Research and Development in Forensic Science: a Review

Bernard Silverman

Chief Scientific Adviser

Home Office

This review was conducted by Bernard Silverman, Home Office Chief Scientific Adviser, supported by Andrew Rennison, Forensic Science Regulator, and Iain Williams, Head of Home Office Science Secretariat.

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Executive Summary and list of recommendations

There are several factors, in addition to the managed closure of a major provider, which make it timely to carry out this review. These include the distributed nature of forensic science provision, the rapid pace of scientific and technological advances in various areas, and the changing nature of public sector research funding and accountability.

There is a very wide range of research and development relevant to forensic science, carried out by forensic science providers, universities, and laboratories associated with Government. It includes blue-sky research, strategic research informed by applications, translational research and development, and the improvement and advancement of methodology already deployed in practice.

The forensic science providers who responded to the consultation all have active research and development programmes related to their own fields of activity, typically commensurate with their size. A large number of universities reported relevant research, which when mapped against conventional subject boundaries shows a startling degree of cross-disciplinarity. Government-related laboratories are actively involved, particularly in setting standards, and in work relevant to defence and security. Overall the research landscape that has developed is varied and in some ways fragmented, and improvement in the degree of linkage and communication would drive forward innovation most effectively.

The research of the Forensic Science Service (FSS) has made a significant contribution to the development and practice of forensic science. In common with other providers, the FSS has an active multi-disciplinary research programme. In order to remain successful and competitive beyond the short term, any provider taking on the current work of the FSS will need to embrace wholeheartedly the requirement within the Framework Agreement for Forensic Providers to carry out appropriate research and development.

For new forensic techniques to be fully effective, especially in court, there is a need for better communication and presentation of their scientific and technical basis. This is a fruitful area where researchers and providers can increase the influence of their research and development work to the benefit of the criminal justice system.

Representative organisations and learned and professional societies, such as the Forensic Science Society and the Association of Forensic Science Providers, together with a number of other specialist societies and societies with more general scientific interests, have a crucial role in providing a forum for the communication, development and validation of ideas, to act as advocates and representatives of the field, and generally to be a focus for the relevant research and development communities.

There is a widely held perception that the funding of academic research relevant to forensic science is disadvantaged by its cross-disciplinary nature. One of the components of the forthcoming Research Excellence Framework assessment will be impact beyond academia, and this is an opportunity for forensic science research to

demonstrate its importance, provided steps are taken to ensure that the impact of this work will be judged fairly. In addition, the interdisciplinary nature and societal importance of forensic science, as well as the opportunities that would be created by better communication, make it an appropriate candidate for particular attention by the Research Councils and the Technology Strategy Board.

Key recommendations

- Forensic science researchers, providers and users should all pay particular attention to appropriate communication within the research landscape, especially in view of the multifaceted nature of research and development in forensic science.

- The Forensic Transition Board should pay specific attention to Section 7.1 of the Framework Agreement for Forensic Science Providers setting out the requirement for providers to carry out appropriate research and development.

- The Forensic Science Regulator, bearing in mind the requirements of the courts, should consult to establish a suitable format for published authoritative reviews of the scientific basis of forensic methods, and to encourage appropriate journals to establish independent robust peer-review processes for their publication.

- The Forensic Science Regulator should act as a facilitator to bring together a consortium of appropriate representative bodies and other parties to organise a regular single cross-disciplinary forensic science conference.

- Representative organisations and their membership communities should work to mobilise voluntary effort (including in leadership roles) to enhance the impact and range of their activities, for example to strengthen linkages and build information resources within the field of forensic science.

- The higher education funding councils' Research Excellence Framework team should remind panel and sub-panel chairs, across the range of relevant disciplines, of the need to appoint assessors able to judge the impact of research on forensic science practice. It should revisit the list of nominating bodies for assessors to include forensic providers other than the Forensic Science Service, either individually or through an appropriate representative body.

- Consideration should be given to the establishment of forensic science as a strategic research priority for the Research Councils. In the first instance, the Home Office should facilitate contacts between Research Councils UK and academics, industry and end users to explore this possibility in detail.

- The Technology Strategy Board should consider whether forensic science could be facilitated through a Knowledge Transfer Network or similar mechanism.

1. Introduction

1.1. Forensic science is the application of the full range of science to questions of interest to a legal system, usually in relation to either criminal or civil action. It is vital for the smooth running of the criminal justice system, for fighting crime and combating terrorism. Research underpins the practice of forensic science to support its development, increase its value to the criminal justice system and improve the efficiency with which forensic evidence is gathered by law enforcement agencies, processed by forensic science providers, and presented to the courts.

