1. Executive summary

1.1 The UCL CFS is an interdisciplinary research centre that seeks to undertake research that brings together the sciences, social sciences and humanities, and forensic science stakeholders across the domains of policing, law and policy. In this response, we highlight the importance of ensuring:

a. Funding for both technological and foundational research that underpins every stage of the forensic science process (crime scene, laboratory, evaluative interpretation, investigation and court).

b. Development of an environment that offers long and short timescales for innovation, which allows for truly interdisciplinary, collaborative, casework-informed, implementable and impactful research.

c. Development of the forensic science knowledge base addressing evidence and its interpretation.

d. Creation of an environment for forensic science research in the UK that can actively contribute to the delivery of justice in a transparent and robust manner.

2. Q2. What are the current strengths and weaknesses of forensic science in support of justice?

2.1 The key strengths of forensic science in support of justice lie within our technological capabilities to detect, identify and analyse traces from a crime scene, such as, DNA, fingerprints, explosives, drugs, pollen etc. We can detect traces that are invisible to the eye, for example, latent bloodstains and fingerprints. We are able to classify trace materials to high levels of accuracy and precision, and establish what type of residue has been recovered from an exhibit or a suspect. We are also able to analyse smaller and smaller levels of trace, for example analysing DNA from just a few cells. These capabilities mean that we recover high quality evidence that can provide investigative leads, identify possible suspects and/or serve as evidence for court. Furthermore, technological advances continue, with respect to both analytical sensitivity, for example with the progress of next generation sequencing tools for forensic DNA analysis, and computational capability, for example with the application of probabilistic genotyping to complex DNA mixture interpretation, which enable even more information to be obtained from smaller amounts of material.

2.2 However, as the Government Chief Scientific Advisor said in his report on forensic science in 2015: "New capabilities create other challenges for our existing systems; in particular, our ability to analyse may outstrip our ability to interpret. Because we can identify very small traces of a substance, we need greater certainty in understanding their significance and better ways to communicate different levels of confidence." This appropriately summarises one of the key weaknesses of forensic science: our limited

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ability to interpret what it means to find a particular trace within the context of the case. For example, the finding of DNA evidence at a crime scene does not necessarily mean that that DNA came from the offender. Similarly, finding gunshot residue on a suspect does not necessarily mean that they have fired a gun recently. The location, quality, and amount of a trace, along with the range of scenarios that may explain its presence, need to be considered in the expert evaluation of that evidence.

2.3 It is a common misconception that when a type of forensic analysis is sufficiently validated for use in forensic casework, then it is ready for use in the courtroom. This is not the case. Further work is required to assess whether we have the ability to interpret the meaning of the results from the forensic analysis within the context of the range of cases within which it may be used. In order to inform such interpretation, and improve our ability to do so, research must be conducted to provide the empirical evidence base required. There is growing recognition in the forensic science community that such interpretative evaluation of evidence is a separate form of expertise than that required to identify the source of evidence.

2.4 This weakness of forensic science in lacking underpinning research is not limited to evidence interpretation (which incorporates human decision making at the crime scene, in the laboratory, and in the presentation of evidence). Foundational research is also required to underpin:
   a) procedures employed at the crime scene, particularly as many procedures are not informed by empirical experimentation and are not standardised across police forces,
   b) future innovation and developments.

2.5 A further weakness of the current use of forensic science is an over-reliance on DNA evidence. With our ability to interpret the meaning of the finding of DNA still relatively in its infancy, this over-reliance is to the detriment of forensic science and of expertise in other types of forensic evidence. For example, fibres were critical evidence in a number of high profile cases, such as Stephen Lawrence, Sarah Payne, and the Suffolk murders case that eventually led to the conviction of Steve Wright. However, in 2015 the main provider of fibre analysis closed due to the focus on DNA over and above other forms of trace, and the number of fibre analysis experts has sharply declined in the UK, arguably leaving the UK without the expertise to harness the capability of fibres as evidence.

3. Q12a. How should further research funding for forensic science be justified?

3.1 Forensic science requires investment and funding. There is no coherent funding for the discipline at the moment. There are small pockets of funding available for bringing technological tools to market, but apart from the occasional general calls (such as the Leverhulme Research Centres that awarded one award to forensic science), there are no dedicated funding streams for forensic science in the broadest sense, and there has not been

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any dedicated funding for foundational forensic science research. Funding for forensic science is justified given the important role science can have within the justice system. It is of paramount importance that forensic science practice and interpretation is evidence-based, transparent and robust. The value of forensic science needs to be defined broadly (beyond the simple financial (return on investment) metrics, or crime detection rates). This is because forensic science is an incredibly complex ecosystem, with multiple actors, institutions, knowledge types, drivers, and timescales that are critical to effective and robust forensic science.

