Forensic science is not an oxymoron, it is a discipline in itself

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“The aim is not to condemn somebody because his measurements correspond to those of another person. We provide only items of information. We provide just a name useful for the examination. It is up to the inquiry to ascertain the exactness, using criminal records, testimonies, etc. It is easy to see that if the information, obtained from anthropometric considerations, is corroborated a posteriori by other evidence, it will become an absolute certainty for the court.”

“The physical certainty provided by scientific evidence rests upon evidential values of different orders. These are measurable and can be expressed numerically. Hence the expert knows and argues that he knows the truth, but only within the limits of the risks of error inherent to the technique.

This numbering of adverse probabilities should be explicitly stated by the expert. The expert is not the judge: he should not be influenced by facts of a moral sort. His duty is to ignore the trial.”

“...with regard to forensic science, the duties of the judge are clear: the judge must be able to understand forensic technology and to evaluate results and their respective strengths; otherwise his personal conviction would be made relying blindly on the expert.

It is the judge’s duty to evaluate whether or not a single negative presumption, against a sextillion of probabilities, can prevent him from acting.”

I believe that if we want to do any progress in forensic science, we shall:

① Abandon unsupportable claims of individualization.

② Redefine the logical underpinning of our reporting schemes.

③ When possible, provide opinions that can be supported by empirical and disclosable data.
What do you mean by “certain”? It means that, on Earth, nobody else but the suspect can be the source of the mark.

“Earth population paradigm”
Let’s consider *a priori* 10 billion individuals.

Recall, this the Earth population paradigm.

What strength of evidence do we need to obtain a reasonable degree of scientific certainty?

Mr DOE is one among 10 billion.

Mr DOE has left the mark to a reasonable degree of scientific certainty.
Hence we talk about a likelihood ratio of the order of $10^{15}$ or more.

By analogy... the expert claims he can distinguish every millimeter from the Sun to Pluton...
We shall move away from the Earth population paradigm.

And completely abandon the concept of individualisation.

There is no need to be certain to be useful.
The likelihood ratio associated with the features at hand exceeds $10^9$

...and this provides extremely strong support for the view that the mark has been left by the same finger as the print as opposed to an unknown finger.


If we can get the logic right - then this helps us to maintain balance.
The single most important advance in forensic science thinking is the realization that the scientist should address the **probability of the evidence**.

The ratio (called the likelihood ratio - LR) of these two determines the way that the scales of justice are tilted by the scientific evidence.
### Reporting Scheme

> It should be based on sound logical principles.

<table>
<thead>
<tr>
<th>$LR$</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$&gt; 10^6$</td>
<td>Extremely strong evidence to support $H_p$</td>
</tr>
<tr>
<td>$10^5$ to $10^6$</td>
<td>Very strong evidence to support $H_p$</td>
</tr>
<tr>
<td>$10^3$ to $10^5$</td>
<td>Strong evidence to support $H_p$</td>
</tr>
<tr>
<td>$10^2$ to $10^3$</td>
<td>Moderate evidence to support $H_p$</td>
</tr>
<tr>
<td>$1$ to $10^2$</td>
<td>Limited evidence to support $H_p$</td>
</tr>
<tr>
<td>$1$</td>
<td>Inconclusive, the findings does not help to progress towards $H_p$ or $H$</td>
</tr>
</tbody>
</table>

Unfortunately, the reporting scales currently proposed by document examiners, footwear mark examiners, firearms/toolmarks examiners do not stand scientific scrutiny.
Support opinions with relevant data

Was Q (left) fired by the same gun (SIG 9mm parabellum) as K (right)?
Measurements with Nanofocus μscan
Primer Cup Cutting

Automatic segmentation of the primer cup by exploiting normal vectors
ICP - Iterative Closest Point

Firing Pin Mark Alignment
ICP - Iterative Closest Point

Firing Pin Mark Alignment
③ Informed opinion with data

Comparisons between Q and 50 cartridges cases fired by this gun

Comparisons between Q and 80 cartridges cases fired by different guns (SIG 9mm)

Distributions of two similarity measures

LR > 10⁹
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2. Redefine the logical underpinning of our reporting schemes.
3. When possible, provide opinions that can be supported by empirical and disclosable data.