1.2. This review was commissioned against the background of the managed closure of the Forensic Science Service. That decision was made on financial and legal grounds, and it is only one of a number of factors which make a review timely. For example, there has been an increase in the number of forensic science providers supplying police forces and the courts over the last two decades; new and emerging scientific developments and disciplines have become integral to forensic science; public sector research budgets are under pressure and need to demonstrate their value; and there is an increasing call for academic research to demonstrate its wider impact.

1.3. This review must therefore be seen in this wider context and its findings will be relevant to researchers, policy makers, forensic science providers and the users of forensic science, independently of any discussion regarding the Forensic Science Service.

1.4. The Terms of Reference of this review are at Annex A. Forensic science is an extremely broad subject, encompassing a wide range of scientific disciplines. This review has deliberately taken a broad view of forensic science to understand the scope of research relevant to the field, as well as its location, motivation, funding, and contribution to law enforcement and the criminal justice system.

2. The current landscape of research and development

2.1. Research and development in forensic science ranges from basic research, some of a speculative nature and some more closely driven by specific requirements, to translational research and development where methodology is put into practice, to the refinement and improvement of existing techniques in the light of experience.

2.2. The nature of forensic science, and the variety of interests involved, have led to a very complex landscape of research and development. It is important for the future health of the area, and for the undoubted energy towards innovation to be properly realised, for there to be the best possible linkages between and within the different parts of the research arena. The review found many examples of excellent co-operative initiatives of various kinds, but also scope for improvement in what can on occasion be a fragmented picture.

Forensic Science Providers

2.3. A number of providers submitted evidence to the review. All have active research and development programmes which are strongly applications- and customer-led. The scale of research and development programmes is typically commensurate with the size of the company. The companies stress the need for research and development to maintain and enhance their position and reputation, and it is clearly a key part of every forensic provider's business. While much of the research is focussed on specific problems and issues, there is little suggestion of a narrow view which only considers matters of immediate concern.

2.4. The submissions give some indication of the scope of the research and development work carried out by providers. It includes work on many aspects of DNA, drugs, fingerprints, mobile telephones and computer devices, scenario evaluation and crime scene analysis, body fluids, and a wide variety of other areas.

2.5. There is considerable evidence of fruitful and mutually beneficial relationships between forensic providers and universities. In addition to joint research projects and research contracts, these include sponsorship and joint support of PhD students; placements for students at all levels; and company staff lecturing on university courses. Both formal (e.g. through memoranda of understanding or knowledge transfer agreements) and informal relationships (built through personal contacts and movement of staff between sectors) are seen to be important.

2.6. One response states that collaborations with academic forensic science groups are fewer than those with leading academic groups in wider scientific fields, and others give examples of relationships with groups other than specific forensic science departments. Links with forensic science departments are clearly only part of the picture.

2.7. On the other hand, some responses (especially those with an e-forensics emphasis) perceive the concerns of academics as being too long term and blue-sky, report bureaucratic obstacles to joint working, and do not find it easy to identify relevant areas of academic research. Other responses, while taking a positive view of links with academia, see potential for improvement, particularly if co-operative approaches can be made to sources of early stage funding. Another issue identified is the difficulty of development funding to bridge the gap between basic science and practical application.

Universities

2.8. The review received nearly fifty responses from universities reporting research in forensic science or in areas applicable to forensic science. Some university-based research is of a blue-sky nature while some is more closely driven by specific requirements and collaborations. Inevitably not all relevant academic research will have been reported, but the responses are useful as an initial version of a catalogue of UK research in this area and also as the

Table 1: Examples of forensic science research falling within various Research Excellence Framework Units of Assessment

REF Unit of Assessment		Indicative examples
1	Clinical Medicine	Toxicology. Physical indications of child abuse
3	Allied Health Professions, Dentistry, Nursing and Pharmacy	Forensic odontology, e.g. bite mark analysis, age assessment. Drugs.
4	Psychology, Psychiatry and Neuroscience	Behaviour and trajectories of offenders in various contexts. Indications of child abuse. Cognitive bias. Reliability of witnesses.
5	Biological Sciences	Many aspects of DNA and genetics; mycology; entomology
6	Agriculture, Veterinary and Food Science	Wildlife forensic science; adulteration of food
7	Earth Systems and Environmental Sciences	Soil analysis
8	Chemistry	Wide range of analytical and detection issues
9	Physics	Microscopy
10	Mathematical Sciences	Statistical approaches to combination and analysis of forensic evidence; cryptography
11	Computer Science and Informatics	Image analysis in many contexts; cyber forensics
12	Aeronautical, Mechanical, Chemical and Manufacturing Engineering	Analysis of vehicle collisions. Microfluidic "lab on a chip". Assessment and development of testing and analytical equipment.
13	Electrical and Electronic Engineering, Metallurgy and Materials	Ballistics and explosives. Textiles. Surface science (e.g. for fingerprints).
14	Civil and Construction Engineering	Analysis of effects of explosions on buildings and infrastructure.
17	Geography, Environmental Studies and Archaeology	Excavation techniques. Osteoarchaeology. Clandestine graves.
20	Law	Evaluation of jury perception of scientific evidence.
24	Anthropology and Development Studies	Isotope analysis for human provenance.
28	Modern Languages	Text analysis of documents and social media.
32	Philosophy	Ethical aspects of forensic technologies. Epistemological nature of forensic evidence.
36	Communication, Cultural and Media Studies, Library and Information Management	Influence of media on practice of investigators, lawyers and juries.