3.2 Funding for the foundational and technological aspects of forensic science, which has short, medium and long term outputs, is needed to ensure that the justice system is equipped appropriately to handle science evidence, and for it to remain a strong foundation of our democratic society.

4. Q12b. What should be the focus of such research?

4.1 In summary, the focus of research in forensic science should address foundational research and technological advancements. It is important that research addresses:
   a) The evidence itself (physical, digital and virtual),
   b) Human actors (decision making, bias, knowledge creation and retention, institutional infrastructures and how they impact knowledge creation and communication), contextual factors (economics, politics, culture).

4.2 Please see the response to Q13 for a fuller dealing with each of these topics.

5. Q12c. What is the role of UK Research and Innovation, especially considering the interdisciplinary nature of much forensic science?

5.1 Forensic science can be considered an ‘orphan’ discipline, in part due to its interdisciplinary and applied nature, and currently that discipline is not within the remit of any of the UK research councils. Forensic science research is therefore commonly conducted under the guise of other research that does fall within the remit. For example, such research might include the development of new chemical/physical/biological techniques that can be applied to forensic science, in addition to those applications for which the funding was obtained. This does not allow the opportunity of funding research to address those issues that are specific to forensic science, such as those listed in Q2. Consequently, “funding” for forensic science research in academia is often sought elsewhere, for example through intelligent budgeting of student tuition fees, or even through Crowd Funding initiatives. In their Second Report of Session 2013–14, the House of Commons Science and Technology Committee reported that: "In 2011 we called for the Home Office and Research Councils to develop a new national research budget for forensic science. The Government agreed with the Silverman Review’s slightly different recommendation that "consideration should be given to the establishment of forensic science as a strategic research priority for the Research Councils". However, neither have happened and the research community did not appear to be optimistic.

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5 https://crowd.science/campaigns/UCL-forensic-science/
about the situation improving.” Four years on and still neither has happened. The House of Commons Science and Technology Committee recommended that “The Government and Research Councils should support forensic science as a strategic priority or give a comprehensive explanation as to why they haven’t.” We would still welcome and support this now.

5.2 It has been proposed that research should be funded and conducted by the private forensic science providers. However, it is unrealistic to expect such private companies to conduct research, where commercial returns are limited. Within companies, there is often a drive to meet turnover targets rather than revenue, and they have to offer short-term return on investment to shareholders. In a briefing for the House of Commons Science and Technology Committee in December 2014, the National Audit Office reported that, “Longer term, private sector suppliers told us that declining profits could make it difficult to invest sufficiently in research and development.” This is particularly notable, given that one of the major forensic science providers in England and Wales, Key Forensic Services (KFS), went into administration in January 2018; KFS only resumed trading in March 2018 when it was acquired by CorpAcq. Furthermore, when research is conducted by private companies, it tends to focus on the development of new products or demonstration of the capabilities of those products, rather than on the other kinds of forensic science research required, such as that to inform evidence interpretation. In addition, if there is commercial value to the research being conducted, i.e. the development of a new product, this dis-incentivises the publication of research to the wider scientific community.

5.3 So how might we move forward from this? UKRI is currently defining its remit and we would argue for a consideration of how forensic science can fit within UKRI’s scope and objectives. This is particularly crucial given the inherent interdisciplinarity of forensic science, which needs the active engagement of traditional science, social science and humanities to address the knowledge gaps, and the creation of pathways to meaningful and valuable impact. A forensic science remit must therefore take into account the breadth of research that needs to be conducted that does not come under the traditional definition of ‘science’ (for example, those topics lists under Q2), such that the focus of research should be on foundational research that addresses the whole forensic science process, as well as novel technological applications and developments.

5.4 Although there are a few opportunities for short-term, tender-based, funding to develop technology to be deployed within 12 months to the crime scene, consideration of mid- and long-term views on funding is also important. To build a sustainable and thriving forensic science field for the decades to come, we need a funding landscape that enables innovation, and this requires longer timeframes and more ambitious projects than are currently possible. Funding that offers mid- to long-term projects, which can develop foundational research that leads to innovations and deployable

7 https://www.keyforensic.co.uk/news/corpacq-acquire-kfs
solutions in the future (e.g. 10-20 years’ time), are critical for the future of forensic science.

