for the examiner to communicate the results of the probabilistic analysis to the decision-maker, with all the potential for misunderstanding that would entail. On the other hand, delegating the decision to fingerprint examiners would seem to raise a number of issues. It would seem to violate the principle that expert witnesses should always avoid testifying (or reporting) about matters that are outside their special competence as experts. This would seem

[23] To be sure, this discussion was not as explicit as Biedermann *et al.* in making clear that the 'decision' is essentially a moral or utilitarian calculation of the relative desirability and undesirability of more or less probable outcomes.

[24] The argument that fact-finders, rather than experts, should make final inferences of this sort has also been advanced in the literature on 'individuation'—as opposed to 'individualization'—in civil law. 'Individuation' is an extension of 'social framework' testimony, which reports social science information about issues like, e.g. gender discrimination. 'Individuation' is the extension of social framework evidence to the individual case. It has been argued that such 'individuations' should be reserved for fact-finders, rather than experts (Monahan *et al*., 2009).

problematic not merely as a matter of law and professional ethics, but also because if scientists testify outside their areas of competence, they risk allowing fact-finders to construe them as having rendered a professionally informed judgement, rather than a personal one.

Importantly, the 'Whose Decision?' question is one for which there is no need for the legal community to sit on the sidelines and 'wait for the science'. Legal expertise is quite relevant to this question (*e.g.* Kaye, 2003b). The choice of decision-maker is an area that courts could confidently resolve as a matter of law. Once the nature of the utility function is understood, it would seem eminently possible for courts to decide that such decisions should be assigned to fact finders rather than to the same scientists who also generated the probability assessment. This might be defended not only on the conventional grounds of preventing usurpation of the role of the fact-finder, but also on the perhaps simpler and more appealing grounds of prohibiting expert witnesses from testifying outside the bounds of their expertise.

6.3 *Summary*

While the 2011 Modification bears the superficial appearance of a dramatic revision of fingerprint testimony and the adoption of a probabilistic and perhaps even a decision theoretic approach to fingerprint evidence, closer examination shows that the 'fixing' of individualization remains incomplete. Individualization is still not dead, but has been granted yet another a new lease on life.

7. Conclusion

The foregoing analysis of efforts to reform the forensic concept of 'individualization' in one important discipline, fingerprint analysis, supports several conclusions. First, semantic difficulties have recurred throughout the reform efforts detailed here. The longstanding confusion between and 'identification' and 'individualization' and the definitional vagueness surrounding both terms has hampered efforts to reform these terms. Second, we can clearly see a recurring pattern of semantic reforms which conceptually change nothing or change very little. I have referred to these by the phrase *le mort saisit le vif.* Third, we see the recurring influence of the toolmark discipline on the latent print discipline. The latent print discipline appears to have consistently looked to the toolmark discipline in framing its reporting conclusions. As a historian of the discipline of fingerprint identification, I must confess that this finding was unexpected. I had not appreciated the degree of influence the toolmark discipline appears to exert on the fingerprint discipline. Fourth, we see a consistent pattern of trying to devise defensible justifications for a desired reporting conclusion ('individualization'), rather than an effort to promulgate a reporting conclusion that flows logically from a justification. It is difficult to avoid concluding that the common cause of the all of the semantic and conceptual difficulties outlined above is the backward process of starting with a historically embedded reporting term ('individualization') and making serial efforts to devise a defensible justification for that term. Would it not make more sense to try to devise a logical and defensible process for reasoning about forensic evidence and then allow that process to dictate the reporting framework? All the reform efforts discussed above continue the practice that has historically been associated with the concept of 'individualization' of reasoning from the desired conclusion to the epistemic basis for that conclusion, rather than the other way round (Cole, 2009). The above case study strongly suggests that forensic identification will have difficulty moving forward until 'individualization' is really dead.

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Conflict of interest

The author served as a consultant and/or expert witness in some of the cases discussed in this article, including *State* v. *Hull, State* v. *Dixon, State* v. *Doe, State* v. *Pope, United States* v. *Faison, United States* v. *McCluskey* and *United States* v. *Zajac.*

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