foundation of a directory of researchers who could form the core of a coherent forensic science research community. In these respects it would complement the NPIA's projected catalogue of research relevant to policing.

2.9. There is a wide range of research areas, including not only the obvious disciplines of biological sciences (DNA) and computer science (e-forensics) but others such as entomology, archaeology and linguistics. The multi-disciplinary nature of the research reported to the review is demonstrated, for example, by mapping it against the Units of Assessment defined for the Research Excellence Framework (REF)[1]; see Table 1. In constructing this table, the examples given for each area are indicative and no attempt has been made to catalogue the submissions exhaustively, but it demonstrates that over half the Units of Assessment contain research of relevance to forensic science.

Research laboratories associated with Government

2.10. Research relevant to forensic science is undertaken by a number of government, and government-linked, laboratories, including the Defence Science and Technology Laboratory (DSTL), the Home Office Centre for Applied Science and Technology (CAST)[2], the National Physical Laboratory (NPL) and forensic laboratories of the Devolved Administrations. Government research has a particular emphasis on work that would not be possible, or likely, to be undertaken in a commercial or academic environment. Examples are the definition of standards, and work with defence or security relevance.

2.11. With guidance from practitioner groups, especially within the police, CAST works both on conventional forensics (fingerprints and footwear) and on areas such as video evidence analysis and illicit drug detection and identification. For example, the *Manual of Fingerprint Development Techniques*, first produced in 1986 and regularly updated, has been adopted by all UK police forces and many overseas law enforcement agencies.

2.12. The work of NPL (which operates partly as a commercial organisation) includes research relevant to fingerprints, hair, drugs, glass and paint, tool marks, firearms, crime scene mapping, counterfeits and forgeries, and so on, utilising broad methodologies such as chemical and physical analytical techniques, dimensional techniques, and image analysis.

2.13. The Forensic Service of Northern Ireland also undertakes research relating to a wide variety of issues including DNA technologies, Raman spectroscopy, fingerprints, computer forensics, and drugs.

[1] The Research Excellence Framework is an assessment of all UK university research, to be carried out by the higher education funding councils in 2014. Each university department's work will be assessed by a national panel in one of 36 broad academic areas, called Units of Assessment (UoAs).
[2] formerly known as the Home Office Scientific Development Branch (HOSDB)

Police

2.14. The police's active interest in research and development is demonstrated by a significant number of submissions from universities citing collaborations with police forces, covering a wide range of forensic science. The Association of Chief Police Officers (ACPO), supported by the National Policing Improvement Agency (NPIA), has developed a strategy setting out the policing requirements for research and have a model in place to guide research and innovation. This approach is to be commended, alongside the current development of a record of research relevant to policing. However, they recognise the potential for further capability built on better links and communication, and the more coordinated use of existing funding and resources. One possible avenue for future communication would be the direct exposure of more university researchers to the practicalities of casework, perhaps through a short-term shadowing scheme.

International networks

2.15. Crime is both a local and a global phenomenon, with the science used to tackle crime equally global in its nature. A prime example of this is the global use of forensic DNA methods built on the original UK research. No single country has the overall lead on forensic science research and all can benefit from international collaboration. The International Forensic Strategic Alliance (IFSA) is a partnership between regional networks (USA, Europe, Australia and New Zealand, and the Asian network) with a focus more on the exchange of knowledge rather than research collaboration; the UK link is through the European Network of Forensic Science Institutes.

The nature of research and development in forensic science

2.16. Forensic science's user community is mainly law enforcement agencies and the criminal justice system. Their needs, particularly the need for forensic evidence to stand up in court, are somewhat different in kind from those of most applied science and engineering, leading to distinctive validation and dissemination requirements. These should be seen as an intrinsic part of research and development.