6. Q13a. Where are the gaps in research and understanding of forensic science?

6.1 There are significant gaps in forensic science that have been highlighted in the last nine years since the National Academy of Science report was released\(^8\). The need for a ‘research culture’ has been described that underpins the discipline and practice of forensic science\(^9\), that emphasises the importance of establishing an evidence base for understanding what forensic science evidence means\(^{10,11}\), and is required in forensic reconstruction practices\(^{12}\). There is also a gap in terms of how to handle digital evidence in a way that ‘future proofs’ the evidence (for example, ensuring the appropriate collection, preservation, and integrity of this form of evidence), and how ‘big data’ that relates to biometric information and other personal data can and should be handled, preserved and utilised.

6.2 More specifically, as mentioned in Q2, a key weakness of our current forensic science provision is the lack of foundational research to underpin key parts of the forensic science process:

6.2.1 Interpretation of forensic science evidence that includes:
   a) evidence dynamics of the full range of trace evidence,
   b) decision-making within the laboratory with respect to which analysis to do and in what order,
   c) decision-making at each stage of the forensic science process and how that impacts forensic reconstructions and intelligence,
   d) the communication of forensic science evidence in the justice system,

6.2.2 Procedures employed at the crime scene with respect to both traditional and digital evidence,

6.2.3 Future innovation and technological developments for current and future types of forensic science evidence.

Interpretation

6.3 The need to develop evidence bases that address evidence dynamics and the evaluative interpretation of evidence is well articulated in the literature, and whilst there has been a growing body of work in the published

\(^{10}\) R.M. Morgan, Conceptualising forensic science and forensic reconstruction; Part I: a conceptual model. Sci. Justice 57(6), (2017) 455-459
literature, the development of these evidence bases has been significantly hampered by the lack of dedicated funding (see Q12).

6.4 There is a need to continue to develop the understanding of ‘evidence dynamics’ with empirical studies that can offer appropriate insights for the collection, analysis and interpretation of forensic science evidence.

6.5 It is important to address our understanding of decision making at every stage of the forensic process (crime scene to court), and the degree to which extrinsic and intrinsic factors can impact the interpretation of the evidence. Some studies have been undertaken to address the impact of context on the interpretation of DNA, fingerprints, blood pattern analysis, forensic odontology, forensic anthropology, handwriting analysis, ballistics, shoeprint analysis, and forensic entomology. Indeed ‘bias’ has become something of a buzz word within forensic science. There is a current gap to address the issues that have been identified and to test frameworks and approaches to increase the transparency of where unconscious bias at each step of the forensic process can occur (and to what degree), and to develop ways of communicating the risk and uncertainty that the presence of bias can introduce at both the individual level and in terms of organisational infrastructure.

6.6 A further gap that needs to be addressed is how to develop a better understanding of risk and uncertainty and how that is communicated to the justice system and lay persons. The scale of this issue is becoming clearer with recent publications demonstrating for the first time the extent of misinterpreted evidence in the Court of Appeal, 22% of upheld cases between 2010 and 2016 could be shown to have misinterpreted evidence at

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the original trial. Another new study\textsuperscript{25} illustrates the issue in DNA interpretation with 108 laboratories across the USA interpreting a series of mixed DNA profiles. For one of the complex mixtures in that study, 78 laboratories (69\%) incorrectly included a donor who was not present in the mixed profile. Seven laboratories correctly excluded this donor (6\%), but the reasons for the correct exclusion varied.

6.7 It is also crucial to address the extrinsic factors that frame forensic reconstruction approaches. Understanding the organisational infrastructures of the different organisations that intersect forensic science (science, the law, policing, policy and government), and engaging with the different forms of knowledge production is critical to underpin developments in forensic science evidence interpretation\textsuperscript{4}.

Procedures at Crime Scene

6.8 In addition to the aforementioned decision making that occurs at the crime scene with respect to deciding how to search the scene and what items to collect as evidence, research is also required to underpin the more practical processes that are employed at the scene, i.e. collection and packaging of exhibits. Many of these procedures are not informed by empirical experimentation and are not standardised across police forces, with methods simply being passed down within each police force, based on the experiences of crime scene investigators. An empirically-informed approach to crime scene procedures is required to ensure that evidence is preserved in the best manner possible and its integrity is maintained.

7. Q13b. How and by whom should the research questions be articulated to fill these gaps?

7.1 Whilst the Forensic Science Strategy, published by the Home Office in March 2016, came under a fair amount of criticism, it did make an important point regarding the value of collaboration between academic researchers and forensic science end-users (i.e. police forces and forensic science providers) in order to progress publishable research that has operational benefits\textsuperscript{26}. It is through these kinds of collaborative partnerships, in addition to collaboration across the various topics that comprise the forensic science discipline, that the appropriate research questions can be articulated, and such collaborative research should be supported at the national level by UKRI to ensure independence and open access. The vision behind FIT-INetwork\textsuperscript{27} is aligned to this, but funding is currently a significant issue for the scope and capability of the network. A collaborative approach is the only way forward to ensure the right kinds of research are being conducted with appropriate research questions, methods and outputs, which can directly feed into forensic science practice.