2.17. The validation of techniques employed in forensic science is an essential part of the process of developing and introducing new or improved methodology. In the context of forensic casework, the Forensic Science Regulator has outlined both the process and the documentation requirements within his Codes of Practice and Conduct. Within these requirements is the need for a clear understanding and articulation of both the potential and the limitations of any particular method.

2.18. Another key aspect is dissemination. Because of the need for results to be understood and accepted by judges and juries, clear presentation and explanation of methods, in an appropriate way, is particularly important. This issue is discussed in more detail in Section 4 below, but the improvement of

methods for disseminating understanding of novel forensic methods is an integral part of their development.

The need for improved linkage and communication

2.19. In addition to a number of specific issues explored in subsequent sections, the main conclusion is the need for improved linkage and communication between the various contributors to, and users of, forensic science research. This would help foster an environment where opportunities, innovations and requirements were more clearly communicated, and obstacles, or perceived obstacles, such as those reported in paragraph 2.7, surmounted.

2.20. It is not appropriate or even possible to take a top-down approach to this essential communication aspect of research and development; rather it is incumbent upon all involved to be particularly aware of this need and to build on the formal and informal networks that already exist. It is therefore recommended that **forensic science researchers, providers and users should all pay particular attention to appropriate communication within the research landscape, especially in view of the multifaceted nature of research and development in forensic science.** Sections 4 to 6 of this report address some specific topics which could contribute positively to the overall research and development environment in forensic science.

3. The Forensic Science Service (FSS)

3.1. Given the position of the Forensic Science Service as a major forensic science provider, it was considered appropriate to investigate the impact of its managed closure on the research and development landscape.

3.2. Research undertaken by the FSS has had a significant influence on the development and practice of forensic science. Some of the FSS's research has been ground-breaking and has had global impact.

3.3. The FSS maintains an active research programme, which benefits from the combined scientific expertise of its staff and its experience in forensic casework and the courts. It has a substantial multi-disciplinary group of research scientists (approximately 60 staff). Because of their co-location, these scientists have had the benefit of being able to collaborate easily with each other and with forensic caseworkers. Concerns have been expressed that the dissolution of this research group could have a deleterious impact on the UK's forensic science research capacity.

3.4. However, the FSS is now only one of a number of forensic providers and, as noted above, the other providers also have active research programmes, with natural links between research and casework. This is in addition to the large body of research in academia and government laboratories. Since the FSS became a Government owned company in 2005, the government has not directly funded its research, but the FSS has funded research in the same way

as other providers, either from internal resources or by competitively winning external funds.

3.5. Any provider taking on the current work of the FSS will need research and development to support their function. Research and development is an integral part of the work of any successful provider, and this is further recognised by the current Framework Agreement for Forensic Science Providers. This contains a section (7.1) giving a requirement to carry out research and development[3] and should prevent providers from taking an inappropriate short-term view of the value of research and development.

3.6. To guarantee the longer-term scientific viability of the work of potential providers, it is therefore recommended that **the Forensic Transition Board[4] should pay specific attention to Section 7.1 of the Framework Agreement for Forensic Science Providers setting out the requirement for providers to carry out appropriate research and development.**

3.7. The issue of fragmentation of forensic science research is broader than the future of the Forensic Science Service research group. It is clearly desirable that in future versions of the Framework Agreement the NPIA (or its successor) should encourage research and development to take place in a context of collaboration and communication. Recommendations made elsewhere in this report address the issues of coordination and multi-disciplinarity, and of links with forensic science practice.

4. The Criminal Justice System

4.1. A key issue is the way that forensic science evidence is presented and used in criminal cases. There is often a communication gap (and even a philosophical difference) between scientists and forensic science providers who develop forensic methods, and judges and juries who deal with evidence based on such methods.

4.2. In principle the scientific aspects of forensic evidence should be uncontroversial but, in practice, court time and effort can be spent disputing what are essentially scientific issues. Furthermore, this can be a barrier to the acceptance, and hence development in the first place, of novel forensic methods. Any steps that could be taken to streamline the treatment of these issues would be desirable.

[3] Some relevant clauses from the agreement are "The Contractor shall undertake Research and Development and keep abreast of any advances within the spheres of forensic analysis in which it operates…. the Contractor shall consider the use of any future advances from any source of research and development that may improve the efficiency of the Services. Future advances shall result in the advancement of evidence gathering techniques and the simplification of test procedures… It is acknowledged that advances in technology may improve the Services" and so on.

[4] The Home Office's Forensic Transition Board is overseeing the orderly wind down of the FSS and transition of work. The Board includes FSS Company Directors, ACPO, senior Home Office and CPS representatives and the Forensic Science Regulator. It has agreed a joint governance process to manage risks and issues associated with the transition and balance financial, strategic and operational decisions.

4.3. The Forensic Science Regulator has the task of establishing an appropriate regime of quality standards for forensic science services across the criminal justice system. However, in addition to assuring the quality of forensic science, increasing the understanding of the techniques used would improve the use of forensic evidence being brought into court.

4.4. The area of patent law has developed a system where the parties to cases agree a technical "primer" which sets out areas of scientific agreement. A typical primer sets out the science in reasonable "text book" style, including a glossary of terms, and is agreed through out-of-court discussion between the parties, so that the court can concentrate on the key relevant issues. The primer may be supplemented by scientific background notes written by a scientific expert, to serve the purpose of "educating the judges". However, the context of typical criminal law cases makes it difficult to see how the "primer" idea could be translated directly to forensic science.

4.5. Nevertheless, an analogous approach would be the preparation and publication of high quality accessible reviews of the current scientific position of relevant forensic methods. Such reviews could be commissioned, for example by the Forensic Science Regulator, or written by experts on their own initiative. Their value and potential impact would be considerably enhanced if they were subject to rigorous peer review and published in an appropriate journal. Reviews of this kind would serve the purpose of informing judges and counsel, and also the police, about the techniques in question. While it could not be guaranteed that they would be agreed between parties in every case, they would nevertheless have the potential to be so agreed, or at least to provide a starting point for any discussion or challenge.

4.6. It is recommended that **the Forensic Science Regulator, bearing in mind the requirements of the courts, should consult to establish a suitable format for published authoritative reviews of the scientific basis of forensic methods, and to encourage appropriate journals to establish independent robust peer-review processes for their publication.**

5. Representative organisations and learned and professional societies

5.1. In all scientific disciplines and areas of application, learned and professional societies and cognate bodies have a crucial role in providing an independent forum for the communication, development and validation of ideas. These activities take place in various ways, for example through publications and conferences, but also within the informal networks that organisations naturally facilitate. In addition, these societies and bodies play an important advocacy role for their relevant communities and professions, for example acting as a first point of contact for funding agencies.

5.2. Specifically within the forensic science field, important organisations, with complementary roles, are the Forensic Science Society, the Association of Forensic Science Providers, and the Fingerprint Society. In addition, there is interest and activity in various aspects of forensics in organisations such as the British Computer Society, the Institution of Engineering and Technology (IET), the Royal Statistical Society and the Royal Society of Chemistry, among others.

5.3. The Forensic Science Society hosts regular conferences and has launched an Education and Industry Forum currently open to its accredited universities, as well as to forensic providers and representatives of users of forensic science. The Forensic Science Society also publishes the journal *Science and Justice* which publishes original articles, reviews and correspondence on subjects relevant to forensic science and the criminal justice sector. The journal "provides a medium whereby all aspects of applying science to legal proceedings can be debated and progressed", and would therefore be an obvious venue for carefully refereed reviews setting out, in clearly accessible terms, the latest scientific understanding underpinning forensic science methods, as discussed in paragraph 4.5. Many other papers relevant to forensic science appear, for example, in *Fingerprint Whorld* (a journal published by the Fingerprint Society), in the various series of the *Journal of the Royal Statistical Society,* and in other scientific journals.

5.4. There are many 'customers' for forensic science research (e.g. the police, criminal justice system, forensic service providers), each, rightly, with their own priorities. The Forensic Science Society's submission to the review sets out in detail the need for greater collaboration between researchers, providers and users in forensic science, as well as the need to reach out internationally. There were other calls for increased communication and co-ordination between the various players across the forensic field and in particular the criminal justice system, and between the police and academia and other researchers.

5.5. Whilst there are many subject / sector specific conferences taking place nationally and internationally at a variety of levels, there is a role for a larger cross-forensic science conference to be held regularly, perhaps annually. As part of such an event, the various 'customers' of forensic science research (e.g. the police, the courts, forensic science providers) could set out their research requirements[5] and another function of such a conference would be as a venue where providers could easily access innovative proposals from academia. Rather than dictating the single strategy envisaged by some submissions to the review, a conference of this kind would allow appropriate customer-driven themes to emerge and be more clearly articulated.