\textsuperscript{27}http://blogs.staffs.ac.uk/research4justice/fit-in/
8. Q14 How can a culture of innovation in forensic science be developed and sustained?

8.1 A culture of innovation in forensic science requires a diverse community with representation from all the main domains that intersect forensic science (science, law, investigation and policy). Strong networks need to be fostered and enabled and a co-creation of valuable and timely research questions that address both robust science and implementation (impact). Innovation requires space for risk taking, refinement and development and so funding for this research and innovation needs to include both longer term blue skies research in addition to shorter term, developments with clear pathways to impact.

8.2 Truly interdisciplinary research is difficult to create, enable and sustain. It relies on strong relationships, trust and a sustainable environment. Funding is critical, but funding sources need to be flexible to accommodate the (often) applied nature of forensic science research, the bridging of the science, social science and humanities, and the theoretical and practical impacts. Funding also needs to be at sufficient levels and over sufficient timeframes to allow for the development of strong and strategic research partnerships within the community that support both the delivery of research and its implementation.

8.3 For innovation in forensic science to grow and be sustainable, there needs to be support for developing communication in forensic science between the different actors, institutions, and philosophies that contribute to the forensic science landscape. Developing language that transcends these traditional domain boundaries and effectively addresses risk and uncertainty will be critical for a sustainable community that is delivering the research that is needed to underpin forensic science innovation, developments and applications. Supporting the communication within the forensic science community will minimise unnecessary repetition of research\(^2\), whilst also ensuring that gaps are identified and can be addressed.

8.4 New Zealand has a National Institute of Forensic Science that has the strategic intent to promote and facilitate excellence in forensic science through, among other services, promoting, sponsoring and supporting research in forensic science in areas of identified strategic importance, and supporting, co-ordinating and conducting training programs in forensic science for practitioners\(^2\). This Institute has no counterpart in any other country.

9. Q15a: Are there current or anticipated skills gap?

9.1 In our opinion, there are currently three key skill gaps within the forensic science process; one that relates to police forces, one that relates to experts who present forensic evidence to court, and one that relates to research skills.

9.2 Streamlined Forensic Reporting (SFR) was introduced in 2012; this consists of reporting forensic evidence in two stages. The first stage is the

preparation of a report (SFR1) that summarises the results of the forensic examinations and/or laboratory analyses, and where relevant, the outcomes of a comparison of those results. On reviewing SFR1, if there are elements of the results that the defence seeks to challenge, particularly whether there could be various interpretations of the results within the context of the case, a stage two report (SFR2) is prepared to address this evaluative interpretation. Although it is explicit in the Crown Prosecution Service guidance that SFR1 is not for court admission, the Forensic Science Regulator reports that scientists are regularly being summoned to give evidence on the basis of an SFR1. Furthermore, on some occasions when a scientist has been summoned in this way, the forensic science provider has requested approval from the police to prepare an SFR2, but that request was refused. Both these occurrences contravene the Criminal Procedure Rules, and so clearly education of police forces that employ the SFR process is required to ensure that the right kind of forensic science report is being submitted to court.

9.3 As mentioned in Q2, the interpretative evaluation of evidence within the context of a case is becoming recognised as a separate form of expertise than that required to identify the source of evidence. Research that addresses this area is critically needed to develop appropriate frameworks for evidence interpretation that goes beyond appropriate use of statistics and probabilities. Forensic scientists who are conducting such interpretation of forensic science evidence require dedicated research-informed training to provide such opinion to the court, for example, within the area of DNA transfer. With such training, this would help ensure transparency and reproducibility in the way forensic science evidence is interpreted and presented across each forensic science domain, which has the potential to reduce the number of challenges made to such evidence in court, thereby saving both time and money, and reducing the risk of miscarriages of justice through the misinterpretation of forensic evidence.

9.4 As mentioned in Q12-14, the future of forensic science depends on ensuring that the discipline retains and attracts strategic, critical thinking researchers who can address the current and future gaps in the discipline. Our opinion is that critical thinking and research skills are increasingly not being taught and developed in undergraduate and masters level programmes and it is important that this is addressed to ensure a research community that can innovate and contribute to the strategic development of forensic science into the future.

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31 Inns of Court College of Advocacy 2017 Statistics and Probability for Advocates: Understanding the use of statistics and probability in court and tribunals. Available at: https://www.icca.ac.uk/expert-evidence