5.6. The organiser of such an event, and publisher of any subsequent report or proceedings, would need to have the confidence of the forensic science providers, criminal justice system, police and researchers. The best way for

[5] In this context, a natural role for the NPIA, or its successors, would be to act as a co-ordinator for the articulation of police requirements.

this to be assured is for it to be organised by a consortium of representative bodies, to ensure both that independence is maintained and that the various interests are all included, but a consortium of this kind would require some facilitation. It is therefore recommended that **the Forensic Science Regulator should act as a facilitator to bring together a consortium of appropriate representative bodies and other parties to organise a regular single cross-disciplinary forensic science conference.**

5.7. Strong representative bodies are essential for the health and success of research and development. In general, large amounts of the work of learned and professional societies are carried out by the voluntary effort of members of their relevant community, facilitated by a central professional staff. It is also typical for relevant commercial companies to sponsor activities. The review found strong evidence of good intentions among representative organisations to play a leading role, but also evidence that the membership organisations could benefit further from additional volunteer commitment from individuals in the field, including in leadership roles. Because of the potential benefits both to themselves and to forensic science more generally, it is not simply altruistic to devote time and energy in this way. It is therefore recommended that **representative organisations and their membership communities should work to mobilise voluntary effort (including in leadership roles) to enhance the impact and range of their activities, for example to strengthen linkages and build information resources within the field of forensic science.**

6. Funding of academic research relevant to forensic science

6.1. A recurring theme among the submissions from academic institutions is the difficulty, or perceived difficulty, of obtaining funding for research relevant to forensic science. Within the dual support system, there are two forms for funding for research in universities: funding council block grant ("QR") informed by the Research Assessment Exercise (RAE) and its forthcoming successor the Research Excellence Framework (REF), and grants for individual research projects through the Research Councils.

The Research Excellence Framework (REF)

6.2. The importance of the REF in driving and motivating the research of individual academics and groups, and in setting the agendas of universities, cannot be overestimated. The REF is important both because of the actual funds allocated and because of the signals it sends, which have an influence on the behaviour and priorities both of individual academics and of university administrations.

6.3. Several submissions to the review comment adversely on the lack of a REF panel in forensic science. Apart from the fact that the structure of the 2014 REF has already been determined, the setting up of a specific forensic science REF Unit of Assessment does not seem viable or even desirable, for two reasons. Firstly, by its nature, forensic science involves the application of research in areas right across the disciplinary spectrum. Secondly, although

forensic science is an important area of work, it does not have sufficient volume of activity to merit a Unit of Assessment of its own.

6.4. However, a key element of the 2014 REF is that 20% of the assessment of each university department will be based on the social, economic or cultural impact or benefit, beyond academia, of its research[6]. Forensic science is an obvious area where the REF should be effective in encouraging research of genuine societal and/or economic impact. It is therefore important that forensic science research, especially its impact, is seen to be assessed to the same standards as other areas that appear to fit more closely to standard academic disciplinary boundaries. This would provide a strong incentive for good applied and translational research in areas relevant to forensic science.

6.5. In 2013 the funding councils will be appointing assessors "to contribute in particular to the assessment of those elements of submissions relating to the impact of research." The list of nominating bodies[7] for specialist assessors includes a wide range of organisations associated with forensic science, including representative bodies, policing organisations and government departments and agencies. The Forensic Science Service is included but, at present, other providers are not represented.

6.6. In order to ensure forensic science research will indeed be appropriately assessed, it is recommended that **the higher education funding councils' Research Excellence Framework team should remind panel and sub-panel chairs across the range of relevant disciplines[8] of the need to appoint assessors able to judge the impact of research on forensic science practice. It should revisit the list of nominating bodies for assessors to include forensic providers other than the Forensic Science Service, either individually or through an appropriate representative body.** The appointment of assessors will need to keep in mind that impact may not only be through commercial exploitation, but also through application in police work or use in court proceedings.

The Research Councils and Technology Strategy Board

6.7. Research Council funding is crucial to all applied research. Just as forensic science research takes place within many of the REF Units of Assessment, it also crosses the boundaries between Research Councils. Several submissions demonstrate a perception that the interdisciplinary nature of forensic science research results in proposals falling between the remits of different Research Councils, making it particularly difficult to secure funding.

6.8. Nevertheless, the Research Councils UK (RCUK) submission reports a number of projects and areas in forensic science which receive Research Council support. These include work relevant to forensic science supported

[6] see http://www.hefce.ac.uk/research/ref/impact/
[7] http://www.hefce.ac.uk/research/ref/panels/nom_bods.pdf
[8] Table 1 gives an indication of the relevant Units of Assessment.

by each of AHRC, BBSRC, EPSRC and ESRC, and also indirect support from MRC[9], as well as specific reference to the RCUK Global Uncertainties Programme. It is also noted that RCUK has specific mechanisms to handle cross-Council research proposals[10].

6.9. The difficulty of gaining funding from Research Councils is ubiquitous across academic disciplines, with demand for research funding far exceeding the funds available. It is impossible, within the present review, to discern whether the treatment by the Research Councils of forensic science research is uniquely disadvantageous, or whether it merely mirrors the generally challenging funding climate. However, the perception that Research Councils do not give sufficient support to forensic science is repeated sufficiently often in submissions that the concern about funding merits consideration.

6.10. The Research Councils (acting individually, bi/tri-laterally, or in concert through RCUK) periodically develop strategic priorities for funding. There is not a unique definition of how strategic priority status works for research proposals, or indeed how a priority is selected. Most strategic priorities are interdisciplinary and meet a societal need. It is not simply a matter of a Research Council decision to classify a subject as a strategic priority. Typically, there would be consultation with academic researchers, industry and end users, with a demonstration that there is both academic potential and end user "pull" within a given area.

6.11. Forensic science is not currently a strategic priority for the Research Councils, but given the above conditions and criteria, it would appear to be a highly suitable candidate for strategic priority status of some kind. In addition to its obvious interdisciplinarity and societal importance, there is significant intellectual energy in the area, from both the UK forensics industry and academia, and clear public interest in having the best possible scientific underpinning for the forensic work of the police, the criminal justice system, and other users.

6.12. It is recommended that **consideration should be given to the establishment of forensic science as a strategic research priority for the Research Councils. In the first instance, the Home Office should facilitate contacts between Research Councils UK and academics, industry and end users to explore this possibility in detail.**

6.13. The Technology Strategy Board is closely associated with the Research Councils and has the specific task of accelerating economic growth by stimulating and supporting business-led innovation. The Technology Strategy Board has various mechanisms to strengthen collaboration and coordination in the field of forensic science research and development, for example through a Knowledge Transfer Network (KTN). A KTN is hosted on a powerful networking platform where people can network, share

[9] AHRC – Arts and Humanities Research Council; BBSRC – Biotechnological and Biological Sciences Research Council; EPSRC – Engineering and Physical Sciences Research Council; ESRC – Economics and Social Research Council; MRC – Medical Research Council.
[10] http://www.rcuk.ac.uk/research/Pages/FundingAgreement.aspx

information and knowledge and work together securely. The aim is to bring together individuals and organisations from businesses, universities, research, finance and technology to stimulate innovation and to drive the flow of knowledge within and between these communities. The opportunities and challenges facing forensic science make it an obvious area where networking of this kind would be of benefit. It is therefore recommended that **the Technology Strategy Board should consider whether forensic science could be facilitated through a Knowledge Transfer Network or similar mechanism.**

7. Concluding remarks

7.1. Forensic science is a vibrant area for research and innovation within the UK and internationally. UK research and development have had notable successes in the past and these have stimulated the growth of interest and activity in the area. Inevitably the research which has grown up is in some ways fragmented. With better coordination and linkages, paying attention not only to making new developments but also to their validation and communication, the energy and commitment in the area has the potential to drive innovation more effectively. Building a more integrated research and development landscape cannot be achieved by top-down direction, but is a co-operative enterprise involving the commitment of all relevant parties, and this report has identified a number of initiatives which should contribute to this aim.

7.2. It is important to thank those who have contributed to the review, those who provided written evidence of the forensic science research they undertake and their links with practitioners and others, and those who have taken time to discuss the review and their work with the review team. These contributions have been extremely valuable to this review, and in publishing these responses alongside this review, it is hoped that they will be equally helpful to others with an interest in forensic science research. Annex B gives details of those who have contributed orally. Those who contributed written evidence to the review are listed in Annex C and contributions are at Annex D. This will be of particular interest to those interested in further details of the research and development being carried out by forensic providers, universities and research establishments.

Annex A: Terms of reference

Review of Research and Development in Forensic Science

Terms of Reference
The aim of this review is to provide Ministers with advice on the current and likely future status of forensic science research and development in the UK and to make other recommendations as appropriate.

The review will encompass the following:
1. The scale, scope and impact of the research and development carried out by forensic science providers and related organisations (in the public and private sector).
2. The extent, and the ways in which, forensic science practice assesses the relevance of, and accesses, the latest advances in technologies and techniques.
3. The scale and scope of forensic science research undertaken in academia and its links with the forensic science practice.
4. The current and potential contribution of international research networks to UK forensic science research and practice.

Scope
1. The scope will include, but not be limited to, fingerprints, DNA profiling, digital forensics (e-forensics) and more specialist aspects of forensic science. Forensic pathology and forensic medicine will be excluded from the scope of the current review.

2. This review will concentrate on research and development relevant to forensic services for the Criminal Justice System within England and Wales. However, with respect to understanding the breadth of the research and development itself, the scope will include the UK.

3. Aspects such as commercial considerations, the size of the forensic market and the provision of forensic science services will be outside the scope of this review, as will the assessment of individual technologies or techniques.

Annex B: Oral discussants

Dr Simon Bramble
Head of Police Science and Forensics
National Policing Improvement Agency (NPIA)

Professor Brian Collins
Chief Scientific Adviser
Department for Business, Innovation and Skills

Dr Derek Craston and Dr Steve Allen
The Government Chemist and Managing Director
LGC Science & Technology (LGC Forensics)

Rebecca Endean
Director of Research and Analysis
Ministry of Justice

ACC Mark Gilmore
West Yorkshire Police
(ACPO)

Lord Justice Hughes
Royal Courts of Justice

The Hon Mr Justice Kitchin
Royal Courts of Justice

Gregory S. Klees
Bureau of Alcohol, Tobacco, Firearms and Explosives
Department of Justice, US

Professor Nicholas Mackintosh FRS
Department of Experimental Psychology
University of Cambridge

Shaun Mallinson
New Business Manager
Police Science and Forensics Unit
National Policing Improvement Agency (NPIA)

Dr Julie Maxton
Executive Director
Royal Society

Graeme Rosenberg
Higher Education Funding Council for England (HEFCE)

Karen Squibb-Williams
Strategic Policy Adviser
Crown Prosecution Service

Lord Justice Thomas
Royal Courts of Justice

Dr Gillian Tully
Head of Research and Development
Forensic Science Service

Dr John Wand
Head of RCUK Global Uncertainties programme
Deputy Director of Research, Economic and Social Research Council (ESRC)

Dr Mark Weiss
Behavioral and Cognitive Sciences
National Science Foundation, US

Annex C: Written submissions received

Universities:

Anglia Ruskin University
Aston University
Barts and The London School of Medicine and Dentistry
University of Bedfordshire
Birkbeck College
University of Bristol
Brunel University
The Institute of Public Health, University of Cambridge
University of Canberra
Canterbury Christ Church University
Cardiff University
Cranfield University
De Montfort University
University of East Anglia
School of Life, Sport and Social Science, Edinburgh Napier University
University of Glamorgan
University of Glasgow
Glyndwr University
School of Applied Sciences, University of Huddersfield
University of Hull
Keele University
King's College, London
King's College Hospital Dental Age Assessment Team - 2011
Lancaster University
University of Lincoln
Loughborough University
Manchester Metropolitan University
Middlesex University
Northumbria University Centre for Forensic Science
Open University
Department of Statistics, University of Oxford
University of Portsmouth
University of Reading
Psychology Department, Roehampton University
Sheffield Hallam University
Southampton University
Staffordshire University
Teeside University
University of Strathclyde Centre for Forensic Science
University of Sunderland
UCL Jill Dando Institute Centre for the Forensic Sciences
Ulster University
Centre for Information, Operations [CIO], University of Wales, Newport
Aberystwyth University
Edge Hill University

Oxford Brookes University
Royal College of Art

Individuals:

Dr. Colin Aitken (RSS)
David Balding (UCL)
Dr. Itiel Dror, University College London
Peter Gill (University of Strathclyde)
Dr Karl Harrison (Cranfield University)
Dr Kevin Sullivan (Chief Scientist's Group, FSS)
Prof Wesley Vernon (Forensic Podiatry)

Other:

ACPO
Advisory Council on the Misuse of Drugs
Analytical Services International Ltd
Association of Forensic Service Providers' Body Fluid Forum
CCL Forensics
Cellmark Forensic Services
Crown Prosecution Service
DSTL
Faculty of Forensic and Legal Medicine
Forensic Access Ltd.
Forensic Isotope Ratio Mass Spectrometry (FIRMS) Network
Forensic Science Northern Ireland
Forensic Science Service1
Forensic Science Service 2
Forensic Science Society
Forensic Telecommunication Services Ltd
Forensic Working Group for the Partnership against Wildlife Crime
Freelance Scientists (but aligned to universities)
Home Office Scientific Development Branch (HOSDB)*[11]
Intellect (trade association for the IT, telecoms and electronics industries)
LGC Forensics
LTG Executive Committee
The Macaulay Institute, Aberdeen
National DNA Database Ethics Group
National Physical Laboratory
National Policing Improvement Agency
Natural History Museum
Prospect
RAND
RCUK
Royal Statistical Society
Wellcome Trust
West Midlands Toxicology Laboratory

[11] In April 2011, HOSDB was re-named the Centre for Applied Science and Technology (CAST)

Annex D: Evidence submitted

Available at www.homeoffice.gov.uk/agencies-public-bodies/fsr